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Rural Poultry Farming: Leveraging Higher Poultry Input Costs to Grow Zambia's Indigenous Chicken Sector

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Abstract: (a) Introduction: Zambia's poultry industry comprises commercial chickens and small-scale producers of indigenous chickens (*Gallus domesticus*) (ICs). Large, integrated entities run the commercial chicken sector, while the indigenous chicken sector (IC sector) is predominantly run by small-scale farmers (SSFs). Increased costs and low access to formal markets for commercial chickens have motivated SSFs to enter the IC sector under the free-range system (FRS) and semi-intensive system (SIS). (b) Objective: This study aimed to highlight the price changes in poultry inputs and outputs and demonstrate that the IC sector has more potential to contribute to farm income than commercial chickens under family poultry production systems. (c) Method: We analysed the prices for inputs and outputs for Zambia's poultry industry for the first quarter of 2016 to 2023 using data from the Poultry Association of Zambia (PAZ). We also analysed data from the 2021 Qualtrics survey to investigate the crops grown and crops used as feed and feed ingredients, the sources of feed, and the use of minerals and vitamins by SSFs for chickens. The gross profit (GP) and benefit–cost ratio (BCR) were analysed to compare the viability and profitability of ICs and broilers under SSFs. (d) Results: Our study shows that prices for day-old chicks (DOCs) and point-of-lay (POL) pullets increased by 57–125%, broiler and layer feeds increased by 67–96%, and soybean meal (SBM) and fishmeal rose by 143–229%. Prices for live ICs, commercial broilers, and ex-layers increased by 150%, 79%, and 71%, respectively. Egg prices rose by 100–124%. Farmers tried to look for local feed sources. Over 21% of the crops grown was maize, and nearly 43% was used for feed. (e) Conclusion: Our analysis and comparison between the ICs and broilers demonstrated that SSFs could achieve more farm income by producing ICs than commercial broilers.

Keywords: gross profit; benefit–cost ratio; indigenous chicken; commercial chicken; small-scale farmer; poultry market prices; rural livelihood

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1. Introduction

Zambia's poultry industry comprises two complementary and essential players: the commercial chicken industry and the indigenous chicken (IC) sector. The former is run mainly by the private, horizontally integrated poultry breeding and producing entities. Private business establishments have invested heavily in Zambia's commercial chicken industry over the past three decades. Between 2007 and 2012, Zambeef and its partners invested over USD 95 million, which contributed to the over 100% increase in the annual production of broiler DOCs to 65 million from 27 million in 2005 [1]. The investments resulted mainly from the government's conducive policies from 1991–2005, which promoted

active participation of the private sector in agriculture and the poultry industry [1,2]. The rapid changes in the poultry industry brought about more investments by integrated and standalone poultry breeders, resulting in the rapid expansion of the commercial chicken sector in Zambia. Breeding companies introduced new chicken breeds and modern breeding technologies, creating employment opportunities and efficiency in the sector. Today, the industry produces over 88 million DOCs annually [3].

During this rapid expansion period, some SSFs attempted to participate in producing commercial chickens at sizes proportional to their resources. This change redefined some SSFs from their traditional ways of rearing ICs [4]. Despite these positive changes in Zambia's poultry sector, most SSFs have started to face obstacles in the more intensive poultry enterprise, including the high cost of poultry feed, feed ingredients, and the prevalence of poultry diseases. Over 50% of the involuntary off-take of ICs among SSFs is attributed to poultry diseases in Africa [5]. The high cost of live inputs, such as DOCs and POL pullets, low access to the formal markets and poor infrastructure further hindered SSFs [1,3,6]. The anti-competition nature of the more prominent players in the sector pushed most SSFs out of production [1].

The IC sector has always been suitable and appropriate for SSFs due to the negligible resources required to start [7,8]. Over 80% of these farmers have thrived in this sector by keeping ICs that require low or negligible inputs, especially under FRS and SIS [9–12]. The sustainable low-input and low-output components of producing ICs have significantly contributed to rural livelihoods in Zambia. This trend is consistent with the prevailing roles of ICs in most parts of SSA [5,11,12]. Previous studies suggest that ICs are an entry point to investment and poverty reduction, as a farmer may start the business with one or two chickens and still access significant socioeconomic gains in a shorter period [7,11]. The easiness of producing ICs will likely attract more participants to the IC sector in Zambia. Increased farmer participation will result in the increased contribution of IC farming to household incomes. The higher prices observed for ICs and products will further open up more opportunities for SSFs in the country [3]. ICs have continued to increase across the country. A 2012 survey by (Lubungu and Mukuka, 2012) [13] found over 12 million ICs among 1.4 million agricultural households. A 2022 livestock census by the Ministry of Fisheries and Livestock (MFL) reported over 21 million ICs owned by over 1.6 million households [14]. The current trend in the IC population makes the IC sector's growth highly likely.

The purpose of this study was not to present an argument that the IC sector will take over the role of the commercial chicken sector in the food supply chain (FSC), as they both have important roles to play. Instead, the primary purpose was to assess and demonstrate that the IC sector has the potential to generate the much-needed income for poor resource SSFs in rural areas compared to broilers or layers. This study acknowledges the fact that the poultry sector is affected by several hindrances. Poultry diseases, poor genetics, and poor market access are among the biggest challenges in the IC sector. Mortality rates of 40–100% during outbreaks of Newcastle disease (ND), respiratory infections, and other diseases have been reported [15–18]. A comprehensive review by Grace et al., 2024 [5] revealed that, in Africa, poultry diseases are responsible for over 50% of mortality in the general chicken population and 75% of mortality in brooding chicks below nine weeks old. However, exploring cheaper and sustainable farming methods is crucial in the face of climate variability and human population growth. For this reason, this study focuses on increased production costs and the effects on small-scale broiler farming.

Increased production costs have been the major hindrance to SSFs' involvement in the production of commercial chickens. This study evaluates price trends for inputs and outputs in Zambia's poultry industry. This increased cost will likely stimulate the production of ICs more than broilers. Rural farmers endeavour to explore cheaper feed sources to enhance production. This study will also evaluate sources of feed and the use of minerals and vitamins among SSFs. Furthermore, this study demonstrates whether the

IC sector may significantly contribute to food and nutritional security and enhance the well-being of SSFs and rural communities in Zambia.

Main Objectives

1. To determine the rate at which the cost of inputs for producing commercial chickens is increasing and its effect on the small-scale producers;
2. To evaluate the primary sources of feed and the contribution of crops such as soybeans, maize, and sunflower to the supply of poultry feed ingredients;
3. Assess the contribution of commercial chickens and ICs to farm income at a small-scale level;
4. To assess the potential of the IC sector under FRS and SI to contribute to rural livelihoods through increased farm income, food, and nutritional security by analysing the GP.

2. Materials and Methods

To assess the potential of the IC sector and its contribution to farm income, we analysed market data of the poultry industry from the PAZ's weekly reports for the first quarters of 2016 to 2023. We sought express permission to use the association's market data.

