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Review

An Assessment of Economic Sustainability and Efficiency in Small-Scale Broiler Farms in Limpopo Province: A Review

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Abstract: An important factor in determining the success of a small-scale broiler farm is its economic viability and efficiency. During times of trouble for the industry, the idea receives more attention. The conceptual considerations of economic sustainability and efficiency are frequently quite constrained, according to the difficulties raised in this study and by other authors. There is a lack of information about South Africa's small-scale broiler production's economic viability and effectiveness. Furthermore, it is clear that small-scale broiler producers have the ability to increase their economic efficiency. By reducing the mortality rate, feed conversion rate, and production duration, both their technical and financial efficiency could be improved. Profitability in the production of broilers will be considerably increased by lowering the cost of these variable inputs, particularly feed and day-old chicks. Additionally, raising the education level, capacity utilization ratio, and broiler production would all contribute to raising the farms' efficiency levels. To ensure effective resource use and to maximize practicable profit, small-scale broiler producers who are not operating close to the profit frontier must make efforts to reduce both technical and allocation inefficiencies. Collectively, all these measures would ensure the economic sustainability of small-scale farmers in South Africa would be met. Moreover, the sustainability of small-scale broiler producers can be achieved if strategies that build local capacity and that empower them to sustain high levels of productivity are provided. In addition, the efficient use of resources will ensure that productivity is enhanced, and might increase profitability. It is therefore important to ensure that small-scale broiler producers achieve maximum profit for a given set of inputs. Approaches in assessing the farm-level profitability such as cost-benefit and gross margin analyses can be used.

Keywords: broiler production; resources-use; economic analysis

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1. Introduction

The largest producer of commercial broilers on the African continent is South Africa, which is followed by Algeria, Egypt, Morocco, and Nigeria [1]. The South African broiler industry consists mostly of subsistence, small-scale, and commercial producers. A small number of large commercial producers account for largest part of national production, which dominates the broiler value chain [2]. The commercial production system can be divided into three categories based on the size of their operations: commercial scale (>50,000 birds), medium scale (20,001–50,000 birds), and small scale (20,000 birds) [3,4]. The majority of commercially produced broiler meat is sold through abattoirs. Hence, small-scale producers thrive on the live broiler meat market [5]. Broiler production provides a significant source of revenue generation [6]. Furthermore, it plays an important role in reducing malnutrition, by providing the cheapest source of protein and promoting the nation's agricultural sector [7]. This is because broiler meat is the greatest white meat (other than rabbit, pork, and other poultry) consumed globally that has limited cultural and religious barriers, and is fairly low in fat and cheap compared to other meat products [8].

Poultry rearing offers a quick return on investment, especially for low-income small-scale farmers. However, despite all the advantages that broiler production promises, small-scale broiler producers need to be sustainable and profitable. The sustainability and profitability of small-scale broiler producers are under threat due to rising feed costs, import of cheaper broiler meat, rising electricity tariffs, and access to finances and markets [1]. Agricultural sustainability can be considered as the set goal of providing sufficient food (food security) maintenance, economic viability, or enhancement of social welfare. Therefore, farm sustainability is achieved when all its operations are well managed in the most economical way, such that every transaction carried out generates a net benefit [9]. Several measures are available, covering the social, ecological/environmental, and economic dimensions for providing an overall assessment of farm sustainability [10]. However, the mentioned considerations put emphasis on economic sustainability at the farm level of small-scale broiler producers. According to Al-Sharafat et al. [11], sustainability is largely related to the economic efficiency of broiler farm activities. The economic sustainability of small-scale broiler producers is strictly associated with the economic viability and risk of business failure [12].

An economically sustainable small-scale broiler farm must meet the producer's individual economic needs of farm families and farmworkers. In a nutshell, a sustainable small-scale broiler farm manages all activities economically. Non-economically viable small-scale broiler farms may be economically sustainable as the result of the off-farm revenue of the family members [13]. Unsustainable farm operations are associated with a significant increase in costs compared to returns [9]. To maintain or improve sustainability, small-scale broiler producers must ethically and profitably produce broilers of high quality according to customers' preferences [14,15]. Again, sustainability will be achieved when the producers can enhance their self-reliance, are profitable and efficient, and their long-term levels of production are guaranteed [11]. Moreover, the productivity and profitability of small-scale broiler producers is affected by several technical factors, including poor biosecurity, insufficient sources of technical information from government extension services, and providers of inputs, as well as various inputs, such as availability of quality chicks, supply of quality feed, vaccine, and medicine [16,17].

There are not enough comparable data from the South African setting to evaluate the sustainability and economic viability of small-scale broiler producers. Therefore, this paper provides a comprehensive evaluation of the literature from the past and present on the economic viability and effectiveness of small-scale broiler farmers. It accomplishes this by helping to establish a framework to understand small-scale broiler farms' economic viability in greater depth, while accepting the limitations of the data that are currently available. Additionally, methods for determining the profitability of individual farms, such as cost-benefit and gross margin studies, are described.

2. Methods

An analysis of the literature served as the basis for this investigation. A variety of internet information sources were used to gather scientific publications relevant to the review's study environment. We referenced scholarly works such theses, conference proceedings, full-text, peer-reviewed journal articles, and book chapters. To understand more about the performance and current state of the poultry sector, publications in the gray literature were also researched (production, feed manufacturing, market and job creation, etc.). In this study, the first step in the search scope was to review the article title, abstract, and keywords. After the titles and abstracts were reviewed, 182 data in total met the requirements for inclusion. This article's layout was created to help readers better understand the research patterns in the South African small-scale broiler farmers' economic sustainability.

3. Overview of the South African Broiler Industry

In South Africa, a significant portion of the livestock market is the poultry industry. With a gross value of ZAR 59.94 billion (about USD 3.37 billion) in 2020 [18]. The industry represents more than 18% of the agricultural gross domestic product (GDP), making it the largest agricultural sector. The poultry industry comprises the production of broilers, egg layers, and indigenous chicken breeds. From a sensory perspective, broiler meat appears superior to other meat types, as it is perceived to be tender, palatable, and easily digestible [19]. As a result, in the South African poultry sector, roughly 74% of the birds are used to produce meat, and the remaining 26% are employed in the egg industry [18]. The South African chicken business takes pleasure in the fact that it feeds the nation because more people consume poultry products annually than all other kinds of animal protein put together [18]. Broiler meat, aside from milk, is still the least expensive form of animal protein on a ZAR per kilogram basis between 2006 and 2020, as shown in Figure 1 [18]. A 5.1% increase over 2019 levels was seen in the gross value of primary agricultural production from poultry meat in 2020, which was ZAR 49.37 billion (or USD 2.78 billion) [18]. The industry is dependent on exotic varieties from several nations, specifically from the United States of America's Cobb, Hubbard, and Arbor Acres, the Netherlands' Hybro, and the United Kingdom's Ross [19,20]. The key advantage of the poultry industry is that broiler rearing is not as capital intensive, and the birds can be efficiently produced within a short period compared to other animals [21].

