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Full Length Research

Investigation of native chicken mortality/loss in the free-range system: Causes, control measures and impact to farmers at the household level, Moyamba District, Southern Sierra Leone

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ABSTRACT: The increase in mortality/loss of native chickens in the rural areas of Sierra Leone is posing a serious threat to the traditional chicken industry. Poultry farmers loss many chickens annually which hugely undercut their livelihood and social status. This research was therefore conducted to investigate the main causes of native chicken mortality/loss, control strategies and how it influences the livelihood of farmers in Moyamba district, Sierra Leone. The data was obtained through field survey, personal discussion and observation from randomly selected 300 participants in 6 villages. The findings revealed that 84.3% of the interviewed farmers were female while the overall illiteracy rate of the participants was 72.3%. The average number of the different livestock kept by the farmers were: 7.8 (chicken), 0.3 (duck), 0.6 (sheep), 0.2 (pig) and 3.4 (goat). 45.5% of the mortality/loss recorded from 2017-2018 was said to be caused by predators while 54.5% was caused by diseases/parasites and other factors (2017-2018). 33.0 and 32.0% of the mortality/loss occurred during the late dry and early rainy seasons while 20.0 and 15.0% occurred in the early dry and late rainy seasons respectively. Settlements along the grassland and forested areas reported a high incidence of predators while the river-line areas reported high cases of diseases/parasites. The main predators identified were hawk, red fox and eagle while Newcastle disease and lice were the most serious disease and parasites named respectively. The animal healthcare services are inadequate and therefore, traditional methods of controlling diseases/parasites and predators are widely adopted. The impact of mortality/loss to farmers at household level include low protein intake, loss of income, weak cultural/religious practices, loss of flock, food insecurity, increase in poverty and lack of job. Therefore, there is a need for effective and continuous implementation of disease/parasites control programs in the study areas by strengthening the veterinary and the extension services for better productivity and improved management practices.

Keywords: Diseases, impact, parasites, practices, predators, seasonal, treatment.

INTRODUCTION

Poultry production is an important component of the smallholder farming system in agriculture which supports and employs millions of people in Africa and its sub-regions. Poultry production in general and native chicken production (NCP) in particular, is an ancient common practice which occupies an integral part of the livestock sector in many developing countries. The significant contributions of native chickens (NCs) to resource-poor farmers in developed and under-developed countries are enormous and are well established (Moges et al., 2010). In Africa and Asia continents, NCs play diverse functions by not only supplying cheap and affordable sources of animal proteins and income but also contributing to poverty alleviation, reduce malnutrition and unemployment

crisis and assist in building food security (Guèye, 2005, Ahmad, 2018). NCs managed by women and children at the free-scavenging level constitutes approximately 98% of the village chicken population (Moreda et al., 2013; Guèye, 2005). NCs possessed strong immunity against certain diseases, and perform better under harsh condition, poor feeding and treatment conditions.

The lack of access to basic human needs, unequal distribution of local resources and gender inequality in Sierra Leone are key reasons why many poor Sierra Leoneans especially rural women go into livestock production. Sierra Leone is endowed with rich varieties and unique animal genetic resources including NCs. Its economy greatly depends on agriculture with 75% of the population depending directly or indirectly on agriculture with 59.0% of its population residing in rural areas (Gboku et al., 2015). Chickens account for the largest livestock species (65.2%) rear in Sierra Leone with the majority being NCs (Population Housing Census, 2015). NCP performs unquantifiable functions in many developing countries including Sierra Leone. Local chickens are the cheapest and fastest means of generating income and direct sources of quality animal protein especially for those who cannot afford the cost of other meat. Besides, NCs are important biological pest controllers and can further boost crop production by providing good quality manure. The main system of NC production in Sierra Leone is the free-range system where chickens depend on scratch feed. In this system, chickens are hardly fed, treated, monitored, housed or protected against harsh weather or predators due to lack of good management system, education and technical support. Irrespective of their contributions, many challenges are hampering their productivity. Death/loss of chickens is associated with natural causes with no research based-evidence to ascertain the main factors responsible. It is on this background that this study is carried out to investigate (1) the main causes of mortality/loss and its seasonal pattern (2) how farmers respond to disease/parasites and predators' attacks (3) effect of chicken mortality/loss to farmers in the study areas. The findings in this study will provide key information on the causes of mortality/loss, control strategy and its consequences on NC rearers which may be required for proper intervention by the appropriate authorities.

MATERIALS AND METHOD

Description of the study area

The research was conducted in Moyamba district which is located in the southern part of Sierra Leone. It is the largest district in Sierra Leone with a human population of 472,287 where 318,588 and 153,699 are female and male respectively (Population and Housing Census, 2015). 88.9% of the district population are crop farmers while 77.8% are engaged in animal husbandry practices. Majority of these people are found in rural areas with diverse culture according to their ethnic groups and beliefs. It is bounded by the Atlantic Ocean; Bonthe, Koinadugu and Port Loko districts, in the West, Southwest, East and North respectively. It is situated at latitude 12^{o}26'0" N and longitude 8^{o}09'38"W. The district lies in an agro-ecological zone with grassland, farm-bush with few patches of forests, rivers and other water body sources, hills and valleys as its main geographical features. Agriculture accounts for the main sources of living followed by fishing, mining and trading.

