CHICKEN PRODUCTIVITY UNDER IMPROVED HEALTH CARE AND MANAGEMENT PRACTICES IN DODOMA REGION, TANZANIA

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ABSTRACT

Raising chickens is an important activity in many resources constrained households in developing countries, as it is an important source of economic resilience as well as nutrition and food security. Despite its importance, the poultry industry faces many difficulties, including diseases due to low biosecurity and a lack of knowledge on proper management. A cross-sectional questionnaire survey was conducted to study the management practices that influence the performance of chickens in the households raising them in the Dodoma region of Tanzania. The results showed that 89% of respondents were vaccinating their chickens against diseases like Newcastle, fowlpox, infectious bursal disease and salmonellosis. However, many chicken farmers had incorrect information on the vaccination programs, including the frequency of vaccination and the timing of vaccinations, versus the provision of drugs for prophylactic purposes. The results showed that 29.5% of the farmers vaccinated weekly and 63.5% provided prophylactic drugs weekly. Furthermore, raising different types of chickens (OR = 1.45; p<0.01), frequency of vaccinations, (OR = 1.23; p<0.04), larger flocks of chickens (OR = 1.7; p<0.01), small number of chickens per drinker (OR = 1.64; p<0.05) and per feeder (OR = 2.4; p<0.05) were management factors associated with positive chicken performance in terms of growth rate, egg production and weight gain. It is recommended that the farmers are equipped with the necessary information on best management practices like vaccination regimes, prophylaxis timing and proper ratios of chickens per feeder and drinker.

Keywords: Chicken production, Veterinary care, Management and vaccines, Growth, Performance

INTRODUCTION

Raising poultry helps women and youth to generate funds, which increases family livelihood resilience as well as food and nutritional security in many developing countries, such as Tanzania (Ahiwe *et al.*, 2015; Ngongolo *et al.*, 2020). A carefully controlled poultry management practice that prevents overcrowding, chilling, overheating, frightening and overstocking is universally recommended (Parkhurst and Mountney, 2012). To ensure the best health and productivity in poultry, the following best practices need to be rigorously followed: light management, feeding, feeding schedules, and disease control initiatives (Zhao *et al.*, 2019; Pius *et al.*, 2021; FAO, 2022).

Light is an important environmental factor that influences egg production, behavior and health of laying chickens and, therefore, is widely regulated in commercial poultry housing (Er *et al.*, 2007). The performance of broiler chickens in terms of development, hens' growth, minimum weight before laying, egg quantity and quality are all significantly influenced by food and feeding regimens (Sujatha *et al.*, 2014; Simeneh, 2019). Proper housing and space are similarly very important for the growth, health and performance of poultry (Krause and Schrader, 2019). Stocking density is calculated depending on the body mass to establish the floor space requirements for both laying hens and broilers (Kang *et al.*, 2016). The recommended spacing for hens is 9 hens per square meter and up to 25 birds per square meter, preferably 733 cm^2 per hen, depending on the body mass (Benyi *et al.*, 2006; Krause and Schrader, 2019). Mismanagement of poultry may be associated with different factors. These factors include the following: poor housing, low-quality feeds, improper feeding regimes, a large number of birds per drinker and feeder, and high stocking density, which exposes birds to diseases and results in poor bird performance (Gholami *et al.,* 2020).

Emergency management of infectious diseases and site biosecurity are of great importance in poultry management (Bagust *et al.*, 2008). Poultry succumb to a number of infectious diseases, including those of viral and bacterial origin and infestations with various internal and external parasites, which significantly contribute to impaired feeding, digestion and absorption of nutrients (Chota *et al.*, 2021). These diseases contribute to significant financial losses for the poultry farmers in Dodoma; thus, taking preventive measures to ensure the health of birds is imperative (Ngongolo and Chota, 2022). In efforts to control diseases that occur in poultry flocks, farmers have developed a tendency to treat their poultry using different drugs, thus, exposing the public who depend on poultry products to drug residues and antimicrobial-resistant pathogens (Ngongolo *et al.*, 2020) and contributing to antimicrobial resistance, a public health concern (Mund *et al.*, 2017).