2.1. Express Permit and Human Ethics Authority

The authors requested an express permit to use the data and other materials from the PAZ market data, and the association granted the authority on 7 April 2021. We also included some data from the Qualtrics survey in the analysis of sources of feed, crops grown by farmers, and the use of minerals and vitamins in poultry production. Research-associated data are shared through this link: https://hdl.handle.net/1959.11/56790 accessed on 19 March 2024 and a previous study (Kanyama et al., 2024) [19]. The Human Research Ethics Committee of the University of New England authorised the Qualtrics survey for the data partly included in the current research on 19 May 2021 (approval number HE21-052).

2.2. Data Collection and Analysis

Market data for the first quarters from 2016 to 2023 were under consideration for the analysis. We analysed the data on prices for a wide range of poultry inputs and outputs reported by the PAZ. The original average prices are in Zambian Kwacha (ZMW) but converted to United States Dollars (USD) based on the average exchange rate of 1 USD to ZMW 14.45. The PAZ market data include and share other poultry-related information. The association reports on the state of the poultry industry across SSA, international issues on the export and import of poultry products, and many other research activities regarding the industry. In this paper, the price dynamics of live inputs (DOC for broilers and layers and pullets), feed ingredients, such as SBM and fishmeal, broiler feeds (starter, grower, and finisher), and layer feeds (pullet starter, pullet grower, pullet developer, and layer mash) are reported. We further analysed market prices for poultry and related products, including those for mature broilers, ICs, and spent layers. Other prices included national retail and farm gate prices for chicken eggs.

Preliminary data on the market price dynamics were analysed using Excel and exported to IBM Statistical Package for the Social Sciences (SPSS) Statistics, version 29.0.1.0 (171), Chicago, IL, USA, United States of America, and accessed through the University of New England. We coded, recoded, and organised parts of the SPSS for further analysis. Similarly, Qualtrics survey data was exported to SPSS for further analysis. Where multiple responses were present, data were converted into multiple response sets to create new variables based on dichotomies. Where applicable, test statistics were used to compare column proportions and identify significant differences, with the p-value adjusted for multiple comparisons through the Bonferroni method in SPSS.

To assess the contribution of crops to poultry feed requirements, we analysed the data from the 2021 Qualtrics survey for 358 households in eastern, central, and southern livelihood zones. We expressed the number of respondents in each livelihood zone in

proportion percentages due to the different sample sizes, as follows: eastern livelihood zone (158); central (100); and southern (100). Using column proportions, we evaluated the primary sources of poultry feeds, the types of crops farmers grew, and crops or by-products used as feed ingredients. Further, we assessed the proportions of farmers supplementing vitamins and minerals to chickens in each zone.

2.3. Assumptions and Context for Analysis of Gross Profit and Benefit–Cost Ratio

The assumptions considered the guidelines and criteria for characterising family poultry production systems [4]. In this case, scenario 1 is the small-scale intensive system based on commercial broiler chickens. In contrast, scenario 2 is an SIS based on an IC breed. In both cases, farmers have equal access to the market.

2.3.1. Scenario 1

An analysis of the two entities' gross profit and profit margins was crucial in assessing their contribution to household income. The current study considered two scenarios. Scenario 1, illustrated in (Figure 1a) represents broiler production where a farmer reared three batches of 100 broilers in six months under a small-scale intensive production approach. Under this enterprise, the farmer relies on available inputs from commercial suppliers (DOCs, feed, drugs, vaccines, and others) [4]. The mortality rate (MR) was 5% because of the existing plan on disease control. Each cycle from production to marketing took eight weeks, of which six weeks were spent on production from DOC to market size and two weeks on selling and preparing the poultry house for the next batch. Therefore, in six months, ceteris paribus, the farmer could raise three batches of broilers, equivalent to 300 birds, in a good-quality housing facility. When the chickens were ready for market, the farmer transported them to the nearest selling point, and the pricing was mainly based on visual assessment rather than live body weight (BW). Visual pricing criteria commonly used in many parts of SSA, especially among SSFs, may result in unfair trade [18].

(**a**)

(**b**)

Figure 1. (**a**) Broilers under small-scale intensive system; and (**b**) rearing indigenous chickens under the free-range system; images source: authors.

2.3.2. Scenario 2

In scenario 2, illustrated in (Figure 1b), the farmer rears 100 ICs under FRS or SIS across six months. Under this system, the farmer kept IC breeds, allowing them to scavenge, and supplemented cheaper homemade feed from DOCs for 28 days or more. MR was 20%, and the farmer sold live chickens at six months. Based on the prevailing conditions in Zambia, we assumed an MR lower than 20% for ICs, where a farmer implements minimal disease control measures such as vaccinations [15]. In this scenario, the farmer rears up to ten hens and two cocks as the breeding stock. The farmer collects the 100 (1–7 DOCs) from 120 eggs that are either naturally or artificially incubated at a fee. The farmer takes advantage of the good mothering ability of the hens to nurture and protect the new chicks. The farmer also applies charcoal heating to mitigate chick mortality at brooding.

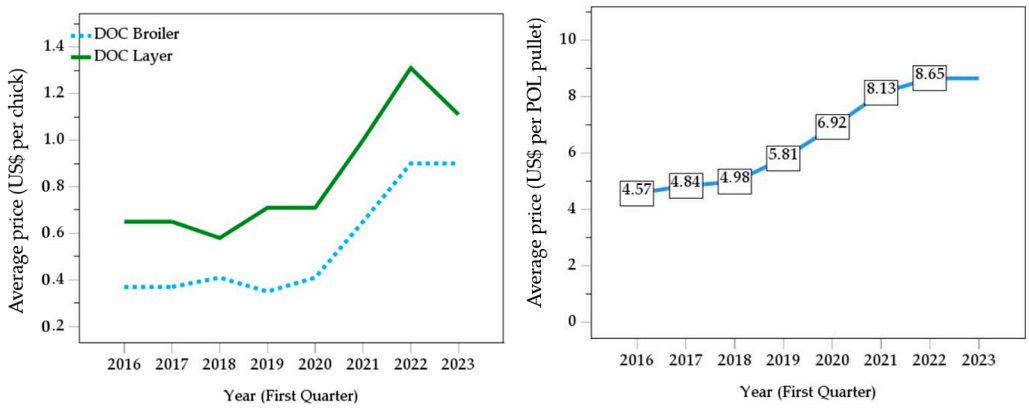
In Zambia, there are minor feed nutritional variations among feed processors. The estimated feed values for the starter are 22% CP, up to 5% crude fat and 12 MJ/kg metabolisable energy (ME), whereas the starter and finisher, respectively, have 19 and 18% CP, 7 and 9% crude fat, and both have 12.5 MJ/kg ME [20]. A three-phase feeding regime is used where the starter is fed to chicks from day 0 to 14; the grower is fed from day 15 to 28; and the finisher is given from day 29 to 42 [20]. In this analysis, we assumed that the litter, fixed costs, vaccines, and heating costs were miscellaneous.