Selected study sites

The study was conducted in six randomly selected villages with three distinct ecological features including savannah/grassland, farm-bush/forested and river-line communities. These features may influence the type of diseases, predators affecting the NCP and the type of agricultural activities engaged in by farmers. The main reasons for choosing the sites were due to a large number of local chickens' rear mainly at the free-range system and the alarming rate of the high rate of mortality/loss with no serious investigation. Farmers in the study areas practiced an integrated system of farming (grow crops alongside with animals) at subsistence levels. The main livestock species kept in these areas are poultry, goat, sheep, swine and cattle. Out of 346,812 indigenous chickens in the district, 95.8% are found in the rural areas managed at the free-range system (Population and Housing Census, 2015). NC rearing is not only limited to crop farmers but also the disabled, educationists, aged people, landless or others (widows, traders, miners).

Study design

This piece of work was carried out for eleven months (September 2018 – July 2019). During this period, a snap-short survey was conducted to identify NC hotspot under the free-range system. Six villages (Taiama, Mano, Gbonjema, Foyah, Senehun and Mbaoma) with approximately 7 to 9 Km apart were included in the study based on stratified random sampling. Each village was selected based on the ecological features specified above with two villages each from savannah/grassland, farm-bush and river-line settlements.

Sampling technique

From each village, fifty (50) respondents were randomly chosen for equal representation among chicken rearers with different flock sizes, management practices and knowledge/skills. In total, three hundred (300) household-

heads participated in the study. A semi-structured household questionnaire was designed to target each household to obtain quantitative primary data. Causes of mortality and management practices were key issues targeted in the questionnaire. Personal interviews were conducted to generate detailed information about the causes of mortality/loss and the management system. Added to this was site tour to harvest first-hand information relating to the management practices such as disease management, feeding/watering, traces of predator and housing management.

Data analysis

Data gathered were verified to ensure that no discrepancy exists and are in-line with the setout objectives. Discussions and observations were transformed into descriptive theory for complete and detailed information. Data manually inputted into an excel spreadsheet and analyzed to present findings in percentages and frequencies using tables and charts.

RESULTS AND DISCUSSION

In Table 1, the socio-economic characteristics of the native chicken rearers revealed that NCP in Moyamba district is predominantly owned by women (84.3%) with male accounting for only 15.7%. Similar findings by Justus et al. (2013) reported that women are in the majority in owning and managing NC especially in developing countries. Contrarily, women represented the minority (10.3%) as household heads with men (89.7%) taking the lead. More than two-thirds of the farmers were married, 10.7% single and 18.7% were either devoice or widow. Generally, the large percentage of women and married women, in particular, engaged in keeping NCs was mainly due to household burden which in most cases are addressed by women. The educational level of the respondents was reportedly low with only 5, 8 and 14.7% attaining higher, lower and primary education respectively while more than two-thirds (72.3%) of the respondents were without formal education. 83.3% of those interviewed were actively engaged in agriculture, 10.7% were traders while 6% were involved in unskilled jobs.

60.3% of the study population has long years of rearing experience (11-15 years) while a few (26.0% and 13.7%) were 5-10, 16 and above years respectively. NCs constitute the main livestock rear under the free-range management system in different geographical features although other livestock (goat, sheep, duck and pig) were also reared. In chart 1, the average number of livestock recorded was 7.8 (chickens), 0.3 (ducks), 0.6 (sheep), 0.2 (pig) and 3.4 for goat. From Table 2, the main purpose of keeping NCs was for household consumption followed by cultural practices, religious obligations, farming activities and income. The rate of mortality/loss recorded was very high, caused by several factors. The most prevailing factors identified were predators, diseases, rampant stealing, unfavourable weather conditions, accident and lack of or inadequate feed/water supply while 8.9% of the farmers did not provide any information on the causes of mortality/loss (Chart 2).

A similar result was reported by Kusina et al. (2001) in Zimbabwe where diseases, parasites, thieves and predators were causes of chicken mortality/loss. The

Table 1. Respondents' demographic information.

Variable	Frequency	Percentage
Gender		
Male	47	15.7
Female	253	84.3
Household head		
Male	31	10.3
Female	269	89.7
Marital status		
Single	32	10.7
Married	212	70.7
Widow/devoice	56	18.7
Education		
Primary	44	14.7
Lower secondary	24	8
Higher secondary	15	5
No schooling	217	72.3
Main occupation		
Farming	250	83.3
Trading	32	10.7
Unskilled job	18	6

Table 2. Farmers' rearing characteristics.