This study examined the existing management strategies for poultry farmers. Also, it identified their shortcomings and offered advice on how to help farmers raise poultry to increase productivity, improve health and ultimately profit from their efforts.

MATERIALS AND METHODS

Study Area: The research was carried out in Kongwa District Council and Dodoma Municipal Council in Tanzania's Dodoma Region. Kongwa district has an annual rainfall average of 736.3 mm between December and April. Livestock keeping is the second main source of income in many poor families after crop cultivation (URT, 2017). In the Kongwa District Strategic Plan 2017 – 2021, the estimate of the poultry population was 0.4 million chickens and 6 thousand ducks (URT, 2017). Dodoma Municipal Council covers an area of 2669 square kilometers, of which 23.4% (625) square kilometers are urbanized. The Dodoma Municipality has 75,000 households and a population of 350,000 people, whose main economic activities include crop cultivation and livestock husbandry (URT, 2017).

Ethical Clearance: The ethical clearance for this study was provided by the University of Dodoma with reference number MA.84/261/02.

Sample Size Determination: The sample size was established using the formula: $n = (Z^2pq)/e^2$ (Mohammed and Obeta, 2015), where n is the required sample size, Z is the 1.96 at 95% confidence interval (CI), p is the prevalence of the disease (0.318), q is 1-p (1-0.318), the percentage of failure and e is the proportion of sampling error standard error, which is the 5% confidence limit. Using this formula, a total of 334 households raising chickens were selected for interview in order to determine the impact of the diseases on chickens. In total, 400 respondents, 200 from each of the two sites, were selected with the help of the District Veterinary Officers and interviewed.

Study Design

Questionnaire administration: A semi-structured questionnaire was prepared and administered to 400 selected members of households in 400 randomly selected households raising chickens in Dodoma Region from July 2020 to October 2020. The questionnaire was face validated, pretested and tested for reliability before administration (Roopa and Rani, 2012). The questions were administered to obtain information on issues of poultry management, including feeds, feeding, disease control and access to veterinary services. Furthermore, the questionnaire obtained information on mortality, the general performance of each of the flocks visited and farmer's household demographic characteristics.

Performance of the Chickens: Using the responses of heads of household on various poultry parameters and flock compositions, the researchers determined the performance of the chickens and graded it in percentages. Egg laying and chickens' age at reaching maturity, growth rate (GR), and the number of eggs a chicken lays in its life span were used to evaluate layers and local chickens. Broiler chicks were evaluated for growth rate (GR) and weight gain (WG).

Data Analysis: Proportions and associations between performance and the management variables were analyzed in R-Studio Platform Version 4.1.2 (R Core Team, 2021) using logistic regression models.

RESULTS

Chickens Flock Composition and Size: The majority of the respondents (70%) raised local chickens, 12% and 6% raised broilers and layers only, and the remaining households raised more than one type of chicken in varying proportions. The flock sizes varied in different households, with 43% raising 1 to 20 chickens and 23% raising more than 100 chickens; the remaining farmers raised varied chicken flock sizes (Table 1).

Different Management Practices: Eighty-nine percent (89%) of the respondents reported vaccinating their chickens at least once against any of the four diseases, Newcastle disease, infectious bursal disease, fowlpox, and salmonellosis. Out of the 89% of respondents who had vaccinated, most vaccinated against Newcastle disease (ND); 74% used an orally administered vaccine (La Sota); 24% used the thermotolerant I-2 vaccine administered with an eye drop; and 2% did not vaccinate for ND. The farmers vaccinated their chickens against infectious bursal disease (58%), fowlpox (56%), and only 3% against salmonella infections. Eighty percent (80%) of the farmers did not provide drinking water to their chickens before administering vaccines in drinking water, and the vaccination frequencies varied among the farmers, with 46% vaccinating once a month. Feed additives were used by 70.8% of the farmers, and most of them (64%) used prophylactic drugs once a week. The percentage of birds per drinker and feeder was 77% (Table 2).