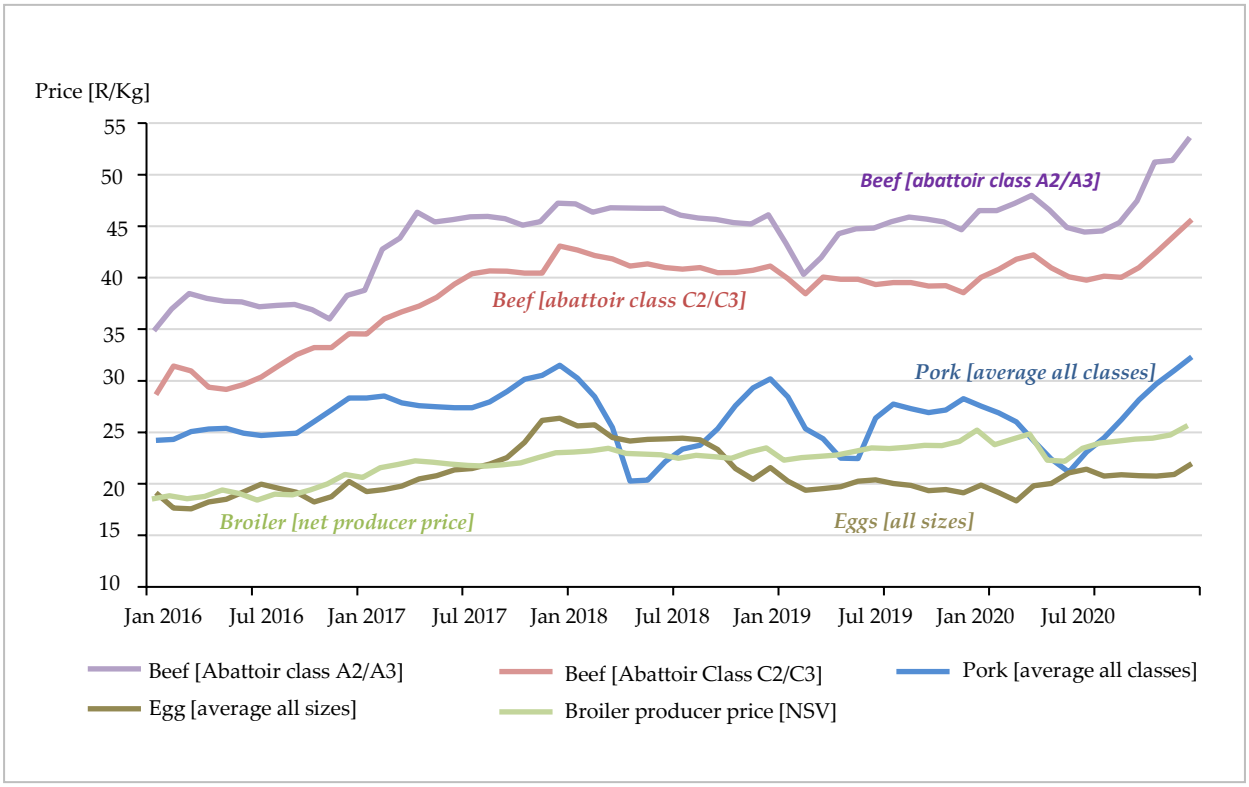

Figure 1. Monthly broiler, egg, pork, and beef producer prices. Adapted from [18].

The general public, regardless of rank or religion, prefers poultry, which has led to a dramatic rise in poultry imports into the nation and a steady growth in the demand for broiler meat [22]. For instance, during the 10 years between 2009 and 2019, South Africa's broiler meat consumption increased by around 25%, while broiler imports increased by 160% [18]. Importers argue these imports are necessary to supplement the shortfalls that the local producers are unable to meet. On the other side, local broiler producers contend that imports are preventing commercial farmers from utilizing their production potential to

the fullest, killing investment, and forcing small-scale producers out of business [18]. The competitive broiler meat prices and economic growth are the two most important factors that drive demand for broiler meat. There is still room for expansion in the South African poultry business, as evidenced by the nation's relatively low per-capita consumption of poultry meat when compared to other economies worldwide [23]. The argument that there is still potential for the local farmers to expand is further supported by the fact that South Africa is a net importer of broiler meat, and that demand there exceeds supply. According to Sovereign Foods [23], as long as food prices continue to rise, there will be a rise in demand for chicken products.

Broiler Industry in the Limpopo Province

The primary responsibility for ensuring that consumers have continual access to high-quality, inexpensive protein rests with the local farmers. Moreover, the broiler industry is currently contributing to the employment sector by absorbing workers from both skilled and unskilled labor markets [24]. Small-scale farming communities, such as those in the Limpopo province's Sekhukhune, Capricorn, Waterberg, Mopani, and Vhembe district municipalities, have a lot of potential for generating high-value agricultural goods. Limpopo, according to reports, is the province that has the fewest broiler producers, who account for only about 3% of overall production [5]. The province features a dual agricultural system, with 273,000 small-scale farmers occupying 30% of agricultural land, and 5000 large-scale commercial farmers using the remaining 70% of the arable land [25]. Previously, the Capricorn District recorded the highest export of broiler meat in 2010, with an export share of 85%, which has been followed by a drastic decline ever since. According to the Department of Agriculture, Land Reform and Rural Development [5], the total broiler exports from Limpopo Province declined in 2018 by 95% because of an HPAI (Highly Pathogenic Avian Influenza) outbreak that led to the banning of exports. Small-scale farmers must perform to high market criteria in order to contribute to high-value chain marketplaces. Due to stringent market entrance restrictions, small-scale farmers are barred from high-value chains across the country. For the community to be able to advance onto high-value markets, a thorough investigation into the economic methods and operating management systems utilized by small-scale broiler producers in Limpopo province is essential.

4. Factors That Influence Broiler Farming

Broiler management practices, profitability, economic efficiency, and resource use efficiency are important factors to consider for any successful farming operative. It is crucial to first have a look at the suggested actions required to run a successful broiler business before reviewing the impact of these aspects on farm sustainability and efficiency. The contemporary broiler chicken can produce muscle with the least amount of diet and grows exceedingly quickly [26]. This emanates from successful breeding programs and their advances in improving the efficiency of broiler production [26]. The modern broiler is, however, more sensitive to the environmental elements, making it more challenging to properly manage the entire broiler farming operation. Careful attention must be paid to water, feed, light, temperature, ventilation needs, and hygiene practices to maintain a healthy and productive flock [26]. While there are various ways of raising and managing broilers, understanding the critical requirements and guidelines for broiler management is important. Small-scale farmers need to educate themselves on these requirements, starting with the ideal broiler facility requirements.

4.1. Broiler House Set Up

A broiler house's primary goal is to establish a setting that enables the birds to realize their genetic potential in the most cost-effective way feasible. The most common style of broiler house used in small-scale broiler production is open-sided, and it is less expensive to construct and run than a controlled-environment house [27]. Utilizing side curtain openings, heaters, and fans allows for the control of the environment [27]. In this manufacturing

process, a layer of wood shavings, or another material that is equally absorbent, is applied to the floor in a layer that is between 5 and 10 cm thick [28]. The litter functions as a cushion and insulator for the chicks, as well as absorbing moisture, diluting feces, minimizing bird contact with manure, and reducing contact between birds and other animals [26]. It is important to keep the environmental temperature controlled to avoid stressing the birds, which may impair their growth performance and health.

4.2. Stocking Density

Through stock density, which measures the unit weight of broilers that can be raised in a specific area, the size of the broiler house also contributes to production efficiency [29]. As the number of birds per unit area increases, stocking density has a substantial impact on broiler farms. The performance, health, and wellbeing of the birds could suffer, though, if densities are too high [30]. In order to produce broilers, it is important to strike a compromise between maximizing the body weight of birds per unit of floor area and losses brought on by overcrowding, claim Benyi et al. [31]. Densely overstocked broilers experience decreased body weight, yield, and feed conversion efficiency, leading to increased downgrades, condemnations, and mortality [32]. Metabolic waste and heat production increases with the higher stocking density [33]. Poor ventilation from overstocking elevates mortality due to ammonia build-up and increased susceptibility to respiratory diseases [29,34]. Therefore, the profitability and full genetic potential of the broiler enterprise can be achieved by providing birds with all the space they need. The use of tunnel ventilation and the provision of an adequate evaporative cooling system can allow the provision of higher stock densities all year round.

According to South African Poultry Association (SAPA) [35], the ideal stocking density is 15 broiler birds per square meter. Additionally, for profitable broiler production, Benyi et al. [31] suggested that broilers be raised in the tropics and subtropics at a stocking density of 30 kg body weight/m^2. Broiler farmers are frequently enticed to increase the quantity of breeding stock per pen in order to lower production costs, such as equipment, housing, and labor costs per pen [36]. Abudabos et al. [37] maintained that the bird/kg must be maximized to achieve acceptable economic returns. According to Škrbić et al. [38], broiler stocking density is an important factor for assessing poultry welfare, carcass quality, and morbidity in birds. Furthermore, Nembilwi [39] and Hall [40] revealed that high stocking densities can negatively affect the welfare and financial side of production, leading to greater mortality and more incidence of leg problems. Stocking density and economic return have been associated with broiler output [41,42].

