Veterinary Sciences and Medicine

RESEARCH ARTICLE

An Evaluation of a Pilot Flock Health and Productivity Monitoring Programme on Performance of Smallholder Layer Chicken in Peri-Urban Kampala, Uganda

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Abstract

We evaluated a pilot flock health and productivity monitoring programme in peri-urban smallholder poultry farms in Kampala, Uganda. A total of 14 flocks were enrolled for this action-oriented longitudinal study. On enrolment, a flock was visited and evaluated every fortnight using a standard flock evaluation form. From each visit, a flock health report was produced prescribing specific on-farm interventions. A linear regression model was fitted to assess the effects of repeated flock visits on fecal coccidian oocyte counts (OPG), flock mortality and daily egg lay. Characteristically, the flocks were mostly (92.7%) Isa Brown chicken kept on deep litter. Most (78.6%) flocks commenced egg lay at 20-24weeks of age and attained peak production five weeks from start of lay (at 25-30weeks of age). At peak production, daily percentage egg lay for most (75%) flocks was 65-85%. The layer flocks (78.6%) were provided branded pre-formulated feeds bought from commercial feed processors. At least 64% of farmers reported outbreaks of diseases including Newcastle, infectious bronchitis, gumboro and fowl typhoid amongst flocks. Farmers (93%) however, vaccinated flocks against Newcastle disease only. percentage egg lay was negatively associated with OPG (β=-0.000180, $p<0.05$). Daily egg lay however, improved (β=0.110, $p<0.05$) following repeated scheduled flock visits. Likewise, flock mortality decreased with the visits. Overall, we concluded that smallholder layer poultry in Uganda are performing below production potential. However, production could be significantly improved through tailored flock-health and productivity monitoring programmes as the model extension approach to support of smallholder farmers.

Keywords: egg lay, intensive management, scheduled visits

Introduction

Animal production in Uganda is a key component of the economy, currently contributing about 17% of the gross domestic product [1]. The industry, especially livestock production is currently growing at an estimated 3% annually [2]. This is attributed to higher demand for animal-sourced products by an exponentially growing human population, expansion of the national economy and rapid urbanisation [3]. Poultry, a key component of livestock accounts for about 20% of the livestock value in Uganda [4]. The poultry value chain is witnessing a gradual transformation from a largely backyard subsistence system to intensive commercial systems [3].

Actually, Uganda is today transitioning into a leading exporter of poultry products (meat, eggs, and day-old chicks) within East Africa [4,5]. Commercial poultry production in Uganda is dominated by peri-urban smallholder producers [3]. The smallholder system is characterised by low inputs with flocks raised largely on home formulated feeds, usually maize or rice bran fortified with varying amounts of silver fish or soybeans [6]. Because nutritional quality of diets is often poor, smallholder flocks generally produce below expected potential [4,5]. For economic efficiency, it is expected that, approximately 90% of birds in a flock should lay every day

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during peak production [7]. Such flocks require sufficient well-formulated feeds [9]. Unfortunately, smallholders find it too expensive to provide such feed formulations, hence the resort to locally available by-products like bran [6].

Besides the afore mentioned feeding challenges, smallholders are also often neglected by existing veterinary extension services [10]. In a typical smallholder setting, veterinary practitioners are invited only when animals are sick or have died on a farm [11]. Such reactionary approach does not holistically address on-farm health and production challenges. Modern commercial livestock production depends on regular scheduled veterinary visits to identify and promptly address health and production challenges on farms [12]. Called herd-health or population medicine, this today is the mainstay of intensive production systems [12]. However, veterinary services in Uganda, like in most developing economies are still case based instead of scheduled visits [10]. We thus developed and assessed a pilot flock-health and productivity monitoring programme for smallholder layer-poultry in peri-urban Kampala, Uganda. We expected the scheduled visits as opposed to case based on-farm interventions to significantly improve indicators of health (especially coccidiosis), and egg production in peri-urban layer flocks in Kampala, Uganda.

Materials and methods

The Study Area

A pilot programme for flock health and productivity monitoring was developed implemented on smallholder layer poultry farms in peri-urban Kampala, Uganda. Participating farms were within Kampala (00°18′49″N 32°34′52″E), the commercial and administrative capital of Uganda. However, majority of the farms were from the surrounding districts of Wakiso (00°24′N 32°29′E) and Mukono (00°28′50″N 32°46′14″E) which are part of the greater metropolitan Kampala (Figure 1). To date, peri- urban Kampala has the highest concentration of commercial poultry farms with about 10% of the total national population of chicken in Uganda [3].

Study Design and Selection of Study Flocks

A longitudinal action research approach was adopted [13]. The study animals were commercial layer flocks in smallholder poultry farms peri-urban communities in Kampala, Uganda. A list of 30 poultry farms was obtained from the Ambulatory Clinic of Makerere University, Kampala. From the list, a poultry farmer was selected to participate in this pilot programme if s/he: a) was a commercial layer producer with flock size of at least 500-layer chicken, b) had a farm located within a 30km radius from the Makerere University campus, and, c) granted informed consent. Based on these criteria, a total of 14 flocks were enrolled to participate in this pilot health and productivity monitoring programme [11]. Data collected in the first herd health visit was used as baseline for comparison with subsequent visits.