Variables	Frequency	Percentage
Experience		
5 - 10 years	78	26
11 - 15 Years	181	60.3
16 plus	41	13.7
Rearing purpose		
Food	256	34.1
Cash	51	6.8
Farming	84	11.2
Cultural	242	32.2
Religion	118	15.7

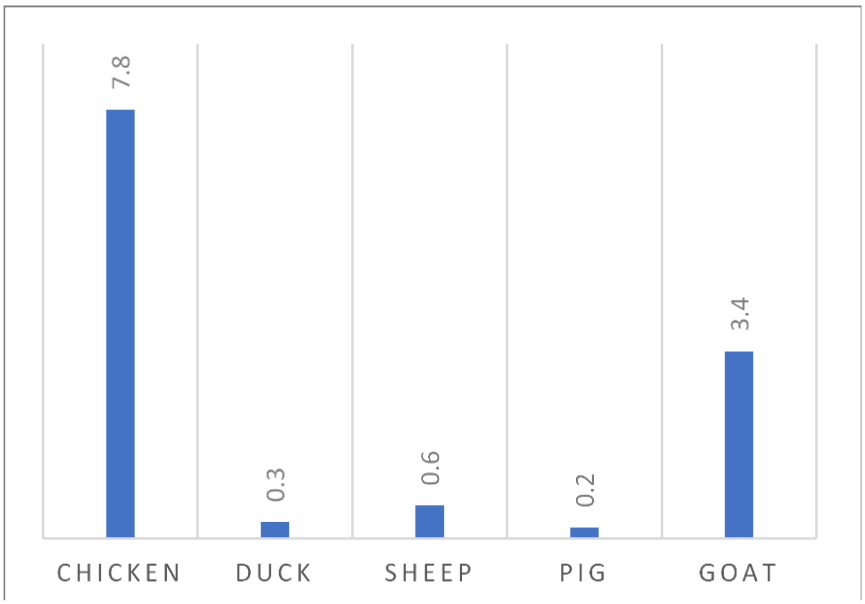

Chart 1. Average number of livestock recorded (%).

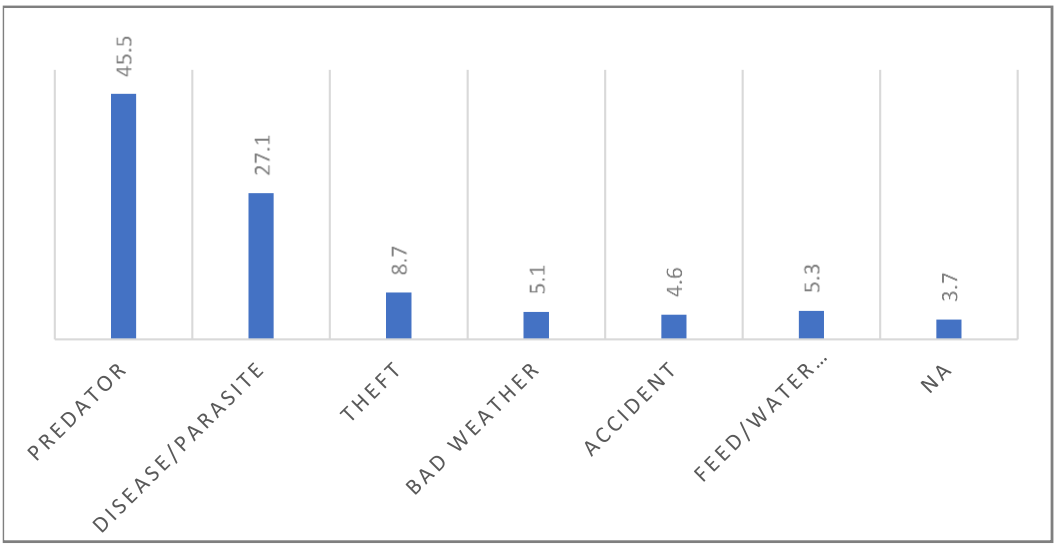

Chart 2. Causes of chicken mortality/loss (%).

severity of the causes varied from one study site to another based on the type of management system and knowledge on the management practices put in place as well as the type of settlement or geographical location. According to the result shown in Chart 3, the problem of predators was high in all the villages. In Gbonjema, Foyah, Senehun and Mbaoma, all the farmers have been suffering from the danger of predators while in Taiama and Mano 47 and 48 NC keepers were affected respectively. Taiama and Mano located along the highway reported high cases of accidents caused by motorbike and vehicle. In Mano and Senehun, mortality/loss due to theft and bad weather condition were high (Chart 3). Bad weather caused by continuous rainfall with poor housing conditions was a serious concern to farmers. The theft was considered as an uncontrollable act which farmers experience throughout the course of the year especially in the festive and hunger period.

These causes of mortality/loss were classified into two main seasons (dry and rainy seasons) with each season sub-divided into two (early and late dry seasons and early and late rainy seasons) (Chart 4). Based on this seasonal division, late dry (32.5%) and early rainy (32.4%) seasons recorded the highest death/loss cases respectively.

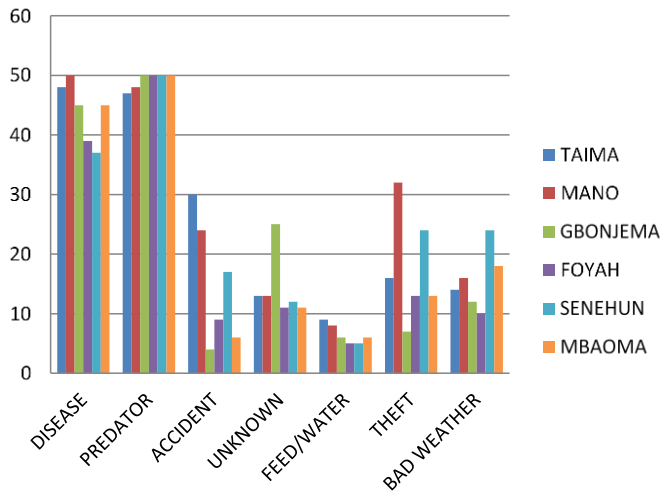

Chart 3. Causes of mortality/loss per village.

