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Husbandry practices, disease management and production profiles among smallholder layer chicken farms in Morogoro Municipality, Tanzania

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SUMMARY

Husbandry practices, disease management and production profiles were examined among 46 smallholder layer chicken farms in Morogoro, Tanzania; using a structured questionnaire and direct observations. Farmers kept their chickens in deep litter system or in cages. The average flock size was 350 birds (97-8000). Chickens were stocked at day old or at 12 to 14 weeks of age. For day old chickens farmers used antimicrobials in the first seven days, combined with multivitamins. Farmers vaccinated chickens against Newcastle disease, gumboro and fowlpox. Beak trimming was performed at 12 to 16 weeks. Most farms had a foot bath at the entrance to poultry houses. Chicken house cleaning was regular for cage system. Some farmers sent dead birds to veterinary centres for necropsy and others disposed or fed them to dogs. Some farmers used commercial feeds for their chickens whereas others made their own. The average age at point-of-lay was 20 weeks (16-22) and peak lay was attained two to three months later. Laying percentage varied greatly between flocks (55-90; mean 76); and fluctuated within flocks. Farmers attributed drop in egg production to diseases, feed quality, stresses and use of sulphur drugs. Viral, bacterial, parasitic and nutritional diseases were reported to be common in the flocks. The culling age was 18 to 24 months. The study revealed inadequacies in layer chicken husbandry and flock health management. Eventually the production was poor with irregularities. Improvements in husbandry and disease management would increase and sustain production.

Keywords: Bio-security, Husbandry practices, Layer chickens, Morogoro, Production profiles

INTRODUCTION

Chicken production constitutes one of the major agricultural activities in Tanzania, with 94% of the total chicken population kept in villages and in peri-urban areas under the traditional free range system, in most cases owned by women (MAFC, 2008). The traditional poultry system is the largest, supplying more than 90% of poultry meat and eggs consumed in rural areas, and 20% of the same consumed in urban areas. A decade ago, improvements in husbandry practices and adoption of a thermostable vaccine (strain I_2) to control Newcastle disease, resulted into an increase in egg production from 790 million in 2002 to1.8 billion in 2006 (MLD, 2008; Msami, 2008). Eventually, the per capita consumption of eggs rose from 23 eggs in 2002 to 50 eggs in 2008 per person per year. Despite an increase in supply of eggs the demand is still high, and the per capita consumption of eggs in Tanzania is quite low, compared with 106 eggs per person per year for Africa and 190 for high income countries (Gueye, 2004). The rising demand for eggs calls for more investments in the intensive layer chicken production and the poultry industry as a whole.

Layer chickens are among the most adaptable domesticated animals and more people are directly involved in layer chicken production throughout the world than in any other single agricultural enterprise (Bishop, 1995). Commercial poultry farming in Tanzania was introduced during the 1980s, and overtime visible growth in the production of layers has been observed to supplement egg supplies particularly in urban areas. The production of layer chickens is a better source of earning cash because it offers higher net returns (Paul *et al.*, 1990); as compared to the production of local chickens which however predominate in the country. Small and medium enterprises have increased the numbers of layers from 27 million in 2001 to 38 million in 2008 while the commercial stock increased from 20 million to 25 million. On average, 5.5 million hatching eggs and one million day old chicks are imported annually to produce a total of 25 million day old chicks for commercial purposes (MLD, 2008). This figure is low compared to the actual requirement of 60 million day old chicks per year.

The production of layer chickens is gaining popularity in Tanzania with people's engagements at different scales. The small scale backyard production predominates, mostly engaging women either as a primary or secondary source of income at household level. This study aimed at evaluating husbandry practices, disease management and production profiles of layer chicken kept by smallholder farmers in Morogoro Municipality. The information created will provide basis, for different players in the livestock sector with bias on the poultry industry, to identify entry points for interventions aimed at making the industry a

profitable venture.

MATERIALS AND METHODS

Study area

The study was conducted in Morogoro Municipality, Eastern Tanzania. Geographically the study area is located within the tropical Savannah woodland at the foot of the Uluguru Mountains at the altitude of 500-600 m above sea level; and the latitude 5.7 N and 10^0S and longitude 35.6^0W and 39.5^0E. The average annual rainfall is between 600-1000mm with peaks usually in December and April. Among the farming activities in the Municipality are commercial (broiler and layer) and free ranging chicken production, mainly as backyard activities involving family members. Layer chickens produce eggs which are sold directly to consumers or to retailers and whole sellers. At the end of the laying period layer chickens are sold as spent layers for human consumption.

Study design, sample size determination and sampling procedure

This was cross-sectional study conducted from April to July 2017 with the aim of determining husbandry practices, disease management and production profiles of layer chicken kept by smallholder farmers in Morogoro Municipality. In total 46 farmers from different locations in the Municipality were involved based on availability and willingness to provide information and allowing the researcher to access poultry units for onsite observation of some attributes. A list of layer chicken keepers in the Municipality was made by the aid of chicks suppliers, input suppliers and veterinary practitioners involved in provision of services to the farmers. A snowball sampling technique was also adopted as farmers tend to know fellows in the industry for different reasons.

Data collection

During collection of data, questionnaire survey (face to face interviews) and direct observation methods were used. At each household, general information of the respondent and poultry farming history were collected first. Collection of information on husbandry practices focused on chicken housing, flock management, feeding, daily routines and animal waste handling. Disease management information targeted areas of prevention and control. Production profiles were assessed based on collection of information in the following areas: the average age at point-of-lay, age at peak lay, the laying percentage, production trends, the culling age and factors affecting egg production.

