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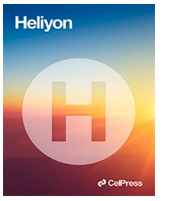

Research article

Management factors associated with the survival and market weight of broiler chickens among small-scale farmers in the Dodoma City of Tanzania

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ABSTRACT

Broiler chickens have the genetic potential for significant weight gain over a very short period of time. As a result, they account for over 92 % of the world's poultry meat production in different parts of the world. Yet, to fully realise their growth potential, effective management practices are crucial, encompassing aspects like nutritious feeds, disease control, optimal temperature, and adequate housing. The purpose of the study was to determine the management practices associated with the survival and market weight of broiler chickens in small-scale production. Small-scale poultry production plays a significant role in poverty reduction and household nutrition in developing countries. One hundred and forty small-scale broiler farmers were visited for interviews in the Dodoma City. Employing a structured questionnaire, data on management practices was gathered, while past production records determined market weight and survival rates. Most chickens weighed 1.8–2.3 kg at the end of the production cycle, with a mean live weight of 2.0 kg. Heat provision to chick housing in the early growth stages increased both survival and market weight. Conversely, chicken vaccination and the farmer's experiences were correlated with an increased survival rate. Furthermore, higher feed quantities offered to growers and finishers were linked to greater market weight. It was concluded that enhancing knowledge among small-scale farmers through training and extension services has the potential to increase broiler productivity.

1. Introduction

The poultry sector is experiencing rapid growth across many regions of the world [1,2]. This expansion is primarily attributed to increasing urbanisation, population, and purchasing power among people [3,4]. Advancements in breeding techniques have led to the development of birds tailored for specific purposes and with high productivity, albeit requiring skilled management [5–7]. Among these birds, broiler chickens (*Gallus gallus domesticus*) are bred and raised specifically for meat production. The short production cycle of broiler chickens makes chicken meat the most popular meat produced worldwide [8,9]. Broiler chickens contribute to over 92 % of global poultry meat production, with major producers including the United States of America, Brazil, and China [10,11]. In Africa, indigenous chickens are the dominant type of chicken kept in rural and peri-urban areas [3,12]. However, production of broilers has increased in urban areas due to population growth, driving increased demand for chicken meat [13,14].

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Broiler chickens typically attain an average market weight of 2 kg at around 5–7 weeks of age [8,15]. However, broiler chickens attain optimal growth when raised under ideal conditions [8,16]. Effective management practices encompass various aspects, including nutrition, housing, health management, biosecurity, and flock management [17]. Temperature is one of the critical factors influencing broiler chicken production [8,18]. Maintaining an ideal temperature range for each stage of growth is crucial. Broiler chickens are particularly sensitive to rising ambient temperatures during the growing stage beyond 21 days of age. However, chicks have a lower body temperature than adult birds, thus requiring additional heat sources during the first 21 days of life to maintain optimal growth and development [8,19].

Proper feeding is critical in the management of broiler chickens [20,21]. Broilers have varying nutritional requirements at different stages of growth. During the first 21 days of life, broiler chickens require 1.1–1.2 kg of starter feed, 1.3–1.5 kg of grower's mash from day 22 to day 35, and 1.4–1.5 kg of finisher's mash from day 36 to day 42 [19]. A well-balanced diet that meets these requirements promotes healthy growth, weight gain, and development. Effective feeding practices enhance feed conversion efficiency, enabling broilers to convert feed into body weight more effectively, thereby increasing profitability [16,22]. Furthermore, proper feeding facilitates the achievement of the desired market weight within the expected time frame [16,23]. However, feeds with nutrient levels exceeding their requirements may enhance live performance but could lead to economic losses due to the high cost of feed [16,24].