4.3. Temperature Management

Brooding of chicks is practiced by farmers as a strategy to reduce early mortality [43]. Small-scale broiler producers use whole-house brooding, spot brooding, or partial-house brooding to achieve the optimum temperature in the brooding area [27]. Temperature regulation directly impacts the ability of chicks to grow efficiently. Day-old chicks are brooded for about 2 weeks, depending on the weather conditions. The ideal house temperatures for broiler performance are 32 °C, 29 °C, 27 °C, 24 °C, 21 °C, and 21 °C for week 1, week 2, week 3, week 4, week 5, and week 6, respectively [26,27].

Different sources of heating are used by farmers, namely: electricity, gas, coal, and firewood. Since radiant brooders focus heat on the bottom of the chicken house, they are more effective than forced air furnaces and convectional hovers. In addition, they reduce fuel consumption by 15–30% when compared to the other brooders [26]. Low temperature environmental conditions increases feed intake and oxygen demand as the bird tries to maintain warmth. This, in turn, predisposes the birds to the problem of ascites susceptibility and, eventually, to a rise in mortality incidence. Dehydration, heat stress, and a possible reduction in the disease resistance of birds are all effects of overheating. Apart from monitoring the temperature using thermometers, the behavior of the chicks must also be monitored. If the broilers huddle, they are probably cold, and if they appear to disperse

from heat sources, exhausted, or drowsy, they are probably too warm [26]. Broilers produce heat as well, and in hot weather, this heat might cause the broiler house to overheat, and needs to be removed; however, in cold weather, this bird heat can be beneficial in keeping the right house temperature. Even the transportation temperature conditions of the broilers must be maintained properly to ensure product quality. Poor temperature management will contribute to avoidable economic losses and reflect an unsustainable business operation from the losses the farm will have to incur as a result [26].

4.4. Ventilation

Any ventilation system's primary goal is to remove moisture and ammonia from the broiler house. Ammonia can cause eyes to burn and tear at concentrations between 50 and 100 ppm, which is when the human nose can detect it [26]. Broilers can become blinded by prolonged exposure to high ammonia levels, especially in the colder months of the year. Levels as low as 25 ppm can severely impair broiler performance, by reducing growth by 4–8% and increasing feed conversion by 3–6%. This increases the risk of viral infections, avian condemnations, and air sacculitis. Ammonia has been demonstrated to irritate and harm the protective coating of chick respiratory systems at 5 ppm (undetectable to the human nose), increasing susceptibility to respiratory illness [26]. Ammonia is produced by the bacterial decomposition of broiler waste in the litter. Ammonia generation is aggravated by crowding, wetness, high temperatures, and inadequate ventilation. To ensure desirable air quality, moisture and humidity levels can be controlled using proper ventilation systems. There is no set amount of ventilation needed because every broiler house or farm scenario is unique, however, for starting chicks, a ventilation rate of 2800 cm^3 per bird is typically recommended. To avoid ammonia buildup, partial house brooding ventilation needs to be carefully regulated. Ventilation is also essential in eliminating mortality and decreasing bird performance in warmer periods. An efficiently ventilated broiler facility ensures broiler safety and better profit returns [26].

4.5. Lighting

In broiler production, to minimize mortality, maximize growth, improve efficiency, and reduce electricity costs, light manipulation is used. Broilers kept under continuous light (23 h light: 1 h our dark per day) mature quicker than those using natural light [26]. Feed efficiency can be improved just by using intermittent lighting programmers which maintain bird activity. In order to reduce feed intake and increase feed effectiveness, intermittent lighting has been utilized [44]. This has been shown to reduce excessive belly fat deposition, the likelihood of metabolic issues, and production expenses. Restricted light programs are also believed to enhance the broiler's resistance to disease [44]. Lighting programs, if used properly, can help boost bird activity and aid with finding feed and water. Producers, including small-scale broiler farmers, are encouraged to keep up to date with current lighting program recommendations as more research efforts continue to emerge in a bid to explore optimum lighting programs from one location to another.

4.6. Water

To prevent dehydration-linked disorders, broilers need access to clean, fresh water. A bird can survive only a few days without water, but several weeks without food. A 2.3 kg broiler will consume around 8.2 kg of water throughout the course of its lifetime, compared to 4.6 kg of feed [45]. To provide vaccines, medications, and nutrients and electrolytes to broilers, drinking water is often used. It is vital to keep informed records of the volume of water consumed daily to ensure sufficient supplies are provided all the time. Comparing daily water readings with previous records and/or standard references can alert the producer to apply corrective actions toward any potential disease and management problems. Water quality can be evaluated based on bacterial contamination, pH, and minerals. The pH of the water should be between 6.4 and 8.5 for broilers; anything outside of this range could hinder performance. Health issues may result from excessive amounts

of salt, chloride, sulfates, magnesium, and nitrates. The most typical water quality issue that negatively impacts broiler performance is bacterial contamination. In between cycles, drinking systems should be cleaned with an authorized chemical (such citric acid). The importance of water hygiene can make or break a broiler farming business, as health inspectors can shut down the whole operation if it poses a health threat to both animal and human welfare.

4.7. Broiler Feed

Feed is indispensable in the broiler production process, as it influences the pace and growth rate efficiency of farm broilers [28]. At least 65 to 73% of the overall live broiler production costs in most countries go to feed procurement. In terms of consumption volumes, the poultry industry combined has a higher share of total feed procurement volumes when compared to other livestock programs. For example, according to the Animal Feed Manufacturers Association [46], the livestock industry used 4.37 million tons of feed in 2020, of which 2.83 million tons (65%) were used for poultry feed (Table 1). Limpopo Province reported the least feed consumption records compared to the other eight provinces (Figure 2). According to Hall [47], broilers are fed different feed rations during rearing, to meet their fluctuating requirements, as they grow. Most small-scale broiler producers observe three phases of feeding, namely, starter, grower, and finisher [29]. Usually, chicks are fed a high protein (21%) diet for the first three weeks, then followed by 19% protein, and, later, finish off on a 16% protein grower diet at least 10–14 days prior to market [27]. Different feeding equipment, such as tube feeders and troughs, are used to provide feed to birds. Providing birds with sufficient feed at each stage of development is necessary for an optimal harvest [27].

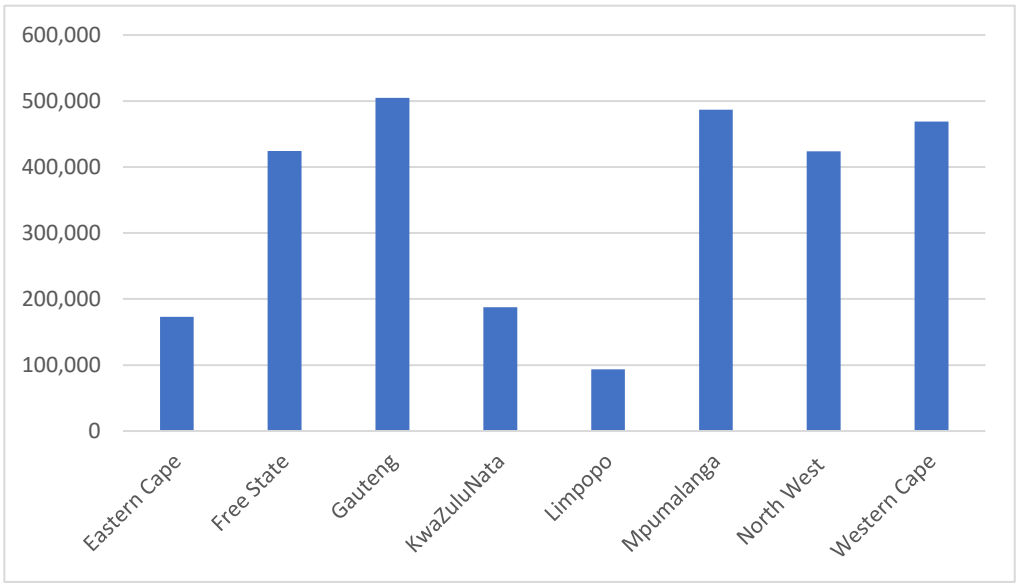

Figure 2. Broiler feed sales per province in 2020–2021 Animal Feed Manufacturers Association AFMA annual report. Adapted from [46].