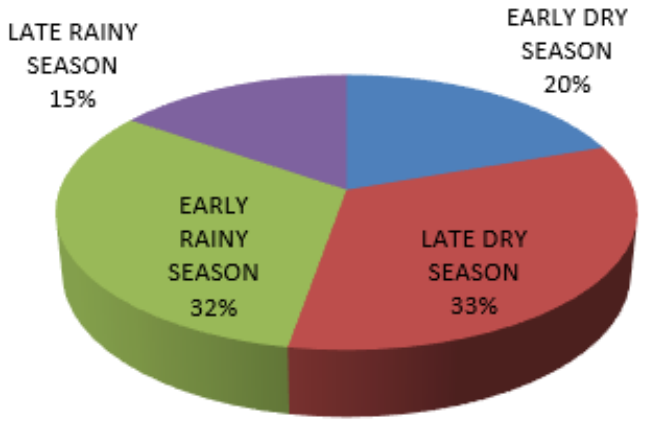

Chart 4. Seasonal mortality/loss caused by predators.

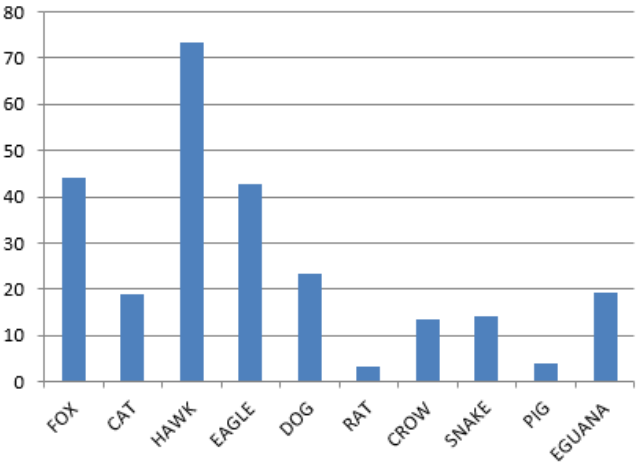

Chart 5. Predators affecting free-range chickens.

The major reasons mentioned for this was the frequent attack by predators and continuous disease/parasitic infections. Early dry and late wet seasons also accounted for some death/loss because of the same aforementioned reasons as well as favourable climatic conditions for disease-causing agents and parasites.

Predators

Several studies across Africa have identified predators as major causes of loss/premature death in poultry production (Ahmed, 2018; Dinka et al. 2010) after diseases. In this study, predators were identified as the main production problem common throughout the year with no effective control measures. Similar findings have been reported by Conroy et al. (2005) and Yitbare and Atalel (2013) where predators were ranked as the main constraint facing indigenous chicken production due to poor housing, thick vegetation, and location of settlements. Predators like a hawk, red fox, and eagle were most serious; dog, iguana, cat (pets and wild), snake and crow were named with moderate effect while rat and pig caused a minor effect (Chart 5). This report is in line with Dinka et al. (2010), where similar predators were identified as a serious cause of early mortality. Although all categories of chickens were affected, chicks (39.0%) were the most vulnerable followed by pullet/cockerel (27.0%) and adult birds (Chart 6).

The incidence of predators varies from one season to another and from one geographical area to another. In the dry season, birds of prey such as hawk (25.4%), eagle (29.6%), crow (18.3%) and iguana (6.6%) were identified as major concern while wild cats (20.8%), rats (11.0%) and pig (5.5%) were a problem in the rainy season due to heavy vegetation which serves as a hiding place. Furthermore, fox (30.3%), snake (24.2%) and dog (18.6%) were active throughout the year (Table 4).

Settlements along forested (Gbonjema and Foyah) and grassland/savannah areas (Senehun and Mbaoma) were greatly affected by predators compared to those along the river-line areas (Taiama and Mano). The ecological differences and size of the settlements (large/small) were said to be the main causes. Further discussion revealed that farmers whose chickens spent day-time in the bush experienced a higher incidence of predators due to the different kinds and the large number of predators. In Chart 7, 2,138 chickens were reported dead/lost in the past one year (2017-2018) where 45.5% of the death/loss was caused by predators. A similar result was also reported by Yitbarek and Atalel (2013) where 52% of the deaths recorded among the indigenous chickens were caused by predators.

The main reasons listed for the frequent attack on chickens by predators were a shortage of feed, destruction of habitat, and unfavourable environmental conditions which is in line with Kusina et al. (2001) findings (Table 3). 33.3% of the respondents considered predators as natural species that could exist anywhere. The most common strategies highlighted in controlling predators were

Table 3. Seasonal variation of predators.