3. Results

3.1. Prices for Live Inputs

Day-Old Chicks and Point-of-Lay Pullets

Our study found price dynamics for primary live inputs for chicken production for meat and eggs. Figure 2 shows the changes in prices for DOCs for broilers and layers, as well as POL pullets, in the first quarters of 2016 to 2023. In Figure 2a, the prices for broiler DOCs increased by 125% from USD 0.40 per bird, while the layer DOCs increased by 70% from USD 0.65 each. Prices for POL pullets increased from USD 4.60 per bird in 2016 to USD 8.70 per pullet in the first quarter of 2023, as shown in Figure 2b.



(**a**) (**b**)

Figure 2. Price trend for live inputs: (**a**) broiler and layer DOCs; and (**b**) POL pullets. Note: the average exchange rate was USD 1 = ZMW 14.45, DOCs = day-old-chicks, POL = point-of-lay.

3.2. Feed Ingredients and Poultry Feeds

During the period under review (the first quarter of each year from 2016 to 2023), the prices for main feed ingredients and poultry feeds were volatile. The price changes according to the data analysis are presented in Figures 3 and 4.

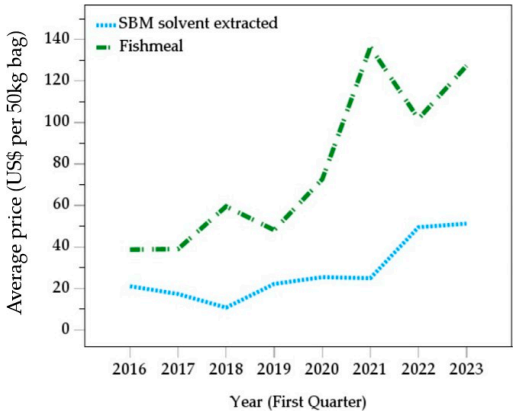
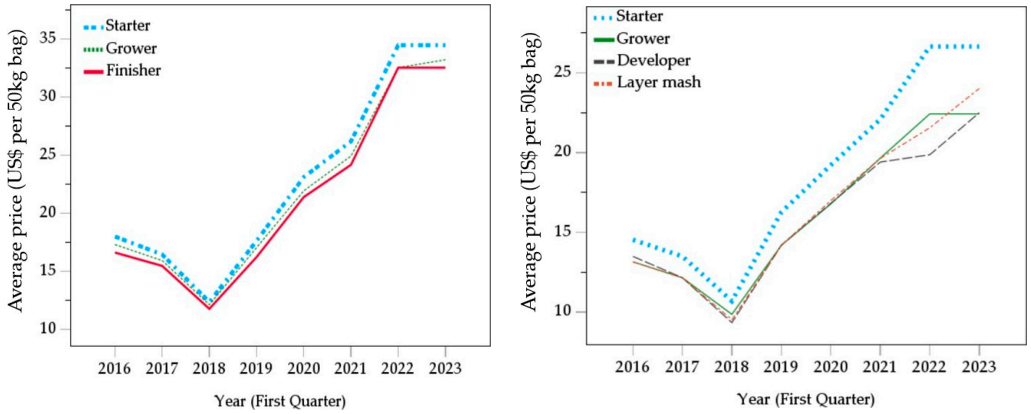


Figure 3. Price trend for selected feed ingredients—SBM and fishmeal. Note: the average exchange rate was USD 1= ZMW 14.45, SBM = soybean meal.



(**a**) (**b**)

Figure 4. Price trends for poultry feeds: (**a**) broiler starter, grower, and finisher; and (**b**) layer starter, grower, developer, and mash. Note: the average exchange rate was USD 1 = ZMW 14.45.

3.2.1. Soybean Meal and Fishmeal

Among the primary sources of crude protein for poultry feed, SBM and fishmeal are the most commonly used in Zambia's poultry sector. The unstable supply of these ingredients results in fluctuations in market prices. Figure 3 shows that SBM prices increased by 143.8% from USD 21.00 per 50 kg bag, while fishmeal prices increased by nearly 229% from USD 38.70 per 50 kg bag. Fishmeal is one of the poultry industry's most expensive protein sources in Zambia. The solvent-extracted SBM is usually processed from good-grade commercially de-hulled and autoclaved (cooked) soybeans.

3.2.2. Broiler and Layer Feeds

Figure 4 shows the price dynamics for broiler and layer feeds in the Zambian poultry market in the first quarters from 2016 to 2023. Figure 4a shows significant price changes for broiler feeds, including the broiler starter, grower, and finisher. Prices for 50 kg broiler starter increased by 95.8% from USD 16.60, grower increased by 92.5% from USD 17.30, and the price for broiler finisher rose by 91.7% from USD 18.00 per 50 kg bag. Prices for pullet starter, grower, developer, and layer mash increased by 88%, 71%, 66.7%, and 83.2% from USD 14.15, USD 13.10, USD 13.50, and USD 13.10 per 50 kg bag, respectively (Figure 4b). Generally, the first quarter of 2018 showed a slight reduction in prices for all poultry feeds, a pattern linked to the unstable exchange rate of the local currency against the US dollar and an increased supply of primary feed ingredients such as maize and soybeans.

3.3. Market Prices for Chickens and Related Products

Consumer demand and preferences significantly affect the prices of chickens and related products in Zambia. Generally, live broilers and ICs were priced per live bird regardless of the live BW. However, most market outlets sell frozen broiler products on a carcass-weight basis. Average mature weights for most ICs in Zambia and other parts of SSA range from 1.2–3.2 kg for cocks and 0.7–2.1 kg for hens [6,12,21,22].

Live Chickens and Eggs

In the past eight years, there have been upward movements in prices for live chickens and eggs, as shown in Figure 5. The national average prices for ICs rose by 150% from USD 3.60 per bird, broilers increased by 78.6% from USD 2.80, and ex-layers increased by 70.80% from USD 2.40 each. Figure 5b shows changes in the farm gate and national retail prices for chicken eggs during the review period. The farm gate prices doubled for a tray of thirty chicken eggs from USD 1.50 to USD 3.00, whereas the national retail price increased by 123.5% from USD 1.70 per tray of eggs. The erratic supply of eggs to the market resulted in significant price fluctuations.

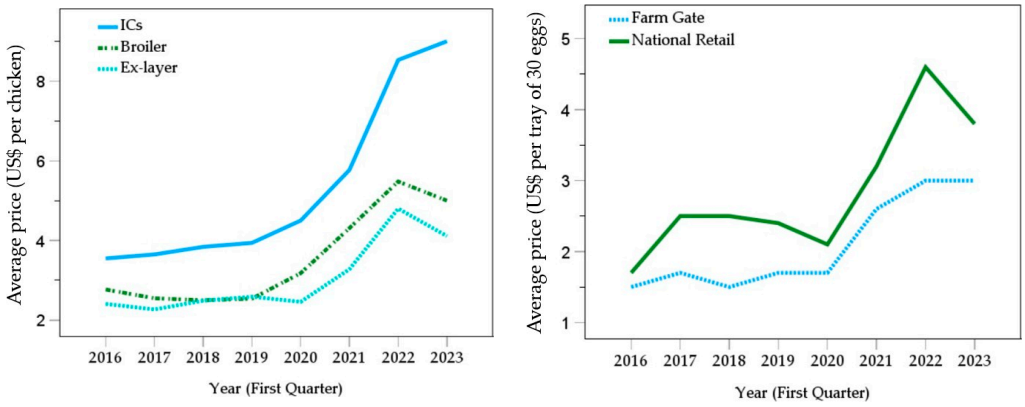


Figure 5. Price trend for chickens and products: (**a**) ICs, broilers, and ex-layers; and (**b**) farm gate and national retail prices for a tray of 30 eggs. Note: the average exchange rate was USD 1 = ZMW 14.45, ICs = indigenous chickens.