Feed conversion, which is calculated by dividing the weight of consumed feed by the live weight of broilers, is a useful technique for comparing flock performance on different farms. Feed conversion is influenced by environmental temperature conditions. Any deviation from thermal comfort zones causes the birds to use energy, to either cool or warm themselves, that could have been used for growth [27]. In one study, it was discovered that broilers raised at 24 °C from 5 weeks of age till market age had a 2–4% better feed conversion than those raised at 35 °C [27]. According to Abed et al. [48], the main factor affecting feed conversion, weight gain, and flock size appeared to be feed. Furthermore, birds that are given unlimited food gain weight more quickly, easily achieve market weight,

and fetch greater prices per unit. The profitability of the farm is significantly impacted by the poor body weight of broilers, which is a sign of inadequate feeding management [49,50]. Numerous studies [51–53] have suggested that in order to reduce feed prices, farmers should be taught how to purchase feeds locally.

Feed prices can vary from one brand to another, with variable qualities being found on the market. This, in turn, greatly impacts profitability and the feed conversion ratio [54]. Broiler market prices are governed by the cost of production, hence, high feed costs cut the producer's profit. In most situations, an increase in feed prices is not accompanied by an increase in prices, particularly for locally produced broiler products. Even for tariff lines that are not subject to dumped imports, the domestic broiler price is now higher than the import parity price, leaving South African producers vulnerable to imports [18]. The results of [55] showed that the prices of day-old chicks and feed are the two key factors that have a negative impact on profitability. According to Dziwornu and Sarpong [56], small-scale broiler farmers' profits are quite sensitive to variations in the price of feed and day-old chicks. In order to increase the profitability of broiler production, these two input costs must be reduced [56]. Therefore, lowering the costs of these two inputs will significantly boost profitability in the production of broilers [56].

To improve profitability, broiler producers need to efficiently control input costs. Costs of production will be decreased by selecting the proper kind of feed. Farms who employed ready-made feed technology had higher profitability than their counterparts, who adopted self-made feed technology, according to Adeyonu and Odozi [8]. The quality of ready-made feed may not be as challenging to achieve and maintain as the self-made feed that is intended to be more affordable [8]. In addition to slowing broiler growth, poor quality feeds can also result in nutritionally linked illnesses, increased mortality, an increase in average production costs, and, ultimately, lower profit margins [8].

To ensure that birds reach the proper market weight by six weeks, broiler farmers must feed chicks with a balanced and nutritious feed available at all times. This will make sure that feed supplies are used effectively, lowering feed costs and allowing producers to operate economically [56]. According to Dziwornu and Sarpong [56], small-scale broiler producers are less economically efficient than those who vary less from the usual 42 days needed for broilers to be ready for market. The extra cost of production for the extra days is incurred when keeping birds longer than 46 days, which reduces profit margins. As broilers age, their feed efficiency also declines because more feed is required to maintain the same level of body mass [56]. According to Schmidt [57], as markets get older, production efficiency suffers dramatically, potentially driving up costs. For chickens to be economically effective, Baéza et al. [58] and Szollosi et al. [59] suggested slaughtering them at 42 days of age. There is no doubt that broiler feed contributes significantly to the economic health and efficiency of the farming business, and producers must pay extra attention to all feed-related matters for the broiler farm business to thrive.

Table 1. Animal Feed Manufacturers Association (AFMA) member's animal feed sales in tons for 1 April 2020 to 31 March 2021 (Metric Tons × 1000). Adapted from [46].

	Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Limpopo	Mpuma-Langa	North West	Western Cape	SADC	Total [× 1000 t]
Dairy	194.30	40.14	32.36	240.53	0.26	34.85	25.56	373.97	0.39	942.37
Beef and sheep	26.85	97.82	8.70	248.06	6.12	322.10	15.39	91.64	7.11	823.80
Pigs	28.84	58.40	34.61	22.71	2.46	56.63	30.66	145.04	7.69	387.03
Layers	39.17	184.18	335.29	68.54	10.97	96.65	63.28	139.24	53.62	990.93
Broilers	182.38	392.27	507.72	172.88	76.02	486.71	401.97	452.54	162.15	2 834.63
Broiler breeders	27.30	41.50	99.41	129.42	0.44	105.05	39.67	67.16	25.03	534.97
Ostriches	0.11	0.06	0.07	0	0.10	0.21	0	13	0	14

4.8. Growth Rate

Broilers go through a rapid growth rate during the first 6–7 weeks of age, which deteriorates thereafter as the bird ages further. Feed conversion accelerates with growth,

as more energy is needed to maintain heavier body weights. However, calorie conversion rates keep rising as body weight increases, suggesting that bigger birds are less efficient. Understanding the relevance of growth rate increases the likelihood of better predicting variation causes, such as disease, extreme weather, and any mismanagement that will have impacted average bird weight and performance. However, the growth rate of broilers does not follow a standard rate. Differences between sexes, initial egg size, natural biological variation, management practices, and disease prevalence all affect the growth rate of broiler birds. Some producers have explored raising male and female broilers separately. This practice is taking center stage as the broiler market continues to become more specific with their demands regarding broiler weight.

Younger chickens, those aged six weeks or less, are what define the modern broiler bird industry. This is in response to consumers' preferences and expectations for tender chicken from fast-food chains. The optimum broiler market-dressed weight varies from 1.1 to 1.3 kg [60]. Although the fast-food markets prefer a relatively small bird, it is more cost-effective to grow even larger broilers because of the economics of further processing (3.7–4.2 kg). Producers may take advantage of these requirements and opt to raise both sexes separately so that they can access both markets. Male broilers grow more quickly and efficiently, since the nutritional requirements vary by sex type. Producers may even feed males a different diet from females and manage to reduce feed costs by doing so. Low live weights may be caused by inadvertent feed or water restriction as a result of management errors, such as letting feed supplies run low, poor equipment repair, and insufficient cooling, especially at night in hot weather when appetite is depressed. The growth rate of broilers sets the pace for when to harvest and market the birds, and is an important indicator of performance efficiency.

4.9. Mortality

Understanding the factors that can contribute to broiler mortalities is important in order to prevent them from occurring and lower the risk incidence. The mortality rate for broilers varies with location, management, and disease exposure. Early causes of mortality include malnutrition, dehydration, and infections, whereas late causes include conditions connected to growth, such as ascites, leg issues, and sudden death syndrome. Disease-related issues and manufacturing errors such over-scaling, contamination, and insufficient bled off might result in the condemnation of a broiler. Blisters, fragmented and shattered bones, exposed fresh meat, and bruising are common reasons why meat gets degraded. By using the right vaccines, good ventilation, and physical handling practices, field-related downgrading and condemnation losses can easily be prevented.

5. Other Factors Contributing to Good Broiler Farming Management Practices

5.1. Biosecurity and Vaccination

Prevention is better than cure, and, therefore, implementing biosecurity measures to ensure the health and safety of broiler flocks is a prerequisite for all farmer operations. Biosecurity measures, according to Ajewolwe and Akinwunmi [61], are a collection of activities and systems designed to lessen the burden of any disease-producing agent on farms and, as a result, minimize the negative impacts of illnesses on farms. The transmission of disease pathogens and potential zoonosis outbreaks can be reduced, controlled, and prevented via biosecurity [62]. According to Negro-Calduch et al. [63], small-scale commercial chicken production facilities rarely employ biosecurity measures as a whole. However, significant risk behaviors were discovered, such as the improper disposal of carcasses and the danger of disease spread from inadequate biosecurity measures used during vaccination [63]. The practice of vaccinating chicks was familiar across all farms, and biosecurity precautions, including using the footpath in front of the farm entrance and using formalin, were essential in the chicken farms [64].

5.2. Record Keeping

Using farm data is one potential strategy for enhancing small-scale farming, according to Henderson and Gomes [65]. A farmer will not get very far in today's corporate world without agricultural data [66]. This is due to the fact that a farmer who keeps a sufficient amount of data is typically more equipped to deal with issues than one who does not [67,68]. Farmers frequently view keeping farm records as a laborious undertaking, despite how crucial they are to the development of a farm business [68], therefore their decisions are frequently based on hazy estimates and speculations [66,69]. Mbuza et al. [21] found that poor record keeping was the common practice among broiler farmers. According to Tham-Agyekum et al. [66], farmers do not retain all kinds of farm data because they believe that records are not useful. A successful farm company is not always guaranteed by good and accurate poultry farm records, according to Minna-Eyovwunu et al. [70], but success is improbable without accurate and efficient record keeping. In affluent nations, small-scale producers' efficient and consistent record-keeping is seen as a key sign of modern agriculture [71]. The requirement for daily broiler performance recorded data was emphasized by Simmons et al. [72] in order to support farmers when other production stakeholders, including as extension officers and veterinarians, assess farm progress. The economic viability of these businesses would increase with improved broiler management skills in terms of record keeping, savings, reinvestment of accrued profit, and business planning.