Broiler chickens are particularly susceptible to infections due to their rapid growth and high stocking densities [25,26]. As a result, vaccination programmes, along with other biosecurity measures and proper sanitation, are crucial components of disease management [27,28]. Housing plays a critical role in maintaining favourable conditions such as temperature, humidity, and light [19]. Bedding material aids in maintaining dry conditions in the broiler house by absorbing moisture from droppings and spilled water. Moisture control is essential to prevent the growth of harmful bacteria and fungi, which can adversely affect the health and performance of broilers [28,29]. Additionally, bedding helps to regulate the temperature within the broiler house, keeping the birds comfortable and reducing stress [30,31]. Commonly used bedding materials in broiler production include wood shavings, rice hulls, and straw [32,33].

Proper management practices increase production efficiency, reduce losses, and safeguard the wellbeing of the chickens. However, specific management practices may vary depending on farm size, location, market demands, and available resources. In Tanzania, broiler production is carried out by both small and large-scale producers [34,35]. Small-scale farmers typically rear fewer chickens, while large-scale farmers operate larger farms in big cities [35,36]. Small-scale poultry farming plays a significant role in poverty alleviation by increasing household income [34,37]. Expanding small-scale chicken production is crucial for poverty reduction and improving household nutrition. However, the effective production of broiler chickens depends on proper management practices. The study examined factors associated with market weight and the proportion of broiler chickens surviving to market age among small-scale broiler farmers in the Dodoma region of Tanzania. Management factors considered included housing, feeding, disease management, and heat supply for the chicks.

2. Materials and methods

2.1. Study area

Dodoma is one of the administrative regions of Tanzania, located in the central part of the country. It is the capital city of the country and serves as the political hub of the country, housing the central government offices and institutions. The region's population has grown from 2,083,588 in 2012 to 3,085,625 in 2022 [38] due to the shift of government headquarters from Dar es Salaam to the region and the establishment of the University of Dodoma in 2007. The climate in the Dodoma region is semi-arid, characterised by two distinct seasons: a dry season from May to October and a wet season from November to April. Annual rainfall ranges between 500 and 800 mm, varying both seasonally and geographically. Temperatures exhibit seasonal variation, with an average minimum and maximum of 18 °C and 32 °C, respectively [39,40].

Agriculture is the primary economic activity in the Dodoma region, with subsistence farming and small-scale livestock production serving as the main sources of livelihood for many residents. Livestock species kept include cattle, goats, sheep, and poultry. Chicken production is dominated by small-scale farmers who keep local breeds, while exotic breeds are common in urban areas [35,39]. Following the population growth in the region, the government has recognised the importance of improving chickens, especially the exotic breeds with high production efficiency. Investments have been focused on feed processing and breeding [41]. However, understanding management practices and their influence on chicken productivity is important for improving education and extension services, especially among small-scale farmers.

2.2. Data collection

Data collection was conducted from March to May 2023. Five wards, namely Makole, Ipagala, Chang'ombe, Miyuji, and Nkuhungu, were purposefully selected from the Dodoma City due to the availability of broiler chicken farmers. About 220 broiler chicken farmers were estimated in the study area with assistance from district livestock officers. One hundred and forty farmers were selected randomly from the three wards based on Yamane's formula, which is given as: $n = \frac{N}{1+N(e)^2}$ where n = sample size, N = study population, and e = sampling error [42]. The selected farmers were visited, and a semi-structured questionnaire was used to collect information about management practices, the production cycle, and social-demographic aspects of the household. The management information collected included the amount and type of feed offered to the chickens, the heating of the chicken house, bedding materials used, sanitation measures, and vaccination programmes. Information about the amount of feed offered to different age groups of broiler

chickens and the market weight (live weight) of the chickens was obtained from farm records. The proportion of chickens that have survived to market age was calculated as the ratio of the number of chickens sold to the initial number of chickens stocked. The study adhered to the principles of confidentiality and informed consent from each participant. Ethical clearance was obtained from the Directorate of Research and Publication of the University of Dodoma, with a reference number of MA.84/261/02.