RESULTS

Respondents socio-demographic profiles and poultry farming history

A total of 46 layer chicken keepers were interviewed in this study reached in different wards i.e. Boma (4.4%), Kichangani (8.7%), Kihonda (8.7%), Kihonda Maghorofan (17.4%), Kilakala (4.4%), Lukobe (13.04%), Mafisa (4.4%), Magadu (4.4%), Mazimbu (21.7%), Misufini (4.4%), Mlimani (4.4%) and Mkambalani (4.4%). Their socio-demographic attributes are summarized in Table 1. There were different experience levels in chicken keeping among the 46 farmers interviewed in this study. Twenty farmers (43.5%) had an experience of up to 5 years, 16 farmers (34.8%) had an experience of between 6-10 years, 10 farmers (21.7%) had an experience of 11 or more years the longest being 28. On entering the poultry industry majority of the interviewed farmers (52.2%) started with layer chicken keeping, 16 farmers (34.8%) started with broiler keeping, four farmers (8.7%) started with local chicken keeping and two farmers (4.4%) started with both broilers and layers. Sixteen famers (34.8%) among those interviewed had attended seminars on chicken husbandry and health. Most of the farmers attended the seminars in Morogoro Municipality (95.6%), while a few (4.4%) attended the seminars in Dar es Salaam. Organizers of the different training events were NGO's (21.7%), feed manufacturing companies (4.4%), drug companies (60.8%), chick supply companies (8.7%) and veterinarians in private practice (4.4%). The sources of information for different aspects of poultry production among the respondents were: Agro- vet shops staff (42 respondents; 84%), fellows (25 respondents; 54.3%) and animal health professionals (40 respondents; 87.0%).

Table 1: Socio-demographic profiles of visited small holder layer chicken keepers in Morogoro Municipality

Attribute	Level	Number of responses	Proportion (%)
Sex	Males	14	30.4
	Females	32	69.6
Age distribution	20-30 years,	6	13.04
	31-45 years	18	39.1
	46-70 years.	22	47.8
Marital status	Married,	40	86.9
	Single	4	8.7
	Widowed	2	4.4
Level of education	Post-secondary	24	52.2
	Secondary level	16	34.8
	Primary	6	13.04
Household size	1-5 people,	30	65.2
	6-10 people	14	30.4
	11-15 people	2	4.4
Primary occupation	Chicken keeping	22	47.8
	Wage employees	12	26.1
	Business	10	21.7
	Retirees	2	4.4

Layer chicken housing and flock characteristics

Majority of the interviewed farmers (78.3%) used deep litter system of rearing their layer chickens; the rest (21.7%) used battery cages. On assessment of the house condition 34 farmers (73.9%) had their poultry houses in good condition and 12 farmers (26.1%) had the houses in a poor condition. Spots of wet litter were common for the deep litter system particularly around drinkers. Ventilation problems were among the deficiencies seen in chicken houses in poor condition. Of the farmers involved in this study, 43.5% kept layer chickens together with other types of birds in the same compound; whereas 26 farmers (56.5%) kept only layers. More than half (56.5%) of the farmers had single flocks at the time of visits during this study. Some of those with multiple flocks had bird flocks that were below the egg production age. The average flock age as found during the data collection period was 46 weeks (23-67). The average flock size was 350 birds (97-8000). Most of the farmers (84.8%) stocked chickens at day old, while a few stocked at 12 to 14 weeks of age. For multi-flock farms there was no clear physical separation between flocks; and most of the farms (60.9%) allowed movement of attendants between the flocks whereas the remaining few farms (39.1%) restricted such movement. Most of the farmers (86.9%) had brooding system and six farmers (13.04%) had no that facility. Of the interviewed farmers 20 (43.5%) had one attendant

while the rest had more than one attendant.

Figure 1. Layer chickens kept in deep litter system in Morogoro, Tanzania

Figure 2. Layer chickens kept in battery cages in Morogoro, Tanzania

Feeding practices and flock management

Fourteen farmers (30.4%) used commercial feeds only, sixteen farmers (34.8%) made their own feed at commercially run poultry feed mills and 16 farmers (34.8%) used both commercial and own made feeds interchangeably. The feeding of chick starter, growers mash and layers mash to respective age groups differed in regimes among farms. Thirty seven farmers (80.4%) used starter from day one up to two months, whereas nine farmers (19.6%) used chick starter from day one to three months. Thirty five farmers (76.1%) fed their chicken with growers mash from two to four months and 11 farmers (23.9%) fed their chicken with growers mash from three to five months. In cases of delayed age at point-of-lay most farmers kept their grower chickens on "growers' marsh" until when egg laying started

before switching over to layers' mash. Almost two thirds of the interviewed farmers (65.2%) switched over from one feed category to the other gradually over a week or two by mixing the two types until they had them on the subsequent; the rest (34.8%) did the switch over abruptly. The majority of the farmers (87%) fed their chicken twice per day, four farmers (8.7%) once per day and two farmers (4.3%) three times per day. Five brands of commercial feeds were commonly used by interviewed farmers, with majority of the farmers (69.6%) sticking to only a single brand. Layers were fed between 125 g and 130 g a day. The drinker/feeder: chicken ratio varied considerably both between and within farms for the deep litter system, ranging from 1 to10 for 100 birds. Chickens in most of the farms (69.6%) received drinking water from the Municipal supply, whereas the remaining (30.4%) used underground water. Treatment of water prior to supply to birds was practiced by very few (15.2%) of the interviewed farmers

Other routine management practices

Apart from feeding, watering and cleanliness; other routine management practices among the layer farms included manure collection and disposal, eggs collection, beak trimming and observation of sick birds. Some farmers associated some of these practices with stress to birds and thus resulting in drop in eggs production (34.8%) and sometimes disease occurrence (23.9%).