5.3. Farmer's Age

Technical inefficiency typically rises as a farmer gets older, according to Ahiale et al. [73]. This is consistent with the findings of Chavanapoonphol et al. [74], who discovered that technical and financial efficiency rise with age and maturity. This finding, however, conflicts with those of Mbanasor and Kalu [75], who found that the household head gets increasingly less able to integrate the available technology as they age. The company experience and the family size were the decisive variables in the study by Pakage et al. [76], which had a positive influence on technical inefficiency. Age, sex, and education level did not, however, have a negative impact on the technical inefficiency [76]. The technical effectiveness of broiler producers was significantly explained by input variables such flock size and water [73]. Age, education, experience as a farmer, and extension visits were discovered to be important farmer-specific characteristics that influence technical inefficiency [73]. The technical efficiency of production is compromised by a lower level of technology, cheap feed, and cheap chicks, as well as their lower quality, which leads to unfavorable economic indicators [5]. Additionally, farms with lower efficiency indicators are more vulnerable to adverse economic consequences brought on by changes in input-output prices [59].

Younger producers had more technical efficiency than older producers, according to Mahjoor [77]. This could be a result of younger producers adopting more efficient production methods and having more education in poultry production. In addition, compared to older producers, younger producers take more risks, and innovate to create more effectively. Additionally, they are more open to new concepts and technologies than are older ones. The sample of broiler farms in Fars Province, Iran, had a significant amount of technical, allocative, and economic inefficiency, which suggests that the farms would have a significant potential to increase profitability if they could operate at full technical, allocative, and economic efficiency levels [77].

5.4. Size

Size of enterprise is considered important, as it may influence resource use efficiency [78]. The more livestock a farmer has, the less inefficient he or she gets, according to Effiong [79] and Nwachukwu and Onyenweaku [80]. Mahjoor [77] asserts that the stock size, feed consumption, and labor input were important factors influencing producers' output. Yusef and Malomo [81] reported that producers with large farm sizes were more efficient compared to smaller ones. In contrast to Onubogu and Chidebelu [78], they discovered that small-scale producers of broiler rearing were more technically proficient than

those working at a large-scale. Therefore, a producer does not have to be a large-scale producer to maximize profit, since he can use less of the required inputs to achieve the required output.

6. Drivers for Technical and Economic Efficiencies in Broiler Production

The performance of broiler farms can be evaluated based on their technical and economic efficiencies. This efficiency describes how effectively a production unit utilizes its variable resources for profit maximization given the best technology available [82]. Empirical studies on broiler production efficiency investigate profitability, production constraints, and resource use efficiency. Efficiency refers to the relative effectiveness of the processes utilized to convert specific inputs into outputs [83]. Technical efficiency, allocative efficiency, and economic efficiency are the three main categories of efficiency. Technical efficiency is the capacity of an organization to apply best practices in the production process to achieve the highest level of output [84]. Understanding the socio-economic characteristics of farmers helps to quickly pinpoint the strength and weaknesses of their operations. For instance, the literacy level of the farmer determines how well they can understand improved poultry production technologies in order to generate more farm income. Having a larger household could positively contribute to the provision of household labor, while the mean farming experience would contribute to better farm management and decision making. Factors such as farmer age and total flock size are also taken into consideration to determine whether their operations are small-scale or not, and if they are still active enough to undertake the different operational challenges that come with poultry production.

6.1. Approaches in Studying Efficiency

In order to measure productive efficiency, one can use one of three methods: parametric (deterministic and stochastic), non-parametric based on Data Envelopment Analysis (DEA), or productivity indices based on growth accounting and index theory principles [85]. The stochastic frontier approach (SFA), developed by Aigner [86], and the data envelopment analysis (DEA), started by Farell in [87], are the two methods that are most frequently used to assess farm level efficiency, according to Vukelic and Novkovi [88]. The latter was reformulated as a mathematical programming problem by Charnes et al. [89]. Both approaches calculate the firm's technical, financial, and cost efficiency in relation to the efficiency frontier. The border is regarded as the effective frontier, since it exhibits the best performance among the enterprises.

The Stochastic Frontier Analysis approach mandates the specification of a functional form for the frontier production function, implying that structural constraints are placed, and raising the possibility that the effects of incorrect functional form specification could be confused with the inefficiency. While the DEA builds a piece-wise frontier that encompasses the observations of all enterprises using linear programming. The DEA technique has the benefit of allowing for the simultaneous consideration of several inputs and outputs [77], as well as the ability to quantify inputs and outputs using a variety of measurement scales. The Data Envelopment Analysis technique, however, does not distinguish between data noise and inefficiency because it is non-stochastic [85]. The non-parametric approaches, such as data envelopment analysis (DEA), are therefore free from misspecification, but they do not take into account the impact of other factors that are typically outside the control of the farmer, making them unsuitable for studying efficiency at the level of smallholder farmers, where conditions are highly heterogeneous [90]. In contrast, stochastic frontier analysis takes into account data noise and measurement mistakes [91]. For analyses of farm level data that typically include measurement mistakes, stochastic frontier analysis is crucial. Furthermore, parametric techniques are recommended, since small-scale production in developing nations is characterized by a wide range of variability [91]. Ricciardi et al. [92] were able to determine the average levels of formal education, the number of people living in each farming household, the number of years they had been raising chickens,

their average age, and their ability to obtain credit by utilizing the stochastic frontier analysis technique.

6.2. Economic Efficiency

Monitoring a farm's ability to utilize its resources to optimize production is the main objective of economic efficiency [93]. Profit, which is calculated as total revenue per flock minus effective operating expenses, and fixed farm factors can be used to assess the producers' economic efficiency. Technical and allocative efficiency, respectively, are combined to form economic efficiency [94]. It seeks to minimize expenses while enhancing advantages. Al-fawwaz and Al-Sharafat [95] define economic efficiency as the distribution of resources to the use that is most highly valued. Additionally, an economically efficient situation is one in which every resource is efficiently distributed, or one in which broiler production happens at the lowest possible per-unit cost of a resource [95]. Akinwumi and Djato [96] pointed out that a corporation could be technically or allocatively efficient without also being economically efficient. The farmer that raises broilers in this situation may not be able to use inputs effectively, which could be the cause [93]. Therefore, it is crucial to be aware of the production efficiency level. Running efficiency analyses, in accordance with Yeni [97], enables knowing the efficiency degree of input utilization and other preventative measures. Economic efficiency analysis thus provides a more comprehensive picture of a farm's competitiveness and performance [92].

6.3. Allocative Efficiency

Allocative efficiency is the process of selecting the ideal mixture of inputs in accordance with the relative factor prices [98]. Therefore, if a producer is able to equate the marginal value product of the output to its factor price, he is seen to be allocatively efficient in the use of that resource. Therefore, when the input mix is inconsistent with cost minimization, allocation inefficiency will result [99]. The broiler farmers failed to obtain an allocative efficiency index of "1," which would indicate that they did not reach optimal allocative efficiency, according to Ezeano and Ohaemesi [100]. In the utilization of all the inputs, they found glaring inefficiencies [100]. This outcome was in line with the conclusions of Ike and Udeh [101] about the effectiveness of credit- and non-credit-using small-scale poultry farmers in Nigeria's Delta State. The findings of Pakage et al. [76] show that farmers have been allocatively effective. Ullah et al. [102] noted an allocation inefficiency of 16% in the cost of producing broilers in the research region. It demonstrates that the farmers could have produced 16% more output, or could have used 16% less expense, to attain a similar level of output with the available resources [102]. The farmers' best resource allocation performance was in the use of feed input, while their worst resource allocation performance was in the use of medications and vaccinations [100]. Ike and Udeh [101] stated that in order to achieve maximum allocative efficiency, farmers must increase the costs allocated to the feed input and decrease the costs allocated to the use of other inputs. Conditions of over or underutilization of farm inputs indicate the directions in which farm inputs could be re-allocated. Although farmers are typically and allocationally efficient, Chukwuji et al. [103] noted that in order to optimize earnings, farmers must increase the quantity of their inputs.