Levels of Mortality Resulting from Different Diseases: Farmers with up to 20 birds reported fowlpox as a major cause of mortality in their flock and salmonellosis was reported to have less impact. Newcastle disease and Infectious bursal disease were more or less equally distributed in causing mortality to flock with up to 20 birds. However, less mortality from salmonellosis was reported by farmers that kept more than 20 birds (Table 2).

Different Key Records Kept by Farmers in the Management Practices: Most of the farmers (58%) did not keep records as compared to 42% who kept records. Out of those that kept records, majority (12%) kept records on treatment and vaccinations (Table 3).

Cumulative Households' Chickens' Percentage Scores of the Performance: The performances of the chickens scored by percentage showed that 81 – 90% of the farmers had good performance, followed by those with 71 – 80%.

Table 1: Proportions of respondents' distributions in districts, chicken flock composition and size

Parameter	Responses	Number of respondents	Percentage of respondents
Districts	Dodoma mjini	225	56
	Kongwa	175	44
Types of chickens per households	Broilers	48	12
	Broilers and layers	6	2
	Broilers and local	10	3
	Broilers, layers and local	10	3
	Layers	25	5
	Layers and local	22	5
	Local	279	70
Flock size per household	1 to 20	171	43
	21 to 40	89	22
	41 to 60	10	3
	61 to 80	16	4
	81 to 100	22	6
	100+	92	23

Table 2: Proportions of respondents' responses on different management practices

Variables	Vaccines administration		Number of respondents	Percentage of respondents
Vaccination	Yes		356	89
	No		44	11
Types of vaccines and the mode of administration	Newcastle Disease	Oral	295	74
		I-2 NDV	95	24
		No	10	2
	Infectious bursal disease	No	232	58
		Oral	168	42
	Fowlpox vaccine	No	225	56
		Injection	175	44
	Salmonella	Oral	10	3
		No	390	97
Vaccination frequency	Once in a month		184	46
	Once in a week		118	29
	Once in three months		35	9
	Three times in a month		3	1
	Twice in a month		60	15
Deprive water before vaccination	Yes		321	80
	No		79	20
Veterinary services	After a problem		3	1
	Frequently		3	1
	Once in a month		225	56
	Once in a week		118	29
	Twice in a month		51	13
Additional feed additive	Yes		283	71
	No		117	29
Prophylaxis	After every two months		3	1
	Every day		35	9
	Once in a month		48	12
	Once in a week		254	64
	Three times in a week		3	1
	Twice in a months		54	12
	Twice in a week		3	1
Number of drinkers	One for ten		308	77
	One for twenty		57	13

	One for thirty	19	8
	One for forty	10	1
	One for fifty	6	1
Number of feeders	One for ten	305	77
	One for twenty	60	15
	One for thirty	25	6
	One for forty	6	2

Table 3: Proportions of respondents' responses on different key records kept in the management practices

Parameter	Responses	Number of respondents	Percentage of respondents
Record keeping	Yes	168	42
	No	232	58
Types of records kept	None	232	58
	Treatment and vaccination	48	12
	Treatment, vaccination and feeding	6	2
	Treatment, vaccination and production	10	2
	Treatment, vaccination and supplementation	29	8
	Treatment, vaccination and weight	3	1
	Treatment, vaccination, feeding and production	22	7
	Treatment, vaccination, feeding and weight	19	5
	Treatment, vaccination, production and weight	10	2
	Treatment, vaccination, production, feeding and supplementation	3	1
	Treatment, vaccination, production, feeding and weight	3	1
	Treatment, vaccination, weight and sup	3	1
	Vaccination	10	2
	Vaccination and supplementation	3	1

A small percentage of farmers had very low performance of between 21 – 30% (Table 3).

Univariate Logistic Regression Model for Performance and Measured Management Variables: Several variables were found to have favorable impact on the performance of chickens in univariate analysis. However, inability to vaccinate against fowlpox (OR = 0.83; 95% CI: 0.72 – 0.96, p = 0.0119) and presence of various challenges in management (OR = 0.45; 95% CI: 0.26 – 0.78, p = 0.0049) had significant negative effects on the performance of the chickens. Increased flock size (OR = 2.19; 95% CI, 1.65 – 2.91; p = 0.005) was also associated with improved chicken performance (Table 4).