Disease management

Access to veterinary services

Forty out of the 46 interviewed farmers (87.0%) make use of animal health professionals in disease management while 6 farmers (13.0%) don't. Of those who make use of animal health professionals, fourteen of them (35.0%) use degree holders, 14 farmers (35.0%) use diploma holders and 12 farmers (30.0%) use animal health professionals whose qualifications they don't know. Some farmers (42.5%) use a specific animal health professional but others (57.5%) use any conveniently available. The animal health professionals providing services to farmers come from a Livestock Training Agency (15.0%), private facilities (65.0%), Sokoine University of Agriculture (15.0%) and from Non Governmental Organizations (5.0%). Among others, services delivered by the animal health professionals include disease treatment, disease prevention, input supplies, extension services; and market search for eggs and spent layers.

Disease prevention by vaccination and biosecurity

Farmers vaccinated their birds against Newcastle disease (100.0%), Infectious bursal disease (100.0%) and Fowl pox (47.8%). Vaccines were sourced from agro-vet shops and were handled on ice packs (43.5%) or in the fridge (52.2%) prior to use. Two farmers didn't use any cold chain in handling the vaccine before use claiming instant use. Two types of Newcastle disease vaccines are used in the study area i.e. LaSota® strain administered in drinking water and the thermo-tolerant I_2 strain vaccine administered as eye drops. For vaccines administered in drinking water, some farmers (19.6%) used underground water and rain water for reconstitution claiming to avoid chlorine in tap water. Following reconstitution farmers allowed the birds to drink vaccine water for an average of 1.5 hours (30 minutes to 3 hours). The fowl pox vaccine is administered through the wing web. Bio-security measures adopted by farmers in disease prevention included isolation of sick birds, disposal of dead birds by burying, traffic control and use of footbaths with disinfectants on their farm entrances (91.3%). Some farmers (15.2%) treated drinking water for birds using recommended levels of disinfectants.

Disease treatment and prophylaxis

A large proportion of the farmers (91.3%) uses prophylaxis for various disease conditions particularly coccidiosis (52.2%), avitaminosis (60.9%), worms (26.9%) and egg peritonitis (10.9%). Some of the prophylactic treatment products are included in feeds as seen for some commercial brands that indicated inclusion of coccidiostats in their feeds. All the farmers who stocked day old chicks supplied them with sub-therapeutic doses of antimicrobial agents in the first seven days, combined with multivitamins. Farmers in the study area used mainly water soluble powders for treatment of different disease conditions (Table 2). They obtained the drugs from veterinary centres, prescribed by animal health professionals following diagnosis based on necropsy or clinical picture as described by farmers or seen by a professional on a farm visit. Forty farmers (87.0%) were aware about the drug withdrawal period following bird treatment, while the rest (13.04%) were not.

Table 2: Common diseases among layer chicken flocks in Morogoro Municipality (diagnosis based on clinical picture and necropsy)

Category	Diseases	Drug used for treatment
Viral	Newcastle	None; supportive therapy provided
	Gumboro	None; supportive therapy provided
	Fowl pox	None; supportive therapy provided
	Avian leucosis	None; supportive therapy provided
	Marek's	None; supportive therapy provided
Bacterial	Fowl typhoid	Oxytetracycline, Sulphur drugs
	Omphalitis	Oxytetracycline, Doxycycline
	Fowl cholera	Sulphur drugs, Norfloxacin
	Necrotic enteritis	Norfloxacin, Enrofloxacin
	Infectious coryza	Chlortetracyclines, sulphur drugs
Parasitic	Coccidia	Sulphur drugs, amprolium
	Helminths	Ivermectin, piperazine citrate, albendazole
	Mites	Carbamates, pyrethroids, ivermectin
	Lice	Carbamates, pyrethroids
Nutritional diseases	Avitaminosis A	Vitamin supplements
	Hypocalcemia	In-feed mineral supplements
	Vitamin E deficiency	Vitamin supplements

DISCUSSION

Production profiles of layer chickens in the study area

It was revealed from farmers' responses that the average age at point-of-lay was 20 weeks (16-22) and peak lay was attained two to three months later. The laying percentage varied greatly between flocks (55-90; mean 76); the highest recorded for caged layers. Within flocks fluctuations in laying percentages were reported by all farmers and many of them attributed these to changes in feed quality, weather, disease, stress and vices. The average production longevity of the layer chicken stocks as captured from interviewed farmers was 19 months (18 to 24) after which the birds were culled. Some farmers had an opinion that the layer chickens they are keeping had a potential to produce eggs for a longer period, but the period is shortened due to several challenges including disease and poor feed quality. Apart from lower percentage rates, other production problems reported by layer chicken keepers included thin shelled eggs, relatively small eggs and occasionally extremely large eggs impacting the vent.