Predators	Dry season		Rainy season		All-season	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Red fox	72	8.3	31	6.9	197	30.3
Cat	9	1	93	20.8	56	8.6
Hawk	218	25.4	19	4.3	63	9.7
Eagle	254	29.6	11	2.5	35	5.4
Dog	30	3.5	75	16.8	121	18.6
Rat	15	1.7	49	11.0	0	0
Crow	157	18.3	33	7.4	13	2
Snake	43	5	98	21.9	157	24.2
Pig	3	0.3	25	5.6	0	0
Iguana	57	6.6	13	2.9	8	1.2

Table 4. No of death caused by predators, reasons for their presence in communities and their control strategies.

Variables	Frequency	Percentage
Death record per village		
Taiama	101	8.8
Mano	120	10.4
Gbonjema	368	32.0
Foyah	296	25.8
Senehun	119	10.4
Mbaoma	145	12.6
Reasons for the increase in predators		
Food	120	40.0
Habitat destruction	32	10.7
Bad Weather Condition	48	16.0
No Answer	100	33.3
Control measure		
Fencing	19	6.3
Tethering	38	12.7
Shouting	174	58.0
Hunting	18	6.0

shouting to help scare predators away (birds of prey), confinement of newly hatched chicks and its mother, traps, poisoning, fencing, and using hunting dogs for foxes and wild cats. Chicks were also coloured with different solutions or tie their wings with polythene materials to enable them escape from predators.

Diseases/parasites

24.9% of the mortality/loss recorded for the past one year was caused by diseases/parasites. In the Africa continent, studies have shown that diseases are a major cause of mortality/loss especially in the extensive management system (Waktole et al. 2018). In tropical Africa, many researches revealed that external parasites are serious constraints hindering rural chicken production due to inconducive environmental conditions and poor management practices (Kebede et al., 2017; Chege et al., 2015). The major diseases listed include Newcastle disease (ND), Respiratory Infections (RI), Fowl Pox (FP), Fowl diarrhoea (FD) and Marek disease (MD). The high prevalence of diseases was observed during the rainy season especially at the beginning of the raining reason (April-May). In its most severe form, ND is catastrophic to chickens and farmers, therefore, birds suffer from high mortality and drop in production and some form of financial implication is also involved in controlling the disease. From

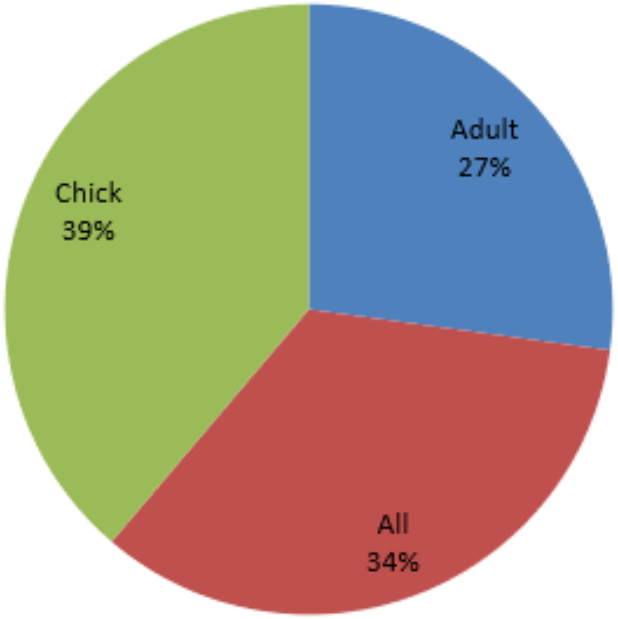

Chart 6. Chicken most at risk.

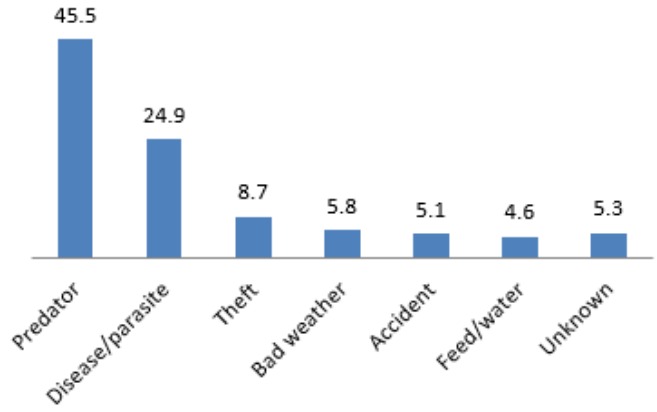

Chart 7. Number of mortality/loss and their causes in the past one year.

Chart 8 showed information on chicken mortality/loss per village during the past one-year was provided by each farmer. Comparatively, the mortality rate in Taiama and Mano due to diseases/parasites was greater than that caused by predators (Table 3 and Chart 10). Mbaoma however, accounted for 19.1% mortality compared to Senehun with similar geographical features (grassland/savannah). Villages along the river-line areas (Taiama and Mano) recorded more disease incidence compared to those in non-river-line areas.