Multivariate Logistic Regression Model for Performance and Measured Management Variables: Multivariate analysis revealed that raising flocks of different types of chickens (OR = 1.45; 95% CI, 1.10 – 1.89, p = 0.0085), a high frequency of vaccinations once a week (OR = 1.23; 95% CI, 1.01 – 1.49, p = 0.039), and larger flocks of 81 – 100 chickens (OR = 1.70; 95% CI, 1.16 – 2.49, p = 0.0072). The presence of various challenges was significantly associated with poor performance (OR = 0.6; 95% CI, 0.37 – 0.99, p = 0.05). Smaller numbers of chickens per drinker and feeder had a positive influence on chicken performance (OR = 1.64; 95% CI: 1.08 – 2.49, p = 0.022) when compared to larger numbers of chickens per drinker and feeder (Table 5).

DISCUSSION

Household Demographics, Flocks Sizes and Management: Raising chickens is a source of income for many resource-constrained families, who primarily raise chickens to meet their households' needs. The study has shown that majority of the farmers raise local chickens, which in most cases were associated with backyard production systems.

Table 4: Univariate logistic regression analysis for performance of poultry in different measured parameters/variables

Outcome	Variable	Odds Ratio	95% Confidence level	P-value
Performance of chickens in terms of production	Type of chicken raised-Mixed raising	1.7	1.3 - 2.24	0.0002
	Vaccination against IBD – Yes	1.22	1.06 - 1.4	0.0066
	Vaccination against Fowlpox – No	0.83	0.72 - 0.96	0.0119
	Vaccination frequency			
	Once in a week	1.19	1.01 - 1.4	0.036
	Once in three months	2.41	1.1 - 5.27	0.0644
	Flock size			
	Flock of 21 – 40 chickens	1.24	1.05 - 1.46	0.013
	Flock of 81 – 100 chickens	2.19	1.65 - 2.91	<0.05
	Facing challenges in raising chicken – Yes	0.45	0.26 - 0.78	0.005
	Ratio of drinkers to chickens			
	One drinker to 10 – 20 chickens	1.81	1.19 - 2.75	0.006
	One drinker to 21 – 30 chickens	1.39	1 - 1.93	0.055
	Ratio of feeders to chickens			
	One feeder to 10 – 20 chickens	2.41	1.1 - 5.27	0.0295
	One feeder to 21 – 30 chickens			

Table 5: Multivariate logistic regression analysis for performance of poultry in different measured parameters/variables

Outcome	Variable	Odds Ratio	95% Confidence level	P-value
Performance of chickens in terms of production	Type of chicken raised-Mixed raising	1.45	1.1 - 1.89	0.0085
	Vaccination frequency – Once in a week	1.23	1.01 - 1.49	0.0391
	Flock size of 81 to 100 chickens	1.7	1.16 - 2.45	0.0072
	Facing challenges in raising chicken - Yes	0.6	0.37 - 0.99	0.0495
	Ratio of drinkers of, one drinker to 10 – 20 chickens	1.64	1.08 - 2.49	0.0223
	Ratio of feeders of, one feeder to 10 – 20 chickens	2.4	1.18 - 4.90	0.0177

This is due to the fact that local chickens were easy to raise with varying degrees of resistance to diseases (Okoye and Aba-Adulugba, 1998; Msoffe *et al.*, 2002). In this study, farmers, despite keeping mostly local chickens, included those who raised different types of chickens in the same households; this report was similar to previous reports of Padhi (2016). Raising different types of chickens aimed at consolidating the households' economic resilience, taking advantage of the ease of raising local chickens, which have low productivity, and the better returns from layers and quick returns from broilers, the latter two being characterized by the need for close management (Msoffe *et al.*, 2002; Padhi, 2016). In many households, small flocks of 1 – 20 and 21 – 40 chickens were mostly local chickens, whereas larger flocks of 81 – 100 and above were mostly exotic chickens, which were broilers or layers; these observations were also reported by Ngongolo and Chota (2021) and Mujyambere *et al.* (2022).