3.4. Promoting the Use of Common Feed Resources

Most rural poultry farmers explore cheap feed sources to reduce production costs. The analysis of Qualtrics survey data from 358 households in eastern, central, and southern livelihood zones demonstrated the primary feed sources, the crops grown by the farmers and those used as feed ingredients at a small-scale level. Our study also investigated the use of mineral and vitamin supplements by SSFs.

3.4.1. Sources of Poultry Feeds

Feed is one of the main constraints for both small-scale and large, established poultry businesses in Zambia. Chicken producers usually seek the cheapest sources and resources for poultry feeds. Figure 6 shows that 40–61.5% of farmers found homemade feed more accessible and valuable, with relatively more farmers in the southern zone using this. Between 8.5–16.3% explored feeds from processors, up to 20.5% preferred sourcing from mixed sources, and 13.5–26.1% utilised scavenged resources. Generally, most farmers keeping ICs exploit the cheaper scavenging option under FRS. There are seasonal variations in the availability of scavenged feed resources. During the dry season, significant feed shortages may compel farmers to explore other feed sources for supplementary feeding.

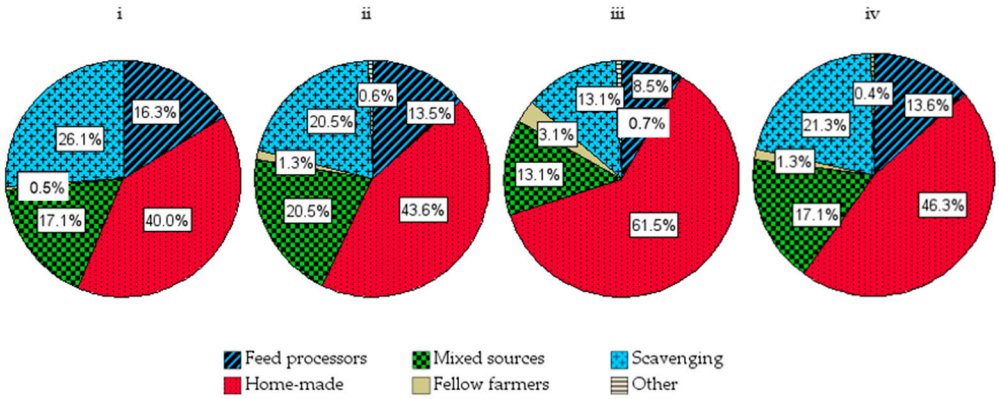


Figure 6. Sources of poultry feed. Note: N = number of respondents in the: (**i**) eastern (N = 158); (**ii**) central (N = 100); (**iii**) southern livelihood zones (N = 100); and (**iv**) overall (N = 358). Other sources were unspecified.

3.4.2. Common Crops Valuable as Poultry Feed

It is evident from the results shown in Figure 7 that farmers grew several types of crops (a) and used some of the crops as feed ingredients (b). Among the top five crops grown by farmers were maize at 21.6%, groundnuts (16.2%), sunflower (13.3%), millet (12.7%) and soybeans at 11.9%. On the one hand, the top five crops or crop by-products used in poultry feeding were maize at 42.9%, sunflower (21.5%), soybeans (10.7%), leafy vegetables usually fed as greens at 9.2%, and groundnuts (9.1%). Fewer farmers used cassava, millet, sorghum, rice, and sweet potatoes to feed chickens. Farmers grew maize, soybeans, and sunflowers as cash crops and for food and nutritional security. Some crops and by-products are also used to feed ICs and other livestock. Maize bran is a product made from grinding grains to maize meal; sunflower and soybean cakes are made from cooking oil extraction.

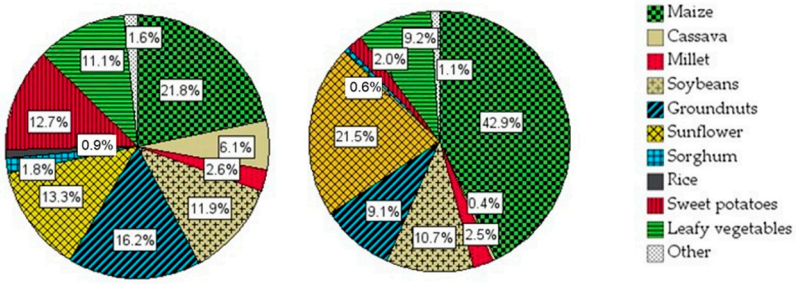


Figure 7. Common field crops: (**a**) that farmers grow; and (**b**) crops or by-products farmers use as chicken feed supplements. Note: N = number of respondents = 358. Other crops included watermelons, velvet beans, tomatoes, tobacco, onion, cowpeas, sun hemp, kidney beans, cotton, and popcorn.

3.4.3. Use of Vitamins and Minerals

Vitamins and minerals are essential for the proper growth and health of all types of livestock. However, the low use of nutritional supplements is a concern among rural farmers. Results in Figure 8 show the responses of households across the three livelihood zones when asked if they supplemented vitamins and minerals for the dietary needs of ICs and other poultry. Between 17–29% responded in the affirmative, while 31–69% did not, with a majority being from the eastern livelihood zone. In addition, 14–52% of respondents used vitamins and minerals inconsistently, as they occasionally supplemented the birds. More than half of the farmers did not use vitamins and minerals.

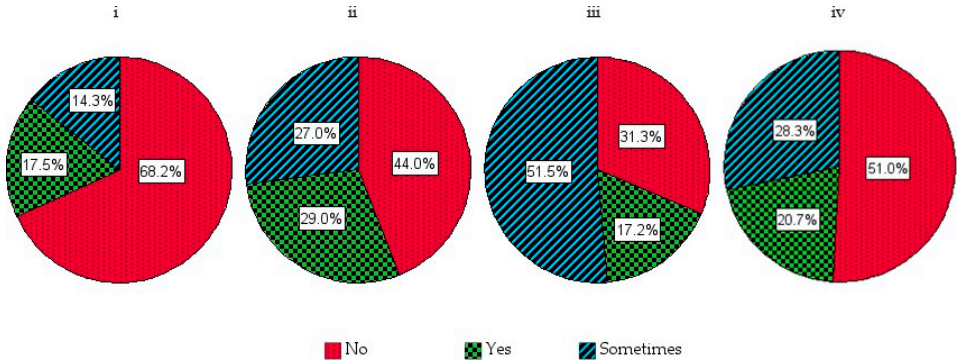


Figure 8. Proportion of farmers' responses when asked if they used vitamins and minerals in poultry production. Note: N = number of respondents in the: (**i**) eastern (N = 158); (**ii**) central (N = 100); (**iii**) southern livelihood zones (N = 100); and (**iv**) overall (N = 358).