2.3. Data analysis

The collected data were coded in Excel, where descriptive statistics were computed to view the data. Further analyses were done in R version 4.3.0. The proportion of chickens that survived to market age per flock was calculated. These proportions and the market weight of the chickens were used as response variables. The response variables were checked to see if they conformed to the assumptions of normality by using histograms. The distribution was normal, as the majority of the chickens weighed 1.8–2.3 kg at market age. A beta regression model was fitted to test the associations between the proportion of chickens that have survived to market age, a set of management practices, and a farmer's experience in chicken production. In addition, a generalised linear model (GLM) was used to test the associations between the market weight of the chickens and management practices. The fitted models were checked for normality by using Q-Q plots and the Shapiro-Wilk test. Additionally, the multicollinearity of the predictors was checked using the variance inflation factor (VIF).

3. Results

The majority of the respondents were female, aged 20–39 years, and had a college education (Table 1). The flock size varied among farmers, with an average of 142 ± 97 SD. The bedding materials used were straw, rice hulls, and wood shavings. The majority of farmers vaccinated their chickens and utilised a heat source to warm the chicken house during the early stages of life (Table 1). The chickens were vaccinated against Newcastle disease, infectious bursal disease (IBD), and fowl pox (34 % of the farmers). The Newcastle disease vaccine was administered on the 7th and 21st days of life, while the IBD vaccine was given on the 14th and 28th days of life. Additionally, the farmers who kept the chickens for more than 5 weeks administered the fowl pox vaccine on the 35th day of life. The average production cycle was 7 weeks, ±1 SD. Most chickens weighed 1.8–2.3 kg at the end of the production cycle (Fig. 1), with a mean weight of 2.0 kg, ±0.5 SD. The amount of feed (mean ± SD) offered to chicks, growers, and finishers per day was 38.7 ± 15.8, 61.8 ± 38.2, and 99.3 ± 51.2 g, respectively. Three-quarters of the initial stock of chickens survived to market age in 41 % of the farmers, half survived to market age in 36 % of the farmers, and a quarter survived to market age in 23 % of the farmers. Diseases were identified as the main challenge to broiler production by 89 % of the farmers, while 7 % identified limited extension services as a main challenge and 4 % identified high feed prices as a main challenge. The main diseases identified were IBD (67 %), coccidiosis (19 %), fowl typhoid (8 %), and avian influenza (6 %).

The main factors associated with the proportion of the chicken flock surviving to market age were vaccination, warming the chicken house during the early stages of growth, and the farmer's experience in chicken production (years involved in chicken production) (Table 2). A larger proportion of chickens survived to market age in farmers who warmed the chicken house, vaccinated the chickens, and had a long experience in chicken production. On the other hand, the market weight was associated with the warming of

Table 1
General characteristics of the respondents and chicken management practices.

Variable	Parameter	Percentage
Sex	Male	20
	Female	80
Age (years)	<20	2
	20–29	36
	30–39	35
	40–49	22
	>49	5
Education level	Primary	29
	Secondary	26
	College	45
Years involved in chicken production	1–2	56
	2–4	43
	>4	1
Bedding materials	Straw	7
	Rice hulls	31
	Wood shavings	62
Feed type	Commercial	50
	Locally made	50
Heating	Yes	83
	No	17
Source of heat	Electricity	44.6
	Charcoal stoves	55.4
Vaccination	Yes	88
	No	12

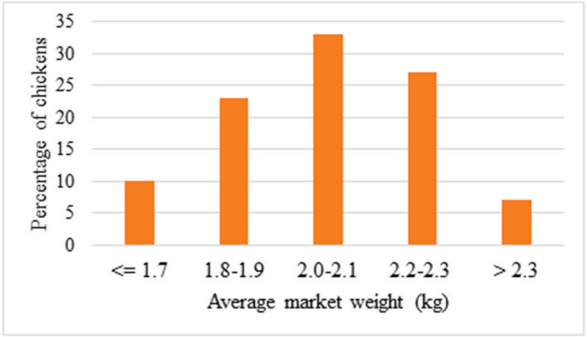

Fig. 1. Percentage distribution of different market weights of the chickens.

the chicken house, the amount of feed offered to growers and finishers, and the length of the production cycle (Table 3). Furthermore, the market price of the chickens had a positive correlation with the market weight ($t = 2.14$, d.f. $= 98$, $p = 0.035$). The market price of the chickens was about 3.5 USD per chicken. Other factors were not associated with response variables.