6.4. Resources-Use Efficiency in of Small-Scale Broiler Production

Resource utilization efficiency, which tracks the number of broilers produced per unit of given resource, is a crucial metric of farm performance [56]. Small-scale broiler producers must be able to effectively use their limited resources if they want to maximize their return on investment. In other words, do they maximize profit from a particular set of inputs? Like any other economic activity, small-scale broiler production requires resource inputs. According to Etim and Udoh [82], maximum poultry production is dependent in part on the environment, technical know-how, and the quality of resources used in the production process. To optimize production and ensure sustainability, the broiler industry's resources

must be carefully managed [103]. Inefficient resource use and utilization can jeopardize and impede food production and availability. To calculate the economic efficiency of broiler production resources, the marginal value product (MVP) of each resource must be compared to its marginal factor cost (MFC), and efficiency indicators must be computed. In order for broiler producers to meet their profit goals, the available production resources must be used efficiently. According to Ike [104] and Effiong [80], producers' inefficient use of resources and technologies will necessitate more cost-effective efficiency improvements in order to increase output. This is due to the fact that productivity growth is influenced by efficiency, particularly in developing economies where resources are scarce and chances to create and adopt new technologies are dwindling [105].

Ng'eno et al. [95] found that all the resources used in poultry production by small-scale boiler farmers were used inefficiently, either underutilized or over utilized, in Bureti District, Kenya. Cost of feed and cost of equipment negatively affected broiler production, as they were underutilized in the production process, indicating that producers were not using these two inputs efficiently [96]. According to Nmadu et al. [105], some inputs—including hired labor, family labor, the amount of feed, the cost of transportation, and the cost of medication and veterinary services—were overused, while the stock of birds (stock size) was underused. Demonstrating that small-scale poultry farmers could increase their output and income by using more feeds, money, vaccines, and medicines effectively [94]. Since the other inputs were overused, the same conclusion could be drawn about them as well [95].

6.5. Cost-Benefit Analysis

A farmer needs to measure the costs and benefits of production if he wants to know whether he is making a profit. A cost-benefit analysis compares all of the costs and benefits involved in a production process and provides a financial evaluation of the activity. While the cost of a broiler may be determined immediately, it is frequently challenging to calculate operational expenses and revenues [106]. Estimating economic returns is crucial in determining whether or not producers embrace new technology, which in turn affects how they manage their resources [107]. The degree of risk that the raised flocks are subjected to bio-security measures is frequently taken into account when determining a poultry enterprise's cost-benefit analysis [108–110]. Aside from these factors, the profitability of the poultry industry is mostly determined by the cost of day-old chicks, the use of feed, and the effective use of resources such land, day laborers, and equipment [111]. The costs and values of investing in integrated broiler farming were examined by Balamurugan and Manoharan [112]. Results showed that small-scale farms had the greatest total fixed investments, total variable costs, and total costs per bird, followed by medium- and large-scale farms. Understanding costs and benefits is a crucial prerequisite for the creation of policies that are intended to increase productivity levels. Cost-benefit analysis is a useful technique for analyzing an enterprise's profitability, but it has a number of drawbacks, according to Nyekanyeka [91]. The tool's primary flaw is that it emphasizes the costs and advantages in terms of money. The projected values are inevitably subjective when intangible costs and benefits are considered in the analysis [113].

6.6. Gross Margin Analysis

To assess the farm's economic viability, its gross margin can be used to gauge its strengths and flaws. According to Johnson [114], the gross margin is the sum of the value of an enterprise's gross output and the variable cost of production. They are employed in farming for farm planning, and assessing other farms of a similar size or different enterprises on a single farm [113]. The estimation of net farm income and cost and return from the broiler producers are both aided by gross margin analysis. Net Farm Income (NFI) is defined by Olukosi and Erhaboro [115] as the difference between gross income

(GI) and total production costs. The model for calculating the NFI is represented by the equation below:

$$\text{NFI} = \text{Gross income (ZAR)} - \text{total variable Cost (ZAR)} - \text{total fixed cost (ZAR)} \quad (1)$$

$$\text{GM} = \text{Total value of production (ZAR)} - \text{total variable cost (ZAR)} \quad (2)$$

where: NFI = Net farm income (ZAR) and GM = gross margin (ZAR).

Total variable: These costs vary depending on production. They include chicks, labor, medicine, feed, immunizations, transportation, water, and energy, among other things.

Total Fixed Cost: These expenses do not fluctuate over the short term depending on the volume of production. This covers expenditures for buildings, machinery, and land.

6.7. Economic Sustainability in Small-Scale Broiler Farms

To maintain production and continue making a profit, the business venture must operate sustainably. The economic viability and risk of business failure are directly correlated with the sustainability of small-scale broiler producers [12]. An economically sustainable small-scale broiler farm must meet the producer's individual economic needs, as well as the needs of farm families and farmworkers. Bachev [116] indicates that an economically sustainable broiler farm allows financial stability and an acceptable economic return on used resources. A sustainable broiler farm manages all activities economically. Due to the household members' off-farm income, farms that are not commercially viable may nonetheless be economically sustainable [13]. According to certain studies, "autonomy" (also known as freedom) serves as a predictor of long-term economic viability [117]. The requirement for off-farm income, debt, and dependence on external inputs are all ways to conceptualize autonomy [118]. Economic viability is primarily assessed by profitability, liquidity, stability, and productivity, according to Latruffe et al. [118] and Grenz [119].

It is often established that small-scale farms are non-viable on their own. Therefore, they are not viable unless they are supported with some supplementary income [120]. Ramakrishna et al. [121] reported that 36.67% of small-scale broiler producers were viable and 63.33% were non-viable. Income from off-farm activities assisted these producers to become sustainable. Singh et al. [122] observed that, in Punjab, that even with the same socio-economic environment, some of the small-scale producers are thriving well and can earn enough income to meet their actual expenditure. The countries with the lowest rates of economic sustainability also had the lowest rates of off-farm employment, according to O'Donoghue [123]. Due to this, Germany, the Netherlands, and Hungary had the highest percentages of sustainable farms and off-farm employment, with the rankings barely changing if the farms were considered to be unprofitable. Additionally, in these nations, the proportion of sustainable farms and the incidence of off-farm work varies by less than 13%. Thus, it is clear that many farms would be economically precarious without additional revenue from jobs off-farm.

Slavickien and Savickien [124] identified one particular indicator (the ratio of production subsidies to gross profit), which demonstrated that broiler farms can only remain profitable with the aid of financial assistance because they exceed the limit of profitability, by five times in Lithuania and by twice in the EU-10 countries. The majority of financial statistics are positively impacted by the direct payments received, which artificially maintains the sustainability of the broiler farms. The producers must select the best management plan, the best decision-making outcomes, and better agricultural activity results without direct rewards to farmers [124].

7. Profitability of Small-Scale Broiler Producer

Farm sustainability and viability are recognized indicators for agrarian achievement and success, hence, for any business operation to thrive, it should show a reasonable net farm income [116,118]. Economic analysis of the running operations of small-scale farmers

is necessary for assessing the profitability and viability of the agricultural enterprise. In every enterprise, profit is the major incentive that attracts people to start a particular line of business. Small-scale broiler producers will base their decisions on their ability to make a profit, which will also decide the amount of investment required to achieve the desired earnings. Profit is defined as "the excess of revenues over outlays and expenses in a business enterprise over a given period, usually a production cycle". In order for producers to remain viable in the poultry sector, profitability is a critical component that influences the sustainability of broiler enterprises [55]. The profitability of businesses can be evaluated using a variety of techniques, including cost-benefit analysis and gross margin [124].