Challenges in layer chicken production

Main challenges mentioned by layer chicken keepers in relation to layer chicken production were diseases, extreme weather, predation, cannibalism, vaccine failures, housing, poor chick quality, fluctuation in poultry feed price and quality, and poor market structure for eggs. Furthermore, farmers mentioned the following problems specific to battery cage housing system: breakages in battery cages, wet floor (17.4%), injury to chickens caused by wire mesh (8.7%), egg perking (8.7%). Problems linked to deep litter housing system included; easy spread of diseases (30.4%), stress (30.4%), dusting and ammonia as a result of poor ventilation.

DISCUSSION

Poultry production is one of the rapidly growing food industries throughout the world (Abdul-Cader *et al.,* 2017). The current study involved 46 layer chicken keepers of which about two thirds were females (Table 1). About half of the participants (47.8%) mentioned chicken keeping as their primary activity in terms of income generation for the family. Other farmers identified it as a secondary activity. This underscores the role of the industry to peoples' livelihoods by contributing to their economic affairs. Some farmers have sustained in the industry for up to 28 years suggesting dependence on the activity for a living. Limited supply of eggs from the industry in the country, as a result of engagement of few farmers and/or small scale of production, provides opportunities for more people to venture in.

Battery cage system of layer chicken rearing is one of the most common methods used in many countries. Relatively few farmers (21.7%) in this study adopted the system in rearing their chickens. Majority of them adopted the deep litter system due to low investment capital needed compared to that for battery cage production system. Studies in Sweden (Fossum *et al.,* 2009) and in Bulgaria (Gerzilov *et al.,* 2012) have attributed housing system to mortality and low production in chicken farming. Both studies have reported higher mortality rates in litter-based system as opposed to battery-cages due the easy with which diseases can be controlled in the later. Similarly, farmers in the current study mentioned this as one of the advantages of battery cages. Other benefits of the battery-cage system include: easy collection of eggs, cleaner eggs, little space requirement; and control of internal and external parasite. On the other hand, bird injury caused by wires and hen's inability to exercise are among the main welfare concerns associated with the battery cage housing system. According to Webster (2004) lack of exercise can easily result in skeletal damage at peak production as a result of bone weakness. The lack of exercise also subjects birds to frustration and boredom and their behaviors may change which affect their production. The deep litter system which is practiced by majority of the farmers in the study area has an advantage of allowing bird mobility but is associated with problems of dust and accumulation of ammonia gas.

Regarding feeding, some respondents reported to use commercial feed made by different companies for their chickens; whereas some opted to make the feed at home or at commercial feed mills offering feed compounding services. One of the major concerns for those buying different brands of commercial feeds was inconsistencies in feed quality as reflected in the performance of their chickens. They associated poor feed quality with increased price of maize the main poultry feed ingredient at certain time of the year of low supply. The speculation is that, for manufacturers not to increase the price of feed proportional to the increase in price of maize, they tend to reduce other components which are not very conspicuous in the feed to take care for the elevated maize cost. Most of them mentioned limited amounts of premixes, lysine and methionine; which are among the most expensive ingredients in feed formulation.

Sufficient amount of feed and fresh water are essential during all stages of layer chicken production. According to Duguies *et al.* (2016), layer chicken feeding must be on a continuous basis; therefore feed should be available to the birds for 24-hours. Farmers in this survey supplied water at adlib where as the amount of feed supplied ranged from 120 g to 130 g per bird per day. They claimed that the supplied feed sufficed their chickens' feed requirements for 24 hours. Most of the farmers fed their chickens twice a day portioning the amount of required feed into two. Others fed their layer chickens once a day preferably in the afternoon. A few portioned the amount of required feed into three and fed their birds three times a day. Those who fed their chickens once a day filled feeders to the brim leading to loss of a significant amount of feed due to bird's "pecking" behavior while eating (Duguies et al., 2016). Extremely full feeders also tend to promote spoilage of feed at the bottom of the feeder which can affect a bird's health and eventually egg-laying performance (Duguies *et al.*, 2016). Providing adequate amount of feed twice a day that is once in the morning and again in the

afternoon, is a better and highly recommended practice (Duguies et al., 2016).

Insufficient feeder and drinker space was a feature in most of the farms that adopted deep litter system. The deficiency may lead to competition among chickens resulting in exclusion of low-ranking hens from the feed and water (Thogerson et al., 2009). As hens prefer to feed synchronously, competition at the feeder during times of intense feeding may disrupt feeding and induce expression of agonistic behaviour (Hughes, 1971; Webster and Hurnik, 1994). Lower ranking birds may be prevented from access to feed and hence suffer adverse effects under conditions of competitive feeding (Hughes, 1983). This eventually leads to poor welfare, reduced productivity, and sometimes mortality. Conversely, increased feeder space could improve well-being by reducing the negative effects of aggressive behaviors or social dominance during feeding (Thogerson et al., 2009). The main problem observed in cages related to water supply to birds was blockage of drinker cups such that birds are prevented from accessing water.

Manure collection and disposal, eggs collection, beak trimming and observation of sick birds were mentioned by farmers as other routine management practices among the layer farms, apart from feeding and cleanliness. Some farmers associated these practices with stress to birds and thus resulting in drop in eggs production and sometimes disease occurrence. Beak trimming involves the removal of two thirds of the upper and one third of the lower mandibles (Van Liere, 1995; Gentle et al., 1995; Sandilands and Savory, 2002). The procedure is mainly aimed at preventing feather pecking, egg pecking and cannibalism; which are common vices in growing and laying flocks resulting to production losses (Allen and Perry, 1975). Though aimed at controlling these vices, beak trimming can cause acute or even chronic pain; and may be associated with undesirable effects on birds' well being (Fahey et al., 2007). According to Lee and Craig (1991), the relative benefits of beak trimming vary among genetic stocks. In the current study the layer chicken keepers mentioned to conduct the procedure to the chickens when they are 12 to 16 weeks old. Early trimming is usually in response to early occurrence of feather pecking and cannibalism. Elsewhere beak trimming is performed at the hatchery where it is considered to be convenient and relatively cheap before delivery of the chicks. Previously, however, reported that beak trimming done to day old chick increases the risk of mortality (Wells, 1983).