3.4.4. Gross Profit and Benefit–Cost Ratio

The analysis of GP is essential in evaluating a business's financial health and stability, while the BCR indicates the viability of the business. GP and the BCR analyses help to identify a viable farm enterprise with the potential to contribute significantly to household or farm income among rural communities. The GP is the profit realised after deducting the total cost (TC) from the total revenue (TR). Equation (1) measures the GP, while Equation (2) measures the poultry project's (BCR) or viability, as follows:

$$GP = (TR - TC) \quad (1)$$

$$BCR = (TR/TC) \quad (2)$$

3.4.5. Gross Profit for Broilers and Indigenous Chickens

We compared the GP and BCR for broilers and ICs to highlight the potential of the IC sector to contribute to household incomes among SSFs in Zambia. Table 1 shows that the GP for broilers at USD 380.59 for producing three batches of broilers (300) at 5% mortality in six months was much lower than the GP (USD 560.02) for producing one batch of ICs (100 birds) at 20% mortality in the same period. Analysis of the BCR shows that under a small-scale farming system, producing ICs with a BCR of 4.5 was over three times more viable than producing broilers, for which the BCR was 1.4. The cost of feed contributed to the major costs for broiler production.

Table 1. Analysis of gross profit and benefit–cost ratio for small-scale broiler and indigenous chicken businesses.

		Scenario 1 (Broilers)			**Scenario 2 (ICs)**		
Input	**Unit Measure**	**QTY**	**Unit Price [a] (USD)**	**Total (USD)**	**QTY**	**Unit Price [a] (USD)**	**Total (USD)**
DOC	each	100	0.90	90.00	100	0.69	69.00
Starter (day 0–14) [c]	kg	119.20	0.69	82.25	-	-	-
Grower (day 15–28) [c]	kg	119.00	0.66	78.54	-	-	-
Finisher (day 29–42) [c]	kg	119.00	0.65	77.35	-	-	-
Cheap feed (28 days or more) [d]	kg	-	-	-	238.00	0.21	49.98
Transport	once-off	1.00	10.00	10.00	1.00	10.00	10.00
Miscellaneous	once-off	1.00	10.00	10.00	1.00	10.00	10.00
Subtotal		-	-	348.14	-	-	159.98
Total cost (TC)	Batches	3	348.14	1044.41	1	159.98	159.98
Revenue (TR)	MR (5–20%) [b]	285.00	5.00	1425.00	80.00	9.00	720.00

Table 1. *Cont.*

		Scenario 1 (Broilers)			Scenario 2 (ICs)		
Input	**Unit Measure**	**QTY**	**Unit Price [a] (USD)**	**Total (USD)**	**QTY**	**Unit Price [a] (USD)**	**Total (USD)**
Gross profit (GP)	(TR-TC)			380.59			560.02
BCR	TR/TC			1.4			4.5

Note: ICs = indigenous chickens, GP = gross profit, BCR = benefit–cost ratio, the average exchange rate of was ZMW 14.45 = 1 USD, QTY = quantity, DOC = day-old chick, compounding homemade feed was nearly 70% cheaper compared to commercial chicken feed, MR = mortality rate for broilers was 5% while for ICs = indigenous chickens, it was 20%. [a] Prices for inputs and outputs, based on PAZ, 2023 [3], [b] MR for ICs in Africa is estimated at over 50%, Grace et al., 2024 [5], [c] Feed regime for broiler production highlighted by C. Anderson, 2014 [20], and [d] Efficient use common feed resources, Goromela et al., 2006 [23].

4. Discussion

In this section, we shall demonstrate the potential likely to be triggered in the IC sector due to the increased production costs for commercial chickens, which has been the biggest challenge. A more significant proportion of production costs incurred by SSFs producing commercial chickens is attributed to costs for feed, feed ingredients, and live inputs. Second, we shall highlight opportunities the IC sector offers for SSFs keeping ICs in Zambia. The last part discusses the implication of the increased costs of inputs regarding the viable farm income by differentiating between the GP and BCR for ICs and broilers.

4.1. Main Challenges in Zambia's Poultry Farming

4.1.1. High Production Costs

The poultry industry faces several challenges. These challenges have a significant bearing on the overall performance of the poultry industry in Zambia [3]. The high production costs result from increased prices for inputs such as DOCs and POL pullets and feed. Several poultry breeders in the country have varying capacities for producing DOCs and POL pullets. However, the demand from local producers and neighbouring countries overwhelms the available supply, increasing prices [3]. Our study found that the current prices for live inputs in the poultry sector are unfavourable for small-scale producers and overall profitability (Figure 2a,b).

Prices for feed and feed ingredients have continued to increase in the past eight years (Figures 3 and 4a,b). The impact of such changes has been unprecedented for SSFs. The high poultry feed costs have been a concern for Southern Africa's poultry sector. Between 2022 and 2023, the Poultry Associations for South Africa, Namibia, and Zambia convened an urgent meeting in South Africa to analyse the poultry industry's challenges. Among those challenges, the erratic supply and shortages of maize and soybeans were at the top of the agenda [3].

The distance of the farmer from district centres affects the prices at which they purchase poultry inputs. Farmers from rural towns experience challenges accessing poultry feed and feed ingredients [3]. Farmers struggle to have a scheduled and regulated supply of DOCs and POL pullets, with prices pegged higher than in urban areas. Agents and outlets providing the much-needed poultry inputs rarely service the farmers in rural areas; in most cases, the inputs are received two or three weeks after purchase [3].

4.1.2. National Crop Production

The crops used as main ingredients for processing poultry feed have significantly contributed to price dynamics for poultry feed and feed ingredients. The changes observed in price increases for poultry feed are due to the competing needs of the major crops such as maize, soybeans, and sunflower between human use and the livestock sector. As demonstrated in the current study, these crops are essential for both the poultry industry and as a basis for household food requirements. Maize, sunflower, and soybeans are

among the top five crops grown by farmers and the top five crops used for feed and feed ingredients (Figure 7). The government conducts crop forecast surveys through the Ministry of Agriculture from 1 October of the immediate farming season to 30 September the following year [14].

The survey helps to obtain valuable information for predicting the food and nutritional security in the country. During the crop forecast survey, the ministry collects data on cultivated hectares for major crops, the estimated metric ton (MT) yields, and the amount of fertiliser and other inputs allocated to farmers [14]. An analysis of data from published reports under Agriculture and Environment of ZAMSTAT shows that the yields of essential crops have fluctuated from season to season due to climate-related conditions and the varying distribution of farming inputs [14]. The yield fluctuations for maize, soybeans and sunflower influence the country's prices for poultry feed and feed ingredients [3].

In the past few years, yield estimates based on crop forecast surveys have shown fluctuating yields in the essential crops. In 2017–2018, maize production was at 2.4 million MT, soybeans at 302,720 MT, and sunflower at 47,594 MT [14]. The report highlights that in 2019–2020, maize yields were estimated at 3.4 million MT, soybeans at 296,866 MT, and sunflower at 50,450 MT compared to the 2020–2021 farming season, with estimated yields of maize at 3.6 million MT, soybeans at 411,115 MT, and sunflower at 79,816 MT [14]. The yield forecasts between 2017 and 2021 highlight the expected fluctuation in crop production. For example, there was a nearly 42% increase in maize yield estimates from 2017–2018 to the 2019–2020 season; however, in the 2020–2021 season, only a 6% increase was observed from the previous season. Similarly, yield fluctuations in soybeans and sunflower were observed.