The Importance of Vaccination as a Disease Control Strategy: Many of the farmers who raise chickens nowadays are familiar with vaccines. According to this study, 89% of the farmers vaccinated their chickens against a variety of diseases that are prevalent in their communities. The results are corroborated by a prior report, which points to vaccination as a crucial managerial technique (Marshall, 2020). Increased vaccine adoption can be attributed to an increase in the flow of vaccine information among chicken farmers (Campbell *et al.*, 2018).

Vaccination Practices as a Control Strategy for Newcastle Disease: The study reported that majority of the farmers vaccinated their chickens against Newcastle disease (NCD) using either water soluble or thermotolerant I-2 Newcastle disease vaccine (I-2NDV). The thermotolerant I-2 Newcastle disease vaccine has been advocated for use in local chickens because it is easy to handle in the absence of a cold storage facility. Furthermore, only 2.5% of farmers that vaccinated their chickens were not vaccinating against NCD. As reported in this study and from previous reports vaccinating against Newcastle disease reduced the losses emanating from this deadly disease (Sedeik *et al.*, 2019) when broilers were vaccinated using various vaccine prototypes. Thermotolerant I-2 NDV has also been reported to confer strong protective immunity in vaccinated village chickens (Wambura *et al.*, 2000; Komba *et al.*, 2012).

Vaccination Practices as a Control Strategy for Infectious Bursal Disease: Less than 50% of the farmers vaccinated their birds against Infectious bursal disease, and this may be due to the fact that the majority of them kept local chickens. There is a perception among farmers raising chickens that infectious bursal disease is not a big problem in local chickens, and they do not vaccinate against the disease. However, the vaccines' pack size, administration in water, need for a cold storage facility and availability of vaccines in local areas may be barriers to vaccination. Previous studies have emphasized the need for vaccination of local chickens and layers (Mammo *et al.*, 2008), and serious problems following outbreaks of IBD in local chickens and layers have been reported (Okoye and Aba-Adulugba, 1998; Chota *et al.*, 2021).

Vaccinations as a Control Strategy for Fowlpox: In addition, less than 50% of the farmers raising chickens, particularly layers and local chickens vaccinated against fowlpox. The low levels of vaccinations may be associated with the vaccine administration route, which is through injections, the vaccine package size, and the requirement of a cold storage facility. Challenges in the administration of this vaccine prompted studies on the other routes, like aerosol, oral (drinking water), or cutaneous, in the 1990s, which provided promising results when viral concentrations were high (Nagy *et al.*, 1990; Mockett *et al.*, 1990; Jieyuan and Spradbrow, 1992). Currently, the vaccine for control of fowlpox used in Tanzania is an injectable preparation.

Vaccinations as a Control Strategy for *Salmonella* Infections: Low vaccination rates were also recorded in the control of Salmonella infections; only 3% of the farmers vaccinated the chickens they raised. Salmonella infections were reported in previous study as a more serious disease in the households where chickens were raised (Chota *et al.*, 2021). According to the nature and epidemiology of the disease, serious programming of vaccination regimes is of paramount importance in reducing the negative impacts emanating from the disease (Ngongolo and Chota, 2022). Most farmers use antibiotics to control the disease (Ngongolo *et al.*, 2020), which raises the risk of antimicrobial resistance and drug residues in chicken products (Chota *et al.*, 2021). Efforts have to be put forward to make sure vaccines are readily available to resource constrained families in developing world, who largely depend on raising chickens as a means of family economic income.