Several diseases were mentioned by farmers in this study to negatively impact on production and cause mortality to layer chickens. They included viral, bacterial, parasitic and nutritional diseases (Table 2). The frequently mentioned diseases have been linked to production losses among layer chickens in previous studies (Lambert and Kabar, 1994; Anjum *et al.,* 1993; Savic, 1999; Demir, 1992; Farooq *et al.,* 2001; Singh *et al.,* 1994; Amin et al., 1995; Bains, 1979; Nicholls, 1984; Reece *et al.,* 1986; Sorensen, 1992; Qu *et al.,* 1997; Sandoval et al., 1999; Taylor et al., 1999; Zanella et al., 2000; Mukhopadhyay *et al.,* 2000; Dhillon *et al.,* 2004). Occurrence of most of these diseases in the small holder farms is associated with poor bio-security and lack of sound disease control programs. This could partly be addressed by involving qualified animal health professionals in this farming activity, an element which lacks in some visited farms.

Viruses constitute a group of pathogens causing diseases with severe impacts in poultry production. The control of diseases caused by these agents solely relies on bio-security measures and vaccination practices (Aichi, 1998; Capua and Marangon, 2006 a&b). All the respondents in the study area vaccinated their chickens against Newcastle disease, gumboro and fowlpox. Most of them use lentogenic LaSota vaccine which has been used by farmers in the country for prevention of Newcastle disease for long time. However, complaints on occurrence of ND in vaccinated flocks have continuously been raised by many farmers in different parts of the country. The same concern was raised by farmers involved in the present study. Some of the mentioned possible causes of vaccine failure have included use of expired vaccine, mismatch between vaccine strain and the circulating strain, poor vaccine handling, vaccinating incubating birds and use of chlorinated water for reconstituting vaccine. This observation of vaccine failure is an area which requires an intensive, thorough investigation to identify the actual causes; and eventually plan and institute mitigation strategies aimed at stemming ND associated losses among chicken keepers.

Failure to institute bio-security at farm level is associated with many disease occurrences in the layer chicken industry as disease pathogens and vectors can gain access to farm premises (Sylejmani *et al.,* 2016). Bio-security measures which include traffic control, sanitation and isolation thus contribute significantly to the poultry industry profitability (Trampel *et al.,* 2014). Most farmers however do not realize the importance of bio-security such that the industry is exposed to different hazards. Evidence of presence and use of a

clean foot bath containing disinfectant at the entrance to poultry houses and isolation of sick birds from others in most of the visited farms reflect some degree of bio-security. Lack of regular cleaning of chicken houses was however observed in the farms adopting the deep litter system increasing possibilities for persistence of disease causing agents in the houses. Further, lack of separation between chicken flocks of different ages seen in most of the multi-flock farms in this study facilitates disease transmission between them, more so from older flocks to younger, susceptible flocks. It is always recommended to progress from younger to older and from healthy to sick flocks during bird care. Other practices that increase farm bio-security include maintaining litter in good condition, adjusting ventilation to avoid moisture and ammonia build-up in the house, strict control of human and equipment movement into the farm, quick and proper disposal of dead birds, limiting workers to a single house and prevention of vermin (e.g. wild birds, insects and rodents) exposure into the houses. Rodents, for instance, are known to be among egg laying birds. According to Fulton (2017) many of the natural causes of mortalities among layers are associated with making an egg. Fulton (2017) further insists that performing necropsies on a regular basis helps to detect deaths due to unforeseen causes in a way providing for timely intervention to allow for the continued health and welfare of the birds (Fulton, 2017). Identified natural causes of mortalities among layers in the current study include; egg yolk peritonitis, cannibalism (pick out), fatty liver syndrome and prolapsed vent which also were reported elsewhere (Fulton, 2017).. Necropsy findings in the study area were frequently supplemented with clinical presentations of different diseases for which most of the farmers had basic knowledge obtained from animal health professionals.

Several factors are known to influence egg production; and these include chicken strain, feeding, mortality, culling, health and management practices, age at point-of-lay, and peak lay and persistency of lay (Farooq et al., 2002). In the present study the average age at point-of-lay was 20 weeks and peak lay was attained two to three months later. An observation on the average age at point-of-lay is more or less similar to what was reported in previous studies (Singh and Belsare, 1994; Petek (1999). Other earlier researchers reported a lower age (Tolimir and Masic. 2000; Farooq *et al.,* 2002). Farooq *et al.* (2002) however, reported a more or less similar age at peak-of-lay to the present findings. A higher age at peak-of-lay than what is reported in this study has been reported by Lai and carriers of many poultry diseases and the most common reason for re-contamination of a cleaned and disinfected poultry facility. They are also responsible for house-to-house spread of disease on a farm.