4. Discussion

The study shows that the market weight of the chickens was within the optimal range of 1.8–2.3 kg, and for the majority of the farmers, three-quarters of the initial flock survived to market age. However, heat provision for the chicks and the amount of feed given to growers and finishers emerged as crucial determinants of market weight. A longer production cycle is correlated with a larger market weight, but this may entail economic implications as extended production cycles increase feed costs. Conversely, the proportion of chickens that survived to market age was correlated with vaccination, heat provision, and the farmer's experience in chicken production.

Broiler chickens are bred for rapid growth, and their nutrition directly affects their growth rate and body weight [5,9,41]. They require a well-balanced diet with all nutritional elements and adequate quantities to maintain their fast growth and health [5,19]. Broilers require high-quality protein for muscle development, minerals for bone health, and essential vitamins for maintaining a robust immune system [16,19]. However, the availability and quality of chicken feed are among the main challenges facing chicken production in Tanzania [36,43]. The majority of broiler chicken farmers use commercially formulated feeds with a nutritional balance. However, due to the high prices of commercial feeds, small-scale farmers normally use locally formulated feeds that are made based on experience [43,44]. Surprisingly, no significant difference was observed in the survival or market weight of the chickens based on the type of feed used, indicating that both the locally formulated feeds and the commercial feeds supplied the required nutrients for the chickens. However, the market weight was associated with the amount of feed given to growers and finishers. The key role of nutrition in the grower stage is to support rapid muscle and skeletal growth while laying the foundation for the final weight of the birds. Finisher nutrition focuses on achieving the desired final weight while maintaining optimal health and meat quality [19,45]. The grower and finisher feeds have lower protein content and higher energy content than the starter feed but are required in larger quantities [46,47]. Consequently, farmers may not be able to buy the required amount at the end of the production cycle, leading to feeding the chickens less than the requirements [43].

Broiler chickens are highly susceptible to poor environmental conditions and management practices due to their fast growth rate

Table 2
Factors associated with the proportion of the chickens that reached market age.

Response variable	Predictors	Levels of the predictors	Estimate	Std. error	t-value	p-value
% chickens reached market age	Intercept		−0.482	0.645	−1.747	0.045
	Feed type	Commercial	0			
		Locally made	0.242	0.133	1.811	0.070
	Vaccination	No	0			
		Yes	0.458	0.201	2.271	0.023
	Bedding materials	Straw	0			
		Rice hulls	−0.116	0.280	−0.414	0.679
		Wood shavings	−0.096	0.264	−0.366	0.714
	Heating provision	No	0			
		Yes	0.560	0.168	3.321	<0.001
	Farmer's experience (yrs.)		0.266	0.101	2.619	0.008
	Flock size		0.013	0.008	1.552	0.121
	Amount of feed (chicks)		0.034	0.005	0.015	0.952
	Amount of feed (growers)		−0.004	0.001	−0.083	0.933
	Amount of feed (finishers)		−0.017	0.003	−0.487	0.625
	Production cycle (weeks)		0.075	0.070	1.072	0.283

Table 3
Factors associated with the weight of the chicken at the end of the production cycle.

Response variable	Predictors	Levels of the predictors	Estimate	Std. error	t-value	p-value
Market weight	Intercept		1.367	0.188	7.246	<0.001
	Feed type	Commercial	0			
		Locally made	0.026	0.042	0.621	0.536
	Vaccination	No	0			
		Yes	−0.017	0.061	−0.289	0.773
	Bedding materials	Straw	0			
		Rice hulls	0.091	0.083	1.085	0.281
		Wood shavings	0.108	0.078	1.390	0.167
	Heating provision	No				
		Yes	0.147	0.045	3.293	0.001
	Farmer's experience (yrs.)		−0.005	0.029	−0.187	0.851
	Flock size		0.015	0.002	0.64	0.949
	Amount of feed (chicks)		−0.002	0.001	−1.269	0.207
	Amount of feed (growers)		0.349	0.076	4.543	<0.001
	Amount of feed (finishers)		0.012	0.005	2.359	0.021
	Production cycle (weeks)		0.042	0.021	1.998	0.048