Maize, soybeans, and sunflowers are vital and commonly used crops in processing poultry feed in Zambia. Maize is a staple crop of the three major crops, the production and distribution of which are critical to meeting the demands of Zambians and the livestock industry [14]. Maize is a strategic crop for national food and nutritional security; thus, government policy has subsidised its production among SSFs in the country. Whole maize's nutritional value per 100 g is approximately 353 kcal (energy), 9.3 g CP, 10 mg Ca, and 2.5 mg of Fe, making it critical for nutritional demands [21]. Generally, the estimated nutritional values depend on the variety and climate conditions of the area where the crop is grown. Feed processors carefully analyse each feed ingredient to ensure they meet the nutritional standards for feed processing. Some oil-based crops, such as sunflower, have anti-nutritional agents, including protease and arginase inhibitors and chlorogenic acid (CGA), which must be managed before feeding chickens [24,25].

4.1.3. Other Poultry Market Hindrances

The availability of major crops for feed processing has been affected by the policy, exports, exchange rate, and, recently, by the outbreak of the COVID-19 pandemic, among others. Samboko et al., 2018 [26] observed that government involvement in the maize value chain hinders processors from accessing the commodity, negatively affecting the poultry feed value chain. Despite the perception of importation of primary feed ingredients, export data show significant poultry feed, soybeans, and maize exports to neighbouring countries such as Zimbabwe and the Democratic Republic of Congo [3,26]. Government policy influences farmers' decisions on crop growth. Previously, increased demand for soybean in the Chinese market resulted in drifts from certain crops, such as maize, to soybeans [3]. The volatile exchange rate has also negatively affected the poultry value chains [26]. Between 2016 and 2023, the exchange rate ranged between ZMW 9 and ZMW 20 to USD [3]. Further, COVID-19 negatively affected the agriculture sector and related supply chains, mainly due to restrictions, health risks, poor market access and reduced production [27,28].

4.2. Opportunities and Potential for Small-Scale Poultry Farming

4.2.1. Poverty Reduction and Nutritional Gains

Despite all the challenges in accessing feed and feed ingredients, including live inputs, such as DOCs and POL pullets, SSFs still have opportunities. These opportunities can be

more effective for SSFs producing ICs under FRS and SIS with minimal production costs. Small-scale poultry farming is described as low-input and low-output but sustainable for rural farmers. The ease of production of ICs makes them more suitable for SSFs with limited resources [10,12,18,29]. The gains from chickens and eggs culminate in the well-being of citizens, as indicated by the national gross domestic product (GDP). Food and nutritional security and poverty reduction are the centre of focus for the Zambian government through agriculture and the poultry industry [14]. Poultry and its products are cheaper and readily available animal protein sources for most rural communities [10,15,18,29]. Previous studies highlighted the nutritional values of chicken meat and eggs. Kityali A, 1998 [21] reported that 100 g of chicken meat had approximately 139 kcal of energy, 19.0 g of CP, 15.0 mg of Ca, 1.5 mg of Fe, and lower vitamin A levels. The nutrition gains from chicken meat and eggs make them much cheaper animal-based protein sources for SSFs. Rural families have taken advantage of the nutritional value of chicken products by feeding eggs to school-going children in rural parts of the country [29]. The demand for chicken eggs has continued to increase, affecting the prices of these by-products on the market.

4.2.2. Increased Demand for Indigenous Chicken and Products

Most farmers are becoming aware of production costs because of primary records and consultations through social linkages. Indeed, awareness of market prices for inputs and outputs has influenced the decisions made by farmers regarding enterprises that can contribute to their household income, food, and nutritional security. In the past eight years, there have been significant increases in the prices of table-size ICs compared to broilers and spent layers [3]. The price increases for ICs open up the opportunity to increase household income and enhance the socioeconomic benefits for SSFs in Zambia. Recent studies highlighted that the attitudes of consumers towards ICs have improved considerably. The perception is that ICs and related products are healthy for consumption because these chickens are free of medications or chemicals [10,12,18]. The consumers' positive perception allows SSFs to increase their farm income through increased production.

In the past eight years, prices for ICs have increased significantly compared to that of broilers; similarly, prices for eggs have increased (Figure 5). The current trend of consumers' preference for ICs and products is the opposite of past decades, where commercial broilers were a rare delicacy accessed by wealthy households. For example, a field study reported that between 1970 and 1990, the commercial poultry sector was poorly developed; 80% of the rural poultry contributed to national production, and households mainly consumed IC meat and eggs [21]. This significant shift in consumer preferences for ICs indicates that small-scale producers can tap into the growing demand for ICs and increase their farm income [10].

4.2.3. Growth in Human Population

The Central Statistics Office-CSO, 2013 [30] projected that by 2035, Zambia's human population will reach over 26 million, up from 18 million reported in 2020. In 2022, the ZAMSTAT reported the country's human population as being 20 million [14]. The demand for animal-based protein is expected to increase with growth in the human population. Furthermore, the rise in food demand is likely to enhance the potential of the IC sector. Household income, food, and nutritional security must increase proportionally with the increase in the human population to provide decent rural livelihoods. There are likely more opportunities for farmers to improve productivity, add value to their products, and work with farmer groups [31]. The consumption of IC meat and eggs will enhance the well-being of rural communities. Improved extension services and community-based interventions could stimulate increased production of the IC sector in the country [15,29,31]. The IC sector can potentially create employment opportunities for women and young adults in the country, effectively reducing poverty and vulnerabilities [10,12,15,32].

Consumers in urban areas, who are mostly willing and able to buy ICs at the farmer's price, are the most likely market base for the IC sector in Zambia [3,18]. In the future, more

changes in consumption patterns and quantities driven by climate change and population growth in most low-income countries are predicted [10,16,32]. The consumption of chicken eggs has also increased in the past years. Imported eggs from neighbouring countries like Tanzania are essential in meeting the deficits [3]. During times of low egg supply, rural farmers have the advantage of selling IC eggs, which are most preferred by consumers, at favourable prices. Farmers are motivated to promote sustainable production and enhanced rural livelihoods through IC farming while maintaining the IC genetic resources [11]. They also trade and exchange fertilised eggs to preserve and share IC breeds in their communities [11,12,16]. Dumas et al., 2017 [15] acknowledge the poor genetics of ICs, which affects the overall performance of ICs and the socioeconomic gains by SSFs. However, they suggest that community-based interventions can improve the performance of ICs and empower rural families.