It was revealed in this study that most farmers send dead birds to veterinary centres for necropsy; though some few disposed or fed them to dogs. Through necropsy veterinarians were able to establish common disease conditions responsible for morbidities and mortalities in the flocks. Sending dead birds for necropsy underscores a recent argument that determining the cause of death in egg laying bird flocks by routine necropsy of daily mortality is useful in helping farmers and the examiner to establish what is normal for a particular flock (Fulton, 2017). Routine autopsy examination of dead hens is a source of disease information (Grimes, 1975); including "background" disease which causes continuous low-level morbidity and mortality. Such a practice is also useful in providing information on the natural causes of mortalities Kan (2000). According to Bell and Weaver (2002), however, the recommended age at point-of-lay is 112 and the age of flock at peak hen-day egg production is 182 days. The results obtained in the current study for these parameters therefore indicate delays in start of production and attaining peak production among the flocks in the study area.

The current study observed variable egg production performance for different flocks. The study also revealed irregularities in egg laying performance within flocks. The average laying percentage was 76 (55-90). The highest laying percentage was recorded for caged layers. Comparable levels of hen-day egg production performance have been reported by previous authors (Akyildiz *et al.,* 1993; Tanaka, 1993; Kristensen and Sillebak-Kristensen, 1996; North, 1984). Factors responsible for varied performance among egg laying flocks include chicken strain differences (North, 1984; Petek, 1999; Tolimir and Masic, 2000; Lai and Kan, 2000), stocking rate (Adams and Craig, 1985; Lee and Moss, 1995), persistency of lay (Akyildiz et al., 1993; Tanaka, 1993; Kristensen and Silleb-Kristensen; 1996) and housing system. Regarding housing, authors found better egg production performance of layers reared in cages than on deep litter (North, 1984; Horne-Van and Van-Horne, 1994; Moorthy *et al.,* 2000). According to farmers, irregularities in production within their flocks were caused by diseases, fluctuations in feed quality, stress and use of sulphur drugs. The influence of the different factors on egg production performance between and within flocks was however not

investigated during this survey.

Commercial egg laying hens normally reduce production after 70-72 weeks of age (Petek, 1999). Hens that are in production for almost two years are considered "spent" layers. Although layers can lay eggs longer than two years, the quality and quantity of the eggs produced are generally considered poor and uneconomical (Duguies *et al.,* 2016). After the chickens' laying capacity decreases, producers cull and sell them as spent layers for slaughter purposes. Farmers involved in this study performed culling of their layer chickens at the age of 18 to 24 months. Some of them opted to continue keeping hens that have dropped production as a way of maintaining their customers for produced eggs while waiting for replacement flock to begin laying eggs. At culling the customers include individuals for home consumption, owners of bars for making soup and businessmen who buy at wholesale price from producers and sell them on retail basis at the market. The entry of spent layer chickens into the food chain is however with some limitations, which include low meat yield and tough meat (Loetscher *et al.,* 2015). Consumers however tend to equate the spent layer chicken meat to meat from free ranging indigenous chickens which are the mostly preferred in the country.

Layer chickens production in the tropics is featured by severe losses attributable to the harsh climate, high disease incidents, stress, poor biosecurity, poor disease management, poor husbandry, poor chick quality, feed-associated causes, and unintended accidents (Sorensen, 1992; Farooq et al., 2002; Shittu et al., 2014). They are at higher risk due to long term exposures (≥72 weeks) to these factors on farms (Sorensen, 1992). Most of these limitations were raised by the layer chicken keepers during this survey. According to literature (Shittu et al., 2014), hot-dry weather is linked to heat stress, waning immunity and inefficient feed usage and increase probability of death with reduced egg production. The authors point out that younger birds (19–38 weeks) are at higher risk of death due to stress of coming into production, management changes and diseases; and speculate that older chickens' better protection from death could be associated with many prophylactic and metaphylactic regimen of medications/vaccination. FAO has demonstrated that at a temperature above 28°C, egg production will significantly wane both in quantity and quality. It should be noted that an environmental temperature between 25-40°C will cause the bird to pant and may lead to heat stroke and eventual death. Farmers in the study area also mentioned low temperatures to be a cause of drop in egg production.

Conclusions and recommendations

The current study highlights on different important aspects of layer chickens production in Morogoro, Tanzania. The study revealed inadequacies in layer chicken husbandry and flock health management. The deficiencies in the two aspects were reflected in poor chicken performance both in health and productivity, eventually limiting profitability of the industry. Improvements in husbandry and health management (including biosecurity) are highly recommended so as to increase and sustain production. Future research should include attempts to devise intervention strategies to address factors attributable to poor productivity in the layer chicken industry. Regulatory agencies should play their part in ensuring the supply of genuine vaccines and quality chicken feeds with all essential nutrients and supplements to support production performance.

REFERENCES

Abdul-Cader MS, Palomino-Tapia V, Amarasinghe A, Ahmed-Hassan H, De Silva Senapathi U, Abdul-Careem MF. Hatchery vaccination against Poultry Viral Diseases: Potential Mechanisms and Limitations. *Viral Immunol,* 00: 1-11, 2017.

Adams AW, Craig JV. Effect of crowding and cage shape on productivity and profitability of caged layers: a survey. *Poultry Sci,* 64(2): 238-242, 1985.

Aichi JK. Assistance of the control of Newcastle disease phase II of TCP/ZIM/4553. Back-yard poultry consultancy (TCDC), TCP/ZIM/8821 (A), 1998.

Akyildiz A R, Konca Y, Ceylan N, Ciftci I, Corduk M. Effects of using barley and/or sorghum in diets on the performance of caged laying hens. Ankara Universitesi Ziraat Fakultesi Yilligi, 43(1-2): 85-95, 1993.