To test the knowledge of farmers on the various diseases identified, they were asked to list apparent clinical symptoms for each disease named which were then used to classify the various diseases in the study areas. In response to this, 50.1% stated greenish-diarrhoea, frequent death, paralysis, ruffled feather, coughing and nasal/oral discharge; 12.4% identified low feed-intake, diarrhoea, abscessed wattle and footpad and death; 24.1% presented lesion (in/on the mouth, head, wattle, vent), inflammation of the head, loss of sight, death especially the chicks and slow growth rate; 10.9% named gasping, coughing and wet eyes; while 2.5% identified paralysis of the limbs, tumour of the liver/kidney when slaughter (sick chicken) and pale wattle and comb, were described for FD, FP, RI, and DM respectively which were in line with the reports of OIE (2008), Chende (2012) and Terregino and Capua (2009). Sharing the same source of drinking water, feeding container, shelter; interaction with other animals (both domestic and wild), improper management of infected carcasses (processing and disposal); unsupervised animal movement, the type of management system and introduction of infected carcass by domestic pets (cats or dogs) were the most frequent ways of disease transmission. Chickens rear in farms were said to be less affected by diseases than those reared in town/village due to low risk of contracting diseases from other birds.

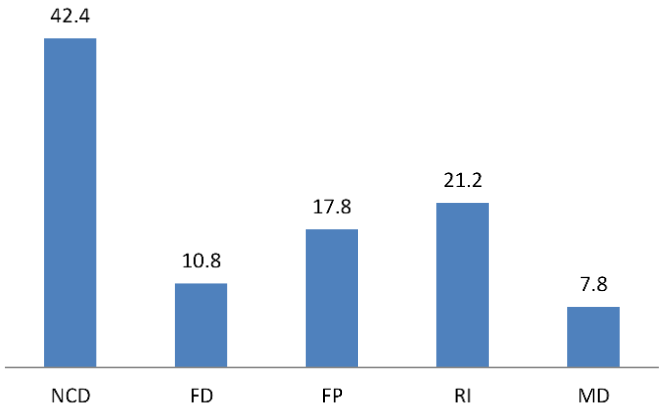

Chart 8. Diseases identified by farmers (%).

During outbreaks, 38.2% of the respondents treat sick birds by themselves, 25.3% eat/sell, 4.5% call either vets or Community Animal Health Worker (CAHW) while 32.0% offer no solution (Table 5). Out of 300 people interviewed, 91.3% lack access to veterinary services, 96.7% have not received any training in either poultry production or disease management while 100% reported lack of livestock extension services. Due to variation in environmental conditions, ND was said to last for one-week whereas FD, FP, RI and MD may be present for at least one month in communities. Traditional herbs including "Hiwii", lime fruit, "Kumuli", sesame, pepper, onion and garlic according to 42.8% of the respondents were considered as the most effective treatment in the study areas. Human antibiotics (17.9% (tetracycline) were also reportedly used including other treatment types (cigarette filter, tobacco leaf and local alcohol) (Table 6).

Table 5. Shows the list of diseases, response strategies, veterinary, training and extension services

Variables	Frequency	Percentage
Different diseases identified by farmers		
NCD	198	66.0
FD	125	41.0
FP	173	57.7
RI	159	53.0
MD	10	3.3
Veterinary services		
Yes	26	8.7
No	274	91.3
Number of people who listed clinical signs and symptoms per disease		
NCD	198	50.1
FD	49	12.4
FP	95	24.1
RI	43	10.9
MD	10	2.5
Training in disease management		
Yes	10	3.3
No	290	96.7
Method of responding to diseases		
Self-treatment	137	38.2
Call vet/AHW	16	4.5
Eat/sell	91	25.3
Nothing	115	32.0
Animal extension services		
Yes	300	100
No	0	0

3.4% of those who rear NCs agreed using veterinary drugs although this was not frequent due to shortage and purchasing cost. Drugs and herbs were acquired from different sources (local farmer, human pharmacy, traditional healers, CAHWs, unauthorized veterinary drug sellers). The main obstacle identified in the control of poultry diseases at the rural level in order of importance were: limited knowledge; lack of vets/CAHWs; type of management system; lack of accessible and affordable poultry drugs and lack of local by-laws to restrict the uncontrolled movement of animals.

In Table 7, different parasites were identified among which lice were the most severe. The high incidence of lice reported in this study agrees with Kebede et al. (2017) who reported 42.71% of lice among chickens in Ethiopia. Others parasites including worms, mites, Coccidiosis, tick and fleas in order of severity were also identified which consents with Swai et al. (2010) finding in Northern Tanzania, where fleas were the most prevalence ectoparasite (Chart 9). Other studies conducted in other countries (Rezaei et al. 2016; Chege 2014) revealed a high prevalence of parasites in indigenous chicken production. Anaemia caused by loss of blood, agitation due to skin irritation, thick and crusty leg, decrease in production, low feed intake, retarded growth, and mortality were observable clinical presentations described by the farmers. The high prevalence of parasites was due to lack of hygiene, interaction with infected birds, presence of other animals in the environment (cat, swing, dog), the type of shelter, and lack of treatment services.

In Chart 10, although parasitic infestations were common throughout the year, higher cases were reported during the wet season which may be due to good climatic conditions for the pathogens and weak immune system of the chickens caused by inadequate feeding. The result is similar to that reported by Chege (2014) where 100 and

Table 6. Treatment types, sources of drugs and its application.