Livestock farms are lucrative businesses, according to several studies [49,125–128] that have been conducted on the subject. They also mentioned that there might be substantial problems with resource usage, sustainability, and accessibility to production [54,129,130]. A narrow margin between cost and revenue prompted the producers to accept relatively little returns because poultry farming can vary from region to region [49]. According to Abdurofi et al. [49], the business maintained profitability in certain places but failed to do so in others. Farm profitability was positively correlated with flock size, diversification, geography, age of the farmer, employment away from the farm, education, and years of experience in raising livestock Figure 2 [131–134]. Several factors influence farm profitability, and these need to be understood as they influence the success of the broiler farming business.

7.1. Access and Quality of Day-Old Chicks

The time between production cycles in broiler production firms is determined by the time spent accessing day-old chicks [135]. The South African Poultry Association [18] claims that breeders and hatcheries make significant contributions to the final product. Daghir [136] underlined that day-old chick quality is crucial, hence, chicks ought to come from a single breeder. The final product is compromised by the day-old chicks' inferior quality. Therefore, for the small-scale broiler producer to attain profit, obtaining access to quality day-olds is important.

7.2. Flock Size

Once more, profitability rises with each additional broiler in the flock. According to Durrani [137], an enterprise's capacity has an impact on its net profit, with high-capacity businesses having higher net profits than low-capacity businesses. Low-capacity businesses have poor financial, economic, profitability, and low output/input ratios, as demonstrated by Sarozkan [138] and Cicek et al. [139]. Farms with larger flock sizes are expected to benefit from economies of scale to purchase inputs at a lower cost than those with smaller flock sizes. Naturally, economies of scale will result in lower manufacturing costs and more profitability. Etuah et al. [140], Nehring et al. [132], Khan and Afzal [134] and Aryemo et al. [141] all reported a favorable correlation between flock size and profitability.

7.3. Cycle Length

Time affects the biological effectiveness of the bird [142] and is frequently overlooked as a metric for determining profitability. In addition to other things, the number of annual cycles has an impact on how profitable broiler production is. In broiler production firms, the time taken to access day-old chicks dictates the space between production cycles [135]. When calculating the broiler business's annual return, cycle length is another crucial consideration. While a shorter grow-out period will result in more harvests per year, a longer cycle duration will enhance the return per bird [143].

In contrast to the customary 42-day cycles with 14-day breaks, Kleyn [142] noted that a 38-day cycle with an 11-day resting period would result in an additional crop each year. Producers start noticing an increase in age-related mortality and an occurrence of limb weakness because of increasing body weight as the production cycle gets longer. Between 43 and 46 days of age, mortality increased by about 1% point, according to Schmidt [57],

reaching 5 to 7 times higher values for broilers raised until 63 days than for broilers raised till 35 or 42 days [58]. Producers should thus not retain broilers over day 49 because the net increase peaked between 42 and 49 days of age before declining [57].

7.4. Access to Finance

A significant improvement in loan delivery to broiler producers will significantly increase output. These production-related variables may have a negative impact on a farmer's profit, which will then have an impact on the subsector's viability and competitiveness [144]. Low output levels among small-scale broiler producers are consistently linked to their inability to acquire credit facilities to buy essential broiler supplies and equipment [145]. According to reports, the lack of financial resources in small-scale broiler production has slowed the growth of the industry, resulting in subpar production output [146,147]. Access to finance and profitability were shown to be positively correlated by Rahman and Chima [147] and Wei et al. [148]. Additionally, having access to reliable financial services enables microbusiness owners to fund revenue, accumulate assets, and lessen their susceptibility to outside shocks [149]. Small-scale broiler farmers who have several sources of revenue are more successful than those who only raise broilers for food. This is to be expected, as the income from other sources may be utilized to quickly purchase the necessary inputs for the production system, increasing profitability [8].

7.5. Marketing

Small-scale producers frequently have to cap the quantity of birds they may produce because there are not enough marketing channels available. When a big number of broilers reach maturity at once and the market is unorganized, there is no guarantee that there will be a market for all of them right away, and the cost of production rises when some of the mature chickens are fed until they are sold. Broilers should be marketed as soon as possible as they reach the required market weight of approximately 2.1 kg to 2.3 kg, according to Ralivhesa et al. [27]. If not, the producer will feed the broilers until they are purchased at a loss. By obtaining a fair price for mature broilers, processing is anticipated to increase the profitability of small-scale farmers [150]. The minimal percentage of broiler processors is a sign of the small amount of value-adding activities among small-scale broiler growers. However, the low level may be explained by the scarcity of abattoirs around small-scale farmers and the high cost of processing facilities, which the producers might not be able to afford [150].

7.6. Farming Experience and Educational Level

Production is significantly impacted by farming experience. The more years of farming experience a person has, the more exposed they are and the more productive they should be [151]. Farmers who produce broilers with education and expertise are more cost-effective than farmers who do not fit this description [8]. The profitability of broiler farms was found to be positively correlated with experience, according to Imtiaz [152] and Khan and Afzal [134]. The technical efficacy of farmers is significantly influenced by education, according to Ali et al. [153]. A farmer's level of education influences both his capacity to comprehend and assess new production technology as well as how productive and efficient his farm is [154]. The degree of formal education and gender, in accordance with Pakage et al. [76], improved technical inefficiency. It is well known that raising poultry helps developing nations achieve food security, reduce poverty, and advance gender equality [153]. According to a study [73] on the profitability of small-scale broiler farmers, the high cost of production and ineffective input management prevented broiler farmers from becoming entirely technically efficient. Individual technical efficiency levels varied from 42% to 99%, with a mean of 87%, indicating that poultry farmers may be able to boost resource utilization at the farm level by 13% in the near future [73]. The technical effectiveness of broiler producers was significantly explained by input variables such as flock size and water. Age, education, experience as a farmer, and extension visits

were discovered to be important farmer-specific characteristics that influence technical inefficiency [73].

7.7. Training

In order to produce broilers, farmers must be properly trained. According to Center [155], farmers who have received training in the production of broilers are more effective and profitable than those who have not. Farm size was influenced by producers of broiler chickens' training. According to Akteruzzaman et al. [156], producers who have received training increase flock number and land area more than untrained farmers. Small-scale broiler producers would benefit from extension and advising services on management, immunization, biosecurity, etc. to increase productivity and maximize profits [54]. The capacity of small-scale broiler producers who receive more extension service visits is increased by the advisory services and technical know-how they receive. They can thus produce more, and become more effective, than those who do not [56]. Rahman [157] pointed out that producers' extension service contacts contributed to their economic effectiveness in their studies. In order to effectively apply their knowledge, small-scale broiler producers should receive regular training on a variety of aspects of husbandry and disease control.

8. Challenges Faced by Small-Scale Broiler Farmers

Flock size is the biggest determinant with regard to the level of farm scale production. According to the general consensus, farmers whose flock sizes are too small to draw sufficient investment to produce appreciable productivity increases and profits can be viewed as small-scale enterprises. The term 'small-scale' can also be interchangeably used with 'smallholder', 'resource poor' and sometimes 'peasant farmer' [24]. The emphasis is on the common challenge of having limited resources when compared to other farmers in the sector. In small-scale farming, the family frequently provides the majority of the labor, and broiler production frequently serves as the primary source of income. The most pressing issues among the frequent problems experienced by small-scale poultry farmers are a shortage of capital and restricted access to credit facilities [144,145].

Small-scale broiler farmers choose to sell live chickens because they lack suitable slaughter facilities. Furthermore, chickens are typically sold on the farm rather than in a formal market [150], therefore it is difficult to determine the exact size of this market [150]. For rural small-scale producers, the over-procurement of day-old chicks is a major issue, especially during the holiday season when there is a high demand but a limited supply [158]. The majority of small-scale broiler farmers often reserve their day-old chicks in advance through middlemen, such as dealers or agents [54]. Another problem is that the local hatcheries occasionally cannot supply all of the day-old chicks that are needed [159].

8.1. Access to Production Inputs

The high cost of feed was one of the biggest problems small-scale commercial chicken farms had to deal with. This was consistent with the findings of Tadelle et al. [160], which stated that one of the most important barriers to poultry production is the availability of feed and nutrition. The biggest obstacles that poultry farmers saw were the lack of day-old chicks, the high cost of day-old chicks, and the lack of medicines and vaccines for producers [158]. The lack of high-quality day-old chicks is a recurrent issue among producers. Day-old chick quality received the highest rating among the producer limitations in the study by Kawsar et al. [54]. The management of breeder farms and hatcheries has an impact on a number of variables, including the quality of chick production [159]. According to reports, the average broiler bird mortality rate in Ghana was 17%, and it was discovered that a reliable source for day-old chicks was crucial to maintaining low mortality rates [161].