4.2.4. Alternative Feed Resources

In pursuing approaches to improving the production of ICs, SSFs are likely to explore cheaper feed sources and utilise some vitamins and minerals. Our study found that over 46% of farmers considered using homemade feed (Figure 6). Further, maize, soybeans, and sunflower were among the top five crops farmers grew and used as feed and feed ingredients for their chickens (Figure 7). Homemade feeds may not be optimal, but farmers consider these diets valuable in meeting chickens' minimal protein and energy requirements [23]. Compounding feed requires farmers to have the skills to ensure that the compounded feed improves chicken performance, especially under FRS. Farmers need skills and good resource management to use crops and crop by-products effectively. These resources are often poorly utilised and fed directly to chickens. Using valuable crop residues, by-products, vitamins, and minerals can significantly improve the performance of ICs, especially in the dry, harsh seasons [23]

4.2.5. Gross Profit and Benefit–Cost Ratio

An analysis of GP and BCR that compared the two scenarios for producing broilers and ICs demonstrated that ICs have a higher potential to contribute to farm income than broilers in small-scale poultry businesses. Costs on feed, management, labour, transport, medications, electricity, and water significantly affect revenue from broiler ventures. In contrast, the minimal or negligible costs of production observed in ICs increase the farmer's opportunity for higher income, as any selling price contributes to household income significantly [7,12,18]. Our study found that farmers producing 100 ICs raised more than USD 560 compared to USD 381 for farmers producing 300 broilers within six months. Thus, the BCR for ICs at 4.5 was three times more than that of broiler production. Based on our assumptions, the analysis of GP and BCR shown in Table 1 suggests that producing ICs was more viable and profitable under small-scale poultry enterprises than producing commercial chickens, mainly due to the effects of production costs and selling prices. Thus, the IC sector has the potential to contribute significantly to households' farm income and food and nutritional security in Zambia. However, to achieve the optimal levels of the IC sector, deliberate interventions are required to mitigate mortality caused by the prevalence of poultry diseases, predators, poor nutrition, and hostile environmental conditions [5,33].

4.3. Implication of Increased Production Costs on the Indigenous Chicken Sector

The IC sector offers a greater chance of increasing farm income for rural farmers. The negligible production costs indicate that at any price, the farmer sells the ICs for a profit [18]. In contrast, increased production costs in broilers and layers make poultry enterprises based on commercial chickens less beneficial to SSFs. These farmers rarely make enough profits and later on break even. The poor access to formal markets exacerbates the low profits for small-scale broiler producers. The Ministry of Fisheries and Livestock data show that most SSFs produce ICs in Zambia. Between 2012 and 2022, there was steady growth in IC numbers, proving that the IC sector is growing [13,14]. During this period, there was

an over 75% increase in IC populations to 21 million. The 2022 livestock survey highlights that rural farmers are predominant in producing ICs, with over 95% of ICs owned by rural households [14]. Previous studies have reported similar trends in the poultry industry in selected parts of SSA [10,21]. These statistics highlight the essential contribution to food and nutritional security held by SSFs in the Zambian poultry industry. The GP and the BCR analysis demonstrate the potential of the IC sector to contribute to rural livelihoods. Farmers need technical and financial support from the government and private sectors to harness the existing opportunities in the IC sector [15,34,35].

5. Conclusions

The chicken sector contributes to the food security and livelihoods of rural communities in Zambia. The ICs have an essential role in the food supply chain, which comprises several activities to make food available to consumers in the correct quantity and quality, and at the correct price. A properly functioning food production or supply chain should position the main actors, small or large, and identify their contribution. These participants have considerable interest in the industry's social, economic, and environmental status. The commercial and indigenous chicken sectors complement each other in providing food and nutritional security.

The two entities contribute to improving livelihoods and enhancing household incomes. However, some challenges faced in the poultry industry may determine its direction in Zambia. The increased costs of live inputs, feed, and feed ingredients have hindered the active involvement of small-scale producers in the commercial chicken sector for many years. Some outcomes of such an impact on the industry include loss of employment and increased prices for commercial chicken meat and eggs. Consequently, more and more small-scale producers were withdrawing from the sector.

Some factors responsible for increased feed and feed ingredient costs include fluctuations in the production and supply of grains such as maize, soybean, and sunflower. Discussions among poultry associations in selected southern African countries show the seriousness and danger, likely due to the unstable supply of grains in the southern region of Africa. The high cost of inputs in the production of commercial chickens will naturally stimulate the IC sector.

Increased consumer demand for IC meat and eggs is likely to turn the production of ICs into a lucrative business for rural farmers. However, to fully harness the IC sector's potential, rural farmers, being major stakeholders, need both technical assistance through extension services and financial support by making loans accessible.

Our study confirms the significant opportunities available in the IC sector regarding the potential of farm income compared to broiler production. The notable viability of the IC sector will trigger growth and increased participation from new players. Skills in compounding chicken feed using locally available feed sources, especially from crops grown by farmers, will enhance the production and performance of ICs.

The Zambian government must enhance policies to promote the sustainable development of the IC sector. Such measures will increase the contribution of the IC sector to the national gross domestic product.

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References

1. Bagopi, E.; Chokwe, E.; Halse, P.; Hausiku, J.; Humavindu, M.; Kalapula, W.; Roberts, S. Competition dynamics and regional trade flows in the poultry sector: The case of South Africa, Botswana, Namibia, and Zambia. In Proceedings of the Pre-ICN Forum, Marrakech, Morocco, 22–25 April 2014; Volume 22.
2. Federico, G. *Feeding the World: An Economic History of Agriculture, 1800–2000*; Princeton University Press: Princeton, NJ, USA, 2008.
3. PAZ. Poultry Association of Zambia weekly poultry news. In *Webpage Weekly Poultry News Issue 3, February 2023*; Poultry Association of Zambia: Lusaka, Zambia, 2023.
4. FAO. *Characteristics of the Four Family Poultry Production Systems*; Technical Report; Food and Agricultural Organisation: Rome, Italy, 2014.
5. Grace, D.; Knight-Jones, T.J.D.; Melaku, A.; Alders, R.; Jemberu, W.T. The Public Health Importance and Management of Infectious Poultry Diseases in Smallholder Systems in Africa. *Foods* **2024**, *13*, 411. [CrossRef] [PubMed]
6. PAZ. Poultry Association of Zambia Weekly Poultry News. In *Webpage Weekly Poultry News*; Poultry Association of Zambia: Lusaka, Zambia, 2021.
7. Dolberg, F. Poultry production for livelihood improvement and poverty alleviation. In *Poultry in the 21st Century*; FAO: Rome, Italy, 2007; p. 26.
8. FAO. *Gross Domestic Product and Agriculture Value-Added 2012–2021—Global and Regional Trends, FAOSTAT Analytical Brief, No. 64. Rome*; Journal Article; Food and Agriculture Organisation of the United Nations: Rome, Italy, 2023.
9. Alders, R.G.; Pym, R.A. Village poultry: Still important to millions, eight thousand years after domestication. *World's Poult. Sci. J.* **2009**, *65*, 181–190. [CrossRef]
10. Bett, H.K.; Peters, K.J.; Nwankwo, U.M.; Bokelmann, W. Estimating consumer preferences and willingness to pay for the underutilised indigenous chicken products. *Food Policy* **2013**, *41*, 218–225. [CrossRef]
11. Gue, E.H.F. Village egg and fowl meat production in Africa. *World's Poult. Sci. J.* **1998**, *54*, 73–86. [CrossRef]
12. Gue, E.F. The Role of family poultry in poverty alleviation, food security and the promotion of gender equality in rural Africa. *Outlook Agric.* **2000**, *29*, 129–136. [CrossRef]
13. Lubungu, M.; Mofya-Mukuka, R. *The Status of the Smallholder Livestock Sector in Zambia*; Indaba Agricultural Policy Research Institute: Lusaka, Zambia, 2012.
14. ZAMSTAT. Ministry of Fisheries and Livestock: The 2022 Livestock Survey Report. In *Formation Center Publications: Agriculture and Environment Statistics*; Zambia Statistics Agency: Lusaka, Zambia, 2022. Available online: https://www.zamstats.gov.zm/ (accessed on 14 January 2023).
15. Dumas, S.E.D.; Lungu, L.; Mulambya, N.; Daka, W.; Lewis, D.; Travis, A. Effect of sustainable poultry interventions on household food security and resilience in game management areas of Zambia's Luangwa Valley: A before-and-after study. *Lancet Glob. Health* **2017**, *5*, S24. [CrossRef]
16. FAO. The Food and Agricultural Organisation of the United Nations. In *The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture*; Scherf, B.D., Pilling, D., Eds.; The Food and Agriculture Organisation: Rome, Italy, 2015.
17. Otiang, E.; Campbell, A.; Thumbi, S.M.; Njagi, L.W.; Nyaga, P.N.; Palmer, G.H. Mortality as the primary constraint to enhancing nutritional and financial gains from poultry: A multi-year longitudinal study of smallholder farmers in western Kenya. *PLoS ONE* **2020**, *15*, e0233691. [CrossRef] [PubMed]