Allen J, Perry GC. Feather pecking and cannibalism in a caged layer flock. *Br Poult Sci,* 16(5): 441-451, 1975.

Amin S, Shafique KA, Arshad M, Rahman SU: Epidemiology Studies on Infectious Bursal Disease in Poultry. In Proceedings of the National Seminar on Epidemiology of Livestock and Poultry Diseases. *Lahore, Pakistan: College of Vet, Sci;* 1995.

Anjum AD, Hassan S, Arbi GS. Infectious bursal disease in chickens. *Pakistan Vet J,* 13(2): 54–58, 1993.

Bains BS. Yolk Sac Infection. In A Manual of Poultry Diseases. Basle, Switzerland: F. Hoffmann-La Roche and Co. Limited Company; 85–105, 1979.

Bell D. D. and Weaver Jr. W. (eds.). Commercial Chicken Meat and Egg Production. 5th Edition. Springer science and Business Media, LLC, 2002.

Bishop JP. Chickens: Improving small-scale production. *Echo technical note,* 1995.

Capua I, Marangon S. Control of avian influenza in poultry. *Emerg Infect Dis,* 12: 1319–1324, 2006a.

Capua I, Marangon S. Control of avian influenza infections in poultry with emphasis on vaccination. *Exp Rev Anti Infect Ther*, 4: 751–757, 2006b.

Demir S: Coccidios in Bursa region of chicken factors and their propagation (Bursa bölgesi tavuklarında coccidiose etkenleri ve bunların yayılışı) (in Turkish). *J Vet Facul Uludağ University (Uludağ Univ Vet Fak Derg)*, 2: 143–151, 1992.

Dhillon AS, Roy P, Lauerman L, Schaberg D, Weber S, Bandli D, Wier F: High mortality in egg layers as a result of necrotic enteritis. *Avian Dis*, 48(3): 675–680, 2004.

Duguies MV, Artero VT, Barcinas JDT. Poultry Production Guide for a 500 Layer Operation. College of Natural & Applied Sciences (CNAS), University of Guam. Pp 26, 2016.

Fahey AG, Marchant-Forde RM, Cheng HW Relationship between body weight and beak characteristics in one-day-old White Leghorn chicks: Its implications for beak trimming. *Poult Sci*, 86: 1312–1315, 2007.

Farooq M, Mian MA, Faisal S, Durrani FR, Arshad M, Khursid A: Status of broiler breeders stocks in Abbotabad and Mansehra. *Sarhad J Agr*, 17(4): 489–495, 2001.

Farooq M, Mian, MA, Durrani, FR, Syed, M. Egg production performance of commercial laying hens in Chakwal district, Pakistan. *Liv Res Rural Devel*, 14 (2) 2002.

Fossum O, Jansson DS, Etterlin PE, Vågsholm I. Causes of mortality in laying hens in different housing systems in 2001 to 2004. *Acta Vet Scand*, 51: 3, 2009.

Fulton RM. Causes of Normal Mortality in Commercial Egg-Laying Chickens Avian Diseases, 61(3): 289-295, 2017

Gerzilov V, Datkova V, Mihaylova S, Bozakova N. Effect of poultry housing systems on egg production. *Bulgarian J Agr Sci*, 18(6):953–957, 2012.

Grimes TM. Causes of disease in two commercial flocks of laying hens *Austrafian Vet J*, 51: 337-347, 1975

Gueye EF. The role of family poultry in poverty alleviation, food security and the promotion of gender equality in rural Africa. *Outlook Agric*, 29(2): 129-136, 2004.

Horne-Van P L M, Van-Horne P L M. Production and economic results of commercial flocks with white layers in aviary systems and battery cages. *British Poult Sci*, 37(2): 255-261, 1996.

Hughes BO. Allelomimetic feeding in the domestic fowl. *Br Poult Sci*, 12: 359–366, 1971.

Hughes BO. Conventional and shallow cages: A summary of research from welfare and production aspects. *World's Poult Sci J*, 39: 218–228, 1983.

Kristensen IS, Sillebak-Kristensen I. Ecological production of eggs and crops. Technical and economic farm results in 1994-95. *Beretning fra Statens Husdyrbrugsforsog*, 730: 93-163, 1996.

Lai MK, Kan CL. Effects of cage floor area and population size on the laying performance of the brown Tsaiya laying ducks. *J Taiwan Liv Res*, 33(3): 281-291, 2000

Lambert C, Kabar AC. Egg drop syndrome (EDS 76) in New Caledonia, first diagnosis and control. Revue d' Elevage-et-de-Medecine Veterinaire-de- Nouvelle Caledonie 1994, 14(7): 12.

Lee HY, Craig JV. Beak trimming effects on behavior patterns, fearfulness, feathering, and mortality among three stocks of White Leghorn pullets in cages or floor pens. *Poult Sci* 70(2): 211-221, 1991.

Lee K, Moss CW. Effects of population density on layer performance. *Poult Sci* 74(11): 1754-1760, 1995

Loetscher Y, Albiker D, Stephan R, Kreuzer M, Messikommer RE. Differences between spent hens of different genotype in performance, meat yield and suitability of the meat for sausage production. *Animal*, 9(2): 347-355, 2015.

Ministry of Agriculture, Food and Cooperatives (MAFC). National sample census of agriculture. Ministry of agriculture report volume.II, 2008.