Variables	Frequency	Percentage
Treatment type		
Herb	203	42.8
H/antibiotics	85	17.9
Vet drug	16	3.4
Others	170	35.9
Sources of drug		
Farmer self	138	46
Traditional healers	30	10
Pharmacy	52	17.3
Local poultry farmers	54	18
Others	36	8.7

Table 7. Parasites identified, chickens most affected and their control measures.

Parameter	Frequency	Percentage
Parasites		
Mite	84	16.4
Lice	209	40.9
Fleas	39	7.6
Tick	36	7
Worm	85	16.6
Coccidiosis	58	11.3
Category of chickens affected		
Chick	64	21.3
Adult	89	29.7
All	103	34.3
Layer	44	14.7
Control measures		
Change litter	85	30.9
Water	74	26.9
Engine oil	48	17.5
Herb	53	19.3
Others	15	5.5
Non	25	9.1

95.83% of the chickens were recorded with parasites infestation during the wet and dry season respectively. Changing of litters and housing were the most control measures reported by 30.9% of the respondents. The use of hot water (26.9%), engine oil (19.3%), native herbs (17.5%) and others [5.5% (pesticides, kerosene, hygiene)] were further control measures while 9.1% lack control measures (Table 6).

According to research, improvement of the nutritional status, provision of cash, poverty reduction, food security, cultural and religious practices and promoting gender equality have been a unique reason for keeping native

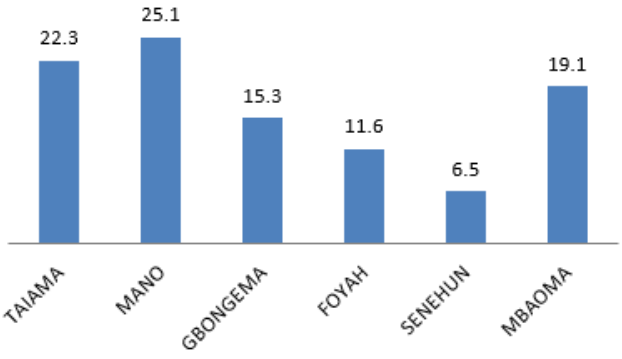

Chart 9. Number of death/loss caused by diseases/parasites (%).

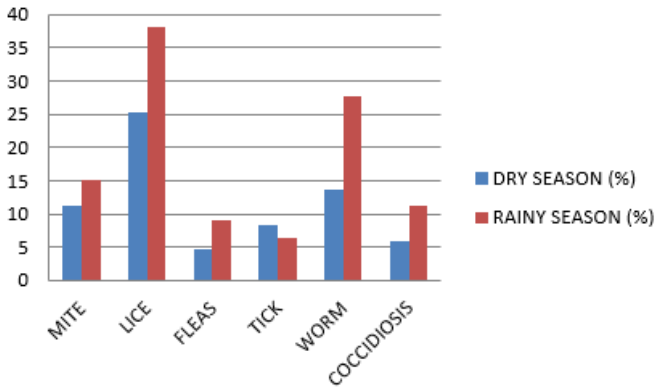

Chart 10. Seasonal parasites named by farmers.

chickens especially in developing nations like Sierra Leone (Ahmed, 2018; Guèye, 2005). Therefore, farmers highlighted the consequences (at rural and household levels) incur due to mortality/loss of ICs. The most direct impacts reported were the lack of animal protein for home consumption, loss of income, abandonment of cultural/ religious practices, loss of unique genetic breeds, increase in food insecurity, high poverty rate and gender inequity and lack of job opportunity.

Conclusion

Native chicken production plays a major role to help improve the nutritional requirement of many household individuals by providing a rich source of protein while at the same time ensuring the farmers earning power, reducing the unemployment rate and meeting cultural and traditional demands. NCP greatly suffers from increase and continuous mortality/loss in the study areas. Predators, diseases/parasites, accident, feed/water shortage, theft and bad weather were the main causes of mortality/loss. Predators and diseases/parasites were

most severe especially during the late dry and early rainy seasons. The severity of diseases/parasites was high in the river-line areas while predators were more of a problem in both forested/farm-bush and grassland/savannah areas. Institutional support such as veterinary and extension services as well as proper implementation of biosecurity and management practices among the chicken rearers were lacking. Also, there were little or no proper control measures observed against predators especially the birds of prey during the study. Therefore, animal health extension services and proper husbandry management practices should be strengthened in rural communities. Furthermore, educational programs with the participatory approach are essential to increase the level of awareness among the farmer. There should be an appropriate intervention in the control of predators by encouraging farmers to confine their chicks for at least two months before allowing them to move freely. There is a need for further research to help determine the prevalence rate of diseases and parasites affecting local poultry for appropriate and timely interventions at the rural level.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCE

Ahmed, M. (2018). Major constraints and health management of village poultry production in Ethiopia: Review School of Veterinary Nedicine, Jimma University, Jimma, Ethiopia. *International Journal of Research Studies in Microbiology and Biotechnology,* 4(1), 1-10.

Chege, H. W. (2014). Seasonal parasite carriage of village chicken in Mbeere Subcounty, antiparasitic treatments used and effectiveness of selected antihekmintics. PhD Thesis, Department of veterinary Parasitology, Microbiology and Parasitology, Faculty of Veterinary Medicine, University of Nairobi.