Vaccines and Vaccination Regimes: This study reports a large variation in vaccination frequencies practiced by farmers raising chickens in the study area, which means most farmers were not well informed on the vaccination regimes. In this study, almost 50% of the farmers vaccinated their birds once a month for Newcastle disease, which requires a booster dose every three months. This added to the cost of production. The study showed that only 9% of the farmers vaccinated their birds at the required frequency of once every three months (Poultry Care, 2021). Previous studies indicated that when vaccines are correctly administered, they prevent diseases. For instance, Dimitrov *et al.* (2017) reported the prevention of disease in healthy chickens when

vaccinated properly against Newcastle disease, despite the challenges that may result in disease outbreaks, including uneven vaccinations in larger flocks, vaccinating free roaming village chickens, multi-aged flocks, and the difficulty in maintaining cold chains. The presence of thermotolerant I-2 Newcastle disease and vaccination in 24% of the chickens helps in overcoming the cold storage facility challenge in village settings; thermotolerant I-2 NDv provides proper immunity in all types of chickens, including broilers (Asl Najjari *et al.*, 2017). For vaccines administered with drinking water, 80% of the farmers deprived chickens of water prior to vaccination to increase the chickens' vaccine consumption in order to minimize uneven vaccinations.

Access to Veterinary Services and Concepts of Vaccinations and Prophylaxis: More than 50% of the farmers had access to veterinary services at least once a month, yet some of them relied on providing prophylaxis once a week and vaccinating frequently in a month, which are not consistent with recommended best practices and vaccination schedules, respectively. This may be due to the fear these farmers have of the economic losses that may emanate from mortality that may result from diseases (Ngongolo *et al.*, 2020). The majority of the respondents had a better ratio of birds per drinker and feeder, and almost half of them kept necessary farm records.

Established Cumulative Performance of the Chicken Flocks: In this study, a large percentage of the farmers reported high performance of their flocks. Generally, the performance was good, when the ratio of drinkers to birds was low. The results were in line with the results reported by Kang *et al.* (2016) on the performance of chickens and blood parameters in relation to stocking density. The observed good performance was an indication of good welfare status.

Management Practices as Factors that Influenced the Chickens' Performance: In management practices, good performance was significantly related to the raising of different types of chickens (OR = 1.45). The raising of different types of chickens implies an increased commitment to raising them and the need for multiple sources of income for the family economic resilience. The performance of the chickens in terms of growth rates, egg production and weight gains have also been reported in previous studies (Bekele *et al.*, 2010; Gimbi *et al.*, 2013; Wang *et al.*, 2018), despite the implied high costs, increased vaccination frequency had a positive impact on performance (OR = 1.23) and decreased to an insignificant association as the frequencies were reduced. Despite the fact that it is not the recommended practice for most of the vaccines for the diseases included in the study, it seemed to have a positive effect as it solidified the control of diseases compared to when the frequency is low. This increased frequency increases the losses gained as a result of disease control (Ngongolo and Chota, 2022), which can be reduced by adhering to the recommended vaccination programs, as also reported by Otiang *et al.* (2021) on Newcastle disease vaccinations. High performance was also significantly higher in flocks with larger flocks (OR = 1.7), which may be due to the increased commitment, be more economical given the flock size, or be because large flock owners had more access to veterinary services. Better performance and an increase in flock size in vaccinated chickens were also reported by Javed *et al.* (2003).

The Influence of Various Challenges on the Performance of Chickens: The famers that reported various challenges (OR = 0.6), including; theft, predation, a lack of experts, and unavailable huts, had a significant negative effect on the performance of chickens. In a previous study, Ngongolo *et al.* (2020) reported these challenges as factors that cause negative social and economic impacts on chicken production.

The Effect of Drinkers and Feeders on the Number of Chickens and their Performance: There was a significant positive association between performance and low birds-to-drinker ratios (1 drinker for 10 birds) with an OR of

1.64 and birds-to-feeder ratios (1 feeder for 10 birds) with OR of 2.4. This implied that there was easy access to drinking water and feed. Previous studies have associated water and feed intake with increased performance (Koelkebeck *et al.*, 1999; Abbas *et al.*, 2009; Gutierrez *et al.*, 2009).

Conclusion: Proper management has a positive correlation with the performance of chickens. However, the farmers raising chickens seem to lack correct information on proper management, or ignore the best practices in poultry management, or fear losing their chickens due to mortality caused by diseases. As a result, they opt for practices that result in high costs of production. The study strongly recommend that extension workers continue educating poultry farmers to consistently follow good poultry management practices, and educate them on appropriate records keeping. Farmers raising chickens should also be assisted in planning for prophylaxis provision.

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