Ministry of Livestock Development (MLD). Investment Opportunities in Livestock Industry in Tanzania, Dar es Salaam, Tanzania, pp. 4-12, 2008.

Moorthy M, Sundaresan K, Viswanathan K. Effect of feed and system of management on egg quality parameters of commercial white leghorn layers. *Indian Vet J*, 77(3): 233-236, 2000.

Msami H. Poultry sector country review. Central Veterinary Laboratory Dar es Salaam, Tanzania, p. 61, 2008.

Mukhopadhyay HK, Paul WM, Dorairajan N, Chandran NDJ. Drop in egg production due to aflatoxin B1 contamination in feed. *Int J Animal Sci* 15(1): 123–126, 2000.

Nicholls TJ. Marek's disease in sixty week-old laying chickens. *Aust Vet*, J 61(7): 243, 1984.

North MO. Breeder Management. In Commercial Chicken Production Manual. The Avi. Publishing Company. Inc. Westport, Connecticut. 298-321. pp. 1984.

Paul DC, Beg CER, Podder CK. Family Chicken and its importance in Bangladesh. *Int J Poult Sci*, 4(5): 6-7, 1990.

Petek M. Production traits and economic efficiencies of different Genotypes of layers reared by enterprises in Bursa province and it's near vicinity. *Veteriner Fakultesi Dergisi Uludag Universitesi*, 18(1-2): 65-77, 1999.

Qu FQ, Yang SQ, Jiu B, Zhang DZ, Li HW, Liu S, Chen SY. Diagnosis and control of swollen head syndrome in layers. *Chin J Vet Med* 23(7): 23, 1997.

Reece RL, Beddome VD, Barr DA. Diseases diagnosed in replacement layer and breeder chicken flocks in Victoria, Australia, 1977 to 1985. *Vet Rec*, 119(19): 471–475, 1986.

Sandoval VE, Terzolo HR, Blackall PJ. Complicated infectious coryza outbreaks in Argentina. *Adv Agr Sci*, 6(1): 65–77, 1999.

Savic V. Epidemiology of intensive poultry production in Croatia during the last 35 years. *Stocarstvo*, 53(6): 449–459, 1999.

Shittu A, Raji AA, Madugu SA, Hassan AW, Fasina FO. Predictors of death and production performance of layer chickens in opened and sealed pens in a tropical savannah environment. *BMC Vet Res*, 10: 214, 2014.

Singh KCP, Verma SK, Prasad CB. Occurrence of infectious bursal disease in Chickens, isolation and clinico-pathology. *Indian J Virol*, 10(2): 83–89, 1994.

Singh VP, Belsare VP. Performance of White leghorn birds under field conditions. *Poultry Advisor*, 27(6): 43-46, 1994.

Sorensen P. Selection, Environment of Layer, and Response on Nesting Behavious. In Proceedings of the 19th World Poultry Congress, Volume 2. Amsterdam, the Netherlands. *World's Poultry Science Association, Netherlands Branch*, 1992: 409–412.

Sylejmani D, Musliu A, Ramadani N, Sparagano O, Hamidi

A. Associations Between the Level of Biosecurity and Occurrence of *Dermanyssus gallinae* and *Salmonella* spp. in Layer Farms. *Avian Dis*, 60(2): 454-459, 2016.

Tanaka S 1993 Studies on management measures of hen egg production under over productive circumstances". Bulletin. Faculty of Agri. *Kagoshinia Univ No,* (43): 125-134.

Taylor RD, Jones GPD, Murison RD. Effect of Calcium Feeding on The Expression of Marek's Disease. In Proceedings of 1999 Australian Poultry Science Symposium, Volume 11. Sydney, NSW. *University of Sydney*, 1999: 128–131.

Thogerson CM, Hester PY, Mench JA, Newberry RC, Pajor EA, Garner JP. The effect of feeder space allocation on behavior of Hy-Line W-36 hens housed in conventional cages. *Poultry Sci*, 88: 1544–1552, 2009.

Tolimir N, Masic B. The results of European egg production tests in 1997-1998. *Zivinarstvo*, 35(5): 66-68, 2000.

Trampel WD, Holder GT, Gast KR. Integrated farm management to prevent Salmonella Enteritidis contamination of eggs. *J Appl Poult Res*, 23: 1–13, 2014.

Webster AB. Welfare implications of avian osteoporosis. *Poult Sci*, 83: 184–192, 2004.

Zanella A, Alborali GL, Bardotti M, Candotti P, Guadagnini PF, Martino PA, Stonfer M. Severe Escherichia coli O111 septicemia and polyserositis in hens at the start of lay. *Avian Pathol*, 29(4): 311–317, 2000.

Sandilands V and Savory CJ. Ontogeny of behaviour in intact and beak trimmed layer pullets, with special reference to preening. *Brit Poult Sci*, 43: 182-189, 2002.

Gentle MJ, Thorp BH, and Hughes BO. Anatomical consequences of partial beak amputation (beak trimming) in turkeys. *Res Vet Sci*, 58: 158-162, 1995.

Van Liere DW. Responsiveness to a novel preening stimulus long after partial beak amputation (beak trimming) in laying hens. *Behav Processes*, 34: 169-174, 1995.

Wells D. Beak trimming, is it really necessary. World Poultry, June, 28–31, 1983.

Webster AB, Hurnik JF. Synchronization of behaviour among laying hens in battery cages. *Appl Anim Behav Sci*, 40: 153–165, 1994.