18. Queenan, K.; Alders, R.; Maulaga, W.; Lumbwe, H.; Rukambile, E.; Zulu, E.; Bagnol, B.; Rushton, J. An appraisal of the indigenous chicken market in Tanzania and Zambia: Are the markets ready for improved outputs from village production systems? *J. Livest. Res. Rural. Dev.* **2016**, *28*. Available online: http://www.lrrd.org/lrrd28/10/cont2810.htm (accessed on 18 January 2022).
19. Kanyama, C.M.; Ngosa, M.; Moss, A.F.; Crowley, T.M. The Status of Indigenous Chicken Genetic Resources: An Analysis of Farmers' Perspectives and Implications for Breed Conservation Priorities in Zambia. *Poultry* **2024**, *3*, 161–176. [CrossRef]
20. Andersson, C. *Broiler Production in Zambia-Management, Growth, Diseases and Welfare*; Swedish University of Agricultural Sciences; SLU Animal Nutrition and Management: Uppsala, Sweden, 2014; Volume 29, Available online: http://urn.kb.se/resolve?urn=urn:nbn:se:slu:epsilon-s-3088 (accessed on 25 June 2024).
21. Kitalyi, A.J. *Village Chicken Production Systems in Rural Africa: Household Food Security and Gender Issues*; Food and Agriculture Organisation: Rome, Italy, 1998.
22. MACO. Ministry of Agriculture and Cooperatives: Report on the state of Animal Genetic Resources in Zambia. In *Contribution to First Report on the World's Animal Genetic Resources*; The Food and Agriculture Organisation: Rome, Italy, 2003.
23. Goromela, E.H.; Kwakkel, R.P.; Verstegen, M.W.A.; Katule, A.M. Strategies to optimize the use of scavengeable feed resource base by smallholders in traditional poultry production systems in Africa: A review. *Afr. J. Agric. Res.* **2006**, *1*, 91–100. Available online: https://library.wur.nl/WebQuery/wurpubs/352283 (accessed on 24 July 2024).
24. Berwanger, E.; Nunes, R.V.; Pozza, P.C.; de Oliveira, T.M.M.; Scherer, C.; Frank, R.; Bayerle, D.F.; Henz, J.R. Nutritional and energy values of sunflower cake for broilers. *Semin. Ciências Agrárias* **2014**, *35*, 3429–3438. [CrossRef]
25. Berwanger, E.; Nunes, R.V.; De Olivera, T.M.M.; Bayerle, D.F.; Bruno, L.D.G. Performance and carcass yield of broilers fed increasing levels of sunflower cake. *Rev. Caatinga* **2017**, *30*, 201–212. [CrossRef]
26. Samboko, P.C.; Zulu-Mbata, O.; Chapoto, A. Analysis of the animal feed to poultry value chain in Zambia. *Dev. South. Afr.* **2018**, *35*, 351–368. [CrossRef]
27. Boniface, G.; Magomba, C. *A Multi-Phase Assessment of the Effects of COVID-19 on Food Systems and Rural Livelihoods in Tanzania*; Foreign, Country Report; Commonwealth and Development Office: London, UK, 2021. [CrossRef]
28. Manda, S. Inside Zambia's 'new normal: COVID-19 policy responses and implications for peri-urban Food Security and Livelihoods. *J. Int. Dev.* **2023**, *35*, 1099–1120. Available online: https://onlinelibrary.wiley.com/doi/10.1002/jid.3720 (accessed on 15 January 2024). [CrossRef] [PubMed]
29. Kanyama, C.M.; Moss, A.F.; Crowley, T.M. Strategies for promoting sustainable use and conservation of Indigenous chicken breeds in Sub-Saharan Africa: Lessons from low-income countries [Version 5; peer review: 1 approved, 1 approved with reservation, 1 not approved]. *F1000Research* **2023**, *11*, 251. [CrossRef]
30. CSO. *Central Statistics Office: Population and Demographic Projections, 2011–2035*; 2010 Census for Population and Housing; Zambia Statistics Agency: Lusaka, Zambia, 2013. Available online: https://www.zamstats.gov.zm/ (accessed on 26 October 2022).
31. Livingston, G.; Schonberger, S.; Delaney, S. Sub-Saharan Africa: The state of smallholders in agriculture. In Proceedings of the IFAD Conference on New Directions for Smallholder Agriculture, Rome, Italy, 24–25 January 2011; Citeseer: Princeton, NJ, USA; Volume 24, p. 25.
32. Reta, D. Understanding the role of indigenous chickens during the long walk to food security in Ethiopia. *Livest. Res. Rural. Dev.* **2009**, *21*, 56–82. Available online: https://www.researchgate.net/profile/Reta-Abdi (accessed on 17 August 2023).
33. Simainga, S.; Moreki, J.C.; Band, F.; Sakuya, N. Socioeconomic study of family poultry in Mongu and Kalabo Districts of Zambia. *J. Livest. Res. Rural. Dev.* **2011**, *23*, 31.
34. Gueye, E.F. The role of networks in information dissemination to family poultry farmers. *World's Poult. Sci. J.* **2009**, *65*, 115–124. [CrossRef]
35. Klingholz, R. Klingholz, R. 3 Twice as many people in 2050. In *Transforming Agriculture in Southern Africa*; Routledge, Taylor and Francis Group: London, UK, 2020; p. 17. Available online: https://www.taylorfrancis.com/chapters/oa-edit/10.4324/9780429401701-5/twice-many-people-2050-reiner-klingholz (accessed on 10 January 2022).