The majority of small-scale broiler farmers obtain their inputs from middlemen, who do not give them deals on day-old chicks and feeds. Due to insufficient markets and excessive feed prices, chickens had to be raised for longer periods of time, which had a detrimental influence on their ability to generate income and impeded efforts to make them

self-sufficient [162]. The poultry rearing systems were characterized by very erratic input prices as a result of middlemen's monopoly on the feed market [4,140,163].

8.2. Poor Physical and Institutional Infrastructure

The ability of a producer to transport inputs, produce, and obtain information is constrained by long distances to towns on poor roads with restricted access to automobiles for transportation. According to National Agricultural Marketing Council (NAMC) [164], producers from Limpopo Province seem to travel long distances to the local market, followed by retail, restaurants, and abattoirs, which offer lower prices compared to the local market. Low biosecurity precautions are typical found in small-scale broiler production [156]. Poor brooding techniques, a lack of health management methods, insufficient biosecurity controls, and feeding birds with unsatisfactory feeds were all blamed for the high chick mortality rate [4]. Small-scale businesses typically produce broilers intensively in deep-litter systems with completely enclosed birds [30].

8.3. Educational Levels

The majority of small-scale broiler farmers lack the technological, financial, and marketing know-how necessary to operate their operations profitably, while the low levels of education make gathering and analyzing information challenging [165–167]. Emaikwu et al. [168] found that, in Nigeria, education influenced people's willingness to adopt innovations that could boost profitability. Furthermore, it has been suggested that higher levels of education are linked to more responsible management and production of poultry projects. Thus, agricultural extension and advisory services for small-scale broiler producers should include the provision of ongoing education and training.

It is well known that the level of education of farm owners has an impact on their farming operations and is very significant in managing broiler chickens. The producers' high literacy level would enable them to comprehend and implement contemporary farming techniques, increasing output and profitability [169]. This shows that a farmer's level of education influences the productivity of his farm and his ability to comprehend and assess new production methods [170]. Low educational background makes it difficult to comprehend and employ scientific knowledge in practice, and even to take part in the training program, according to Ali et al. [157]. Michael et al. [171] reported that education is not only a crucial component of successfully absorbing innovations, but also a crucial instrument for profitable innovations.

Education has a beneficial impact on efficiency because producers with formal education are better able to accept new technology and innovation and use farm resources more effectively, particularly with respect to feeding, mixing, and the use of medicine. Additionally, according to Begun et al. [172], educated farmers are more likely to be productive than their less educated colleagues, probably as a result of their superior knowledge, informational access, and well-thought-out farm plans. However, it disagrees with a number of studies, including those by Ojo [173] and Ezeh et al. [83], whose findings showed a link between technical proficiency and schooling. According to Ojo [173], the farmers' involvement in other social activities left them with less time for effective farm management the more educated and experienced they were.

8.4. Breed

Small-scale farmers struggle with breed performance issues and frequently lack the resources to provide the birds with a controlled housing system and a sufficient power supply [174]. Similar post-hatch issues that broiler breeds face include metabolic problems and leg weakness [175]. Extreme weather is not tolerant of the exotic high yielding broiler strains [174]. Therefore, productivity and survivability decreased during the winter and summer months due to the drop or increase in temperature. According to reports, small-scale farming is severely hampered by high mortality rates, which are primarily brought on by diseases [173].

8.5. Lack of Knowledge

High broiler mortalities are primarily caused by poor cleanliness and a lack of understanding of biosecurity procedures [162,163]. According to Mbuza et al. [21], the majority of producers did not properly clean the chicken premises, since they never cleaned the homes before introducing new batches, which may account for the significant fatality rates before 4 weeks. This issue, according to Sil et al. [176], was caused by the subpar and unreliable veterinary support provided to them.

8.6. Water Supply

Small-scale broiler farmers suffered as a result of inadequate water supplies. One of the main obstacles to the efficient operation of broiler production in South Africa is the lack of water [163,177]. The majority of small-scale producers, according to Badubi [177] and Moreki [4], depended on buying water from those who had constructed their own boreholes. Given the severe water crisis, extension support should also include instruction in gathering, conserving, and safe water recycling [162].

8.7. Marketing

Ali et al. [153] stated that small-scale producers are forced to use the traditional system of marketing, which offers few opportunities for negotiating, because they are poorly organized and lack a regulatory body. Due to growers being compelled to rear birds for longer periods of time until they can all be sold, a lack of slaughtering and chilling facilities contributes to high feed prices. According to Badubi et al. [177], small-scale broiler producers struggle to obtain access to large retail outlets because they are unable to provide a consistent supply of broiler meat, and because they lack access to abattoirs that meet the sanitary requirements for slaughtering poultry for human consumption.

Small-scale broiler farmers in South Africa have very little negotiating leverage because they have limited access to institutional infrastructures, such as abattoirs, market intelligence, and financial markets, which prohibits them from selling their products at the most lucrative time [24]. Additionally, small-scale poultry producers are marginalized because they lack the economies of scale necessary to compete with large-scale commercial enterprises. The main barriers to the transition of broiler production include a lack of entrepreneurship, competence, tenure security, access to product and factor markets, small farm size, and inadequate technology [178].

To address the challenge of meeting capacity production volumes, small-scale broiler producers in South Africa can enter farming cooperatives. Accessing essential support from governmental organizations, such as financial or technical assistance, is made simpler for members who work in cooperatives. A project has a strong chance of growing and making more money, which would secure more jobs [20]. According to Mabelebele et al. [179], there are four different types of broiler farmers in the Greater Tzaneen Municipality's chicken industry namely:

a. Contract growers (keep 40,000 chickens and supply them to their strategic partners)
b. Small scale-market-assured (their capacity ranges from 5001 to 10,000 chickens, and they supply them to local distributors)
c. Small scale-infrastructure subsidized (their capacity ranges from 2501 to 5000 chickens, and they supply them to local distributors)
d. Resource-poor (their capacity ranges from 1000 to 2500 chickens, and they supply them to local distributors). By comprehending the management practice criteria for broiler farmers, the effectiveness of the business may be monitored. Despite the numerous challenges faced by small-scale producers in Ghana's Brong Ahafo Region, broiler production was found to be profitable [161]. Oladeebo and Ambe-Lamidi [180] demonstrated that chicken farming was successful among young farmers.

9. Conclusions

Few studies in this field have been conducted in the South African environment. This analysis shows that small-scale broiler farmers can boost their economic productivity. There-

fore, they can attain economic sustainability if they can increase their technical and financial efficiency by lowering the mortality rate, feed conversion rate, and production duration. The cost of these variable inputs, particularly feed and day-old chicks, will be reduced, which will significantly boost profitability in the production of broilers. The efficiency of the farms would also increase with higher levels of capacity utilization, educational attainment, and broiler yield. To ensure efficient resource utilization and maximize practicable profit, small-scale broiler producers who are not operating close to the profit frontier must make efforts to reduce both technical and allocation inefficiencies. Collectively, all these measures would ensure the economic sustainability of small-scale farmers in the Limpopo province. Moreover, the sustainability of small-scale broiler producers can be achieved if strategies that build local capacity and that empower them to sustain high levels of productivity are provided. In addition, the efficient use of resources will ensure that productivity is enhanced, and might increase profitability. Therefore, it is critical to make sure small-scale broiler producers make the most money possible from a given set of inputs.

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Abbreviations

GDP	Gross domestic product
HPAI	Highly pathogenic avian influenza
SAPA	South African Poultry Association
AFMA	Animal Feed Manufacturers Association
DAFF	Department of Agriculture, Forestry and Fisheries
DALRRD	Department of Agriculture, Land Reform and Rural Development
SFA	Stochastic frontier approach
DEA	Data envelopment analysis
MVP	Marginal value product
MFC	Marginal factor cost
NFI	Net farm income
GI	Gross income
NAMC	National Agricultural Marketing Council

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