and short production cycle [48,49]. As a result, disease prevention is one of the most important management practices in broiler chicken production. Vaccination prevents disease occurrence by boosting the chickens' immune system to produce antibodies for fighting pathogens [50,51]. A proper vaccination programme increases the survival of the chickens and reduces the use of antibiotics and other drugs, which may have a residual impact on consumers [52,53]. However, the availability and quality of vaccines are one of the challenges of small-scale chicken production in developing countries [27,53]. Some farmers in this study did not vaccinate their chickens due to financial constraints and thus opted for traditional medicine, such as medicinal plants, which are cheaper. However, this practice was associated with low chicken survival. Thus, increasing education and support for farmers from extension officers can increase knowledge on the importance of vaccinating chickens [54,55].

Maintenance of optimum temperature is a crucial aspect of chicken production. Being homeothermic, birds maintain their internal body temperature at different ambient temperatures. In warm tropical areas, growers and finishers are typically housed at room temperature with good ventilation without the need for additional heat supply [56,57]. However, an extra heat source becomes necessary during the early stage of growth, when the chicks are unable to regulate their own body temperature [19,58]. The brooder temperature should ideally be around 32 °C during the first week of the production cycle to ensure chick survival, gradually decreasing as the chickens grow [57,58]. At low house temperatures, a significant portion of feed intake is utilised to maintain body temperature, thereby reducing available nutrients for growth [59,60]. In this study, heat provision to the chicks increased both their survival and market weight. The main sources of heat in the chicken house are electric lamps, clay charcoal stoves, and kerosene lamps. However, some farmers couldn't afford these heat sources and thus kept the chicks at room temperature. As temperatures drop during the night [40,61], the survival and growth of the chicks are compromised.

Raising chickens is a rewarding endeavour, but it requires knowledge and expertise to ensure the welfare of the birds and optimise production. However, many small-scale chicken farmers lack formal education in chicken production [36,59]. Consequently, they rely on knowledge and skills acquired through production experience [62,63]. The experience of farmers in chicken production allows them to implement best management practices, make informed decisions, and effectively tackle challenges [64,65]. The findings of this study suggest that chicken survival rates increased with the production experience of the farmers. Nevertheless, it's noteworthy that a significant proportion of farmers in the study are relatively new to the industry. While long-term experience is valuable, it is crucial for farmers to stay updated with the latest research findings, industry trends, and technological advancements in poultry farming. Therefore, enhancing training programmes and extension services is important to facilitate knowledge dissemination and keep farmers informed about marketing and other emerging issues in the poultry industry [55,65,66]. Technological advancements have enabled farmers to access extension information through various platforms such as the internet, televisions, mobile phones, and radio [66–69]. However, unreliable electricity and a lack of knowledge on the use of modern tools limit access to extension information for smallholder farmers [66,69].

5. Conclusions

The study found that heating the chicks' house is linked to higher chicken survival rates and market weight. Additionally, vaccination and the farmer's experience in chicken production correlate with increased survival rates. Moreover, providing adequate feed to grower and finisher chickens is associated with higher market weight. However, most farmers are new to the poultry industry, suggesting a need for enhanced knowledge and capacity-building initiatives through training and extension services. These should cover vaccination programmes, feeding, temperature management, and marketing strategies. Given the scarcity of extension officers, leveraging technology such as the internet and mobile phones can facilitate access to information on chicken management, marketing, and credit. Access to markets ensures the timely sale of chickens, reducing additional feeding costs.

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Data availability statement

Data will be made available on request.

Additional information

No additional information is available for this paper.

CRediT authorship contribution statement

Rosemary Peter Mramba: Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Pensia Elias Mapunda:** Writing – review & editing, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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