Chege, H. W., Kemboi, D. C., Bebora, L. C, Maingi, N., Mbuthia, P. G., Nyaga, P. N., Njagi, L. W., & Githinji, J. (2015). Studies on seasonal prevalence of ecto- and endo-parasites in indigenous chicken of Mbeere Subcounty, Kenya. *Livestock Research for Rural Development,* 27(6). Retrieved from https://www.lrrd.cipav.org.co/lrrd27/6/cheg27113.htm.

Chende, H. C. (2012). Epidemiology of Newcastle disease in village chickens in Ethiopia: risk factors, role of molecular characterization and role of poultry markets. PhD thesis, Faculty of Veterinary Science, University of Petroria.

Conroy, C., Sparks, N., Chandrasekaran, D., Sharma, A., Shindey, D., Singh, L.R., Natarajan, A., & Anitha, K. (2005). The significance of predation as a constraint in scavenging poultry systems: Some findings from India. *Livestock Research for Rural Development,* 17(6). Retrieved from http://www.lrrd.cipav.org.co/lrrd17/6/conr17070.htm.

Dinka, H., Chala, R., Dawo, F., Bekana, E., & Leta, S. (2010). Major constraints and health management of village poultry production in Rift Valley of Oromia, Ethiopia. *American-Eurasian Journal Agriculture and Environmental Sciences,* 9(5), 529-533.

Gboku, M. L. S., Davowa, S. K., & Gassama, A. (2015). Thematic report on agriculture. Population Housing Census, 2015, Statistics Sierra Leone.

Guèye, E. F. (2005). Gender aspects in family poultry management systems in developing countries. *World's Poultry Science Journal*, 61(1), 39-46.

Justus, O., Owuor, G., & Bebe, B. O. (2013). Management practices and challenges in smallholder indigenous chicken production in Western Kenya. *Journal of Agriculture and Rural Development in the Tropics and Subtropics,* 114(1), 51-58.

Kebede, A., Abebe B., & Zewdie, T. (2017). Study on prevalence of ectoparasites of poultry in and around Jimma Town. *European Journal of Biological Sciences,* 9 (1), 18-26.

Kusina, J., Kusina, N. T., & Mhlanga, J. (2001). A survey on village chicken losses: Causes and solutions as perceived by farmers. In *ACIAR PROCEEDINGS* (pp. 148-155). ACIAR; 1998. Available at https://pdfs.semanticscholar.org/98ea/61e95455aee91861069a82193ae79ef58090.pdf

Moges, F., Tegegne, A., & Dessie, T. (2010). *Indigenous chicken production system in Ethiopia: characteristics and opportunities for market oriented development. Nairobi, Kenya*. International Livestock Research Institute.

Moreda, E., Hareppal, S., Johansson, A., Sisaye, T., & Sahile, Z. (2013). Characteristics of indigenous chicken production system in South West and South Part of Ethiopia. *British Journal of Poultry Science,* 2(3), 25-32.

OIE (2008). Newcastle disease. In manual of diagnostic tests and vaccination for terrestrial animals 2008. Chapter 2.3.14. Organization for World Animal Health. 6th ed., pp. 576-589. OIE, Paris, France. Version accepted by the World Assembly of Delegates of the OIE in May 2012. www.oie.int/fileadmin/home/eng/health.../2.03.14_newcastle_dis.pdf.

Population Housing Census (2015). Statistics Sierra Leone, summary of final result.

Rezaei, F., Hashemnja, M., Chalechale, A., Seidi, S., & Gholizadeh, M. (2016). Prevalence of ectoparasites in free-range backyard chickens, domestic pigeons (Columba livia domestica) and turkeys of Kermanshah Province, West of Iran. J*ournal of Parasitic Diseases,* 40(2), 448-453.

Swai, E. S., Kessy, M., Sanka, P., Bwanga, S., & Kaaya, J. E. (2010). A survey on ectoparasites and heamoparasites of free-range indigenous chickens of Northern Tanzania. *Livestock Research for Rural Development* 22(9). Retrieved from https://www.lrrd.cipav.org.co/lrrd22/9/swai22158.htm.

Terregino, C., & Capua, I. (2009). Clinical traits and pathology of Newcastle disease infection and guide line for farm visit and differential diagnosis. In: Capua, I., & Alexander, D. J. (eds.), Avian Influenza and Newcastle disease, a Field and Laboratory Manual. Springer-Verlag, Italy, Pp. 113-125.

Waktole, H., Almaw, M., Taweya, D., Wakjira, B., Kiflom, M., Ashenafi, H., & Ayana, D. (2018). Opportunities and challenges of indigenous chicken in Asella district, Arsi zone, Oromia, Ethiopia: Implications for designing improved productivity schemes. *Journal of Bacteriology and Mycology*, 6(3), 229-235.

Yitbarek, M. B., & Atalel, W. (2013). Constraints and opportunities of village chicken production in debsan tikara keble at gonder zuria woreda, north gonder, Ethiopia. *International Journal of Scientific and Research Publications*, 3(9), 1-8.