Figure1. *Map of Uganda showing Kampala metropolitan area. Retrieved 18th August, 2021 from* https://infrastructuretransparency.org/cost-impact-wakisodistrict/

The Flock Health and Productivity Monitoring

Data Collection

On enrolment, flock health and productivity monitoring programme was implemented through scheduled fortnightly visits to each of the selected flocks. By the time of this report, a total of six (06) visits were made between May- July, 2020. At each scheduled visit, examination of available health and production records were undertaken. After examination of the records (treatments, mortalities and daily percentage egg lay), a general assessment of each flock was undertaken through inspection to identify overtly sick birds [14]. Data was captured and entered into a standard flock evaluation from. From the flocks, fresh faecal droppings were collected and submitted for parasite identification at the Central Diagnostic Laboratory (CDL), College of Veterinary Medicine, Makerere University, Kampala. To assess the level of sub-clinical coccidiosis in flocks, coccidian oocysts in pooled fecal droppings were quantified using the McMaster technique [15] and recorded as oocysts per gram (OPG). Subsequently, a flock health report [16] was prepared with recommendations for improved health, welfare, and productivity for the flock. The printed report was issued days after or during the subsequent visit where the team discussed the recommendations with the farmer and mutually agreed on the on-farm interventions for improved flock health, welfare and productivity. Some of the recommendations in the flock health reports were based on performance standards/ references presented in Table 1.

Statistical Analysis

Data was entered and collated in Excell (MS Windows, 2007-2013). It was then exported to the Stata programme (Stata 14.2, Stata Corp, 4905 Lakeway drive, College Station Texas, 77845 USA). Descriptive statistics were generated and tabulated using the frequency functions of Stata. A linear regression model was fitted to assess the effects of repeated flock visits, sub-clinical coccidiosis (OPG) and flock mortality as fixed (independent) variables on daily percentage egg lay as response (dependent) variable. Effect modification between visits, OPG, flock mortalities and percent egg lay was carried using the log likelihood difference test (chunk test) through Chi-square approximation at df=1, with the outputs reported as beta (β) coefficients. Baseline data collected during the first visit was used as reference (control) point for comparison with data collected during repeated subsequent visits.

Table1. Baseline production characteristics of layer flocks in peri-urban Kampala

Flock characteristic	Status on farm	Percentage of farms (%)	Recommended/target
Breed of layer flocks			Isa brown or others [17]
	Isa brown	92.7%	
	Others (Hysex brown, Kruoiler)	07.3%	
Flock size			>1000 birds [18]
	Up to 500 birds	14%	
	501-1000 birds (Mean 1217)	64%	
	>1000 birds	22%	
Management system			Deep litter [5]
	Deep litter	92.7%	
	Battery cage	07.3%	
Source of chicks			-
	Breeders (day old chicks)	85.80%	
	Other farmers (2-6week old)	14.20%	
Age at commencement of lay			18 weeks [7]
	18 weeks	21.40%	
	20-24 weeks	78.60%	
Start to peak laying			4-5weeks [7]
	From 4-5weeks	32%	
	After 5 weeks	68%	
Laying percentage at peak			About 90% [7]
	Between 65-75%	25%	
	Between 76-85%	50%	
	Between 86-95%	28%	
	Above 95%	2%	

Results

Baseline Production Characteristics of Layer Flocks in Peri-Urban Kampala

The baseline production characteristics of layer flocks in peri-urban Kampala are summarized in Table 1. Isa Brown (92.7%) was the commonest layer breed, but some (7.3%) flocks kept Hysex brown or even the dual purpose Kuroiler breed. Most (64%) flocks had on average 1217-layer birds, mainly (92.7%) kept on deep litter. The farmers (85%) sourced day-old chicks directly from local commercial hatcheries within Kampala. Up to 78.6% of the flocks commenced laying at 20-24weeks and most (68%) attained peak-lay five (5) weeks from commencement of lay. In 78% of the flocks, between 65-85% of birds were laying every day.

Feeds and Feeding Practices for Layer Flocks in Peri-Urban Kampala

The majority (78.6%) of farmers used branded commercial feeds (78.6%), while some (21.4%) bought bran and other ingredients to formulate flock rations on the farms. Nearly all (100%) did not follow any feeding pattern (timing), nor estimate how much feed is required per laying bird (**Table 2**).

Common Flock Diseases and Parasites

Table 3 summarises vaccination status and reported outbreak of Newcastle and other infectious diseases on the study farms prior to the flock health monitoring and productivity programme. Although recent outbreaks of Newcastle, infectious bronchitis, and gumboro disease had reportedly occurred, farmers (93%), however, vaccinated flocks against Newcastle disease only. Besides reported occurrence of infectious conditions, the following important poultry parasites were detected on laboratory examination of faecal samples: coccidia (70.6%), capillaria (32.1%), ascaridia (25%), strongyle (12.5%) and amidostomum (6.25%). All (100%) farmers were using amprolium (100%) prophylactically but some (64.2%) were also using piperazine. The farmers used amprolium monthly (64.5%), every two months (14.3%) or occasionally (21.2%). **Figure 2** summarizes the parasite prevalence and the control practices on layer poultry farms in peri-urban Kampala.

Association between Percentage Mortality, Flock Size, OPG, Scheduled Visits and Egg Production

A summary of results on association between egg lay, mortality, flock size, OPG and scheduled visits is shown in **Table 4**. Egg lay was negatively associated with OPG (β=-0.000180, 95%

Table2. Feeds and feeding practices for layer flocks in peri-urban Kampala

Practice	Status	Distribution of farms (%)	Recommended
Source of feeds	Use branded commercial feeds	78.6%	Balanced branded feeds
	Buy ingredients & mix on-farm	21.4%	
Frequency of feeding	No known pattern	85.7%	Controlled, 2-3 times/day
	Unregulated (*ad libitum*)	14.3%	
Quantity/day (gm)	Not quantified (measured)	All, 100%	Measured amounts

Table3. Reported disease, vaccination, and outbreak status on the poultry farms

Disease	Vaccination status and schedule	Proportion of farms (%)	
		Vaccinated	Recent outbreak
Newcastle disease (NCD)	Vaccinated	93.0%	64.30%
	Vaccinated monthly	42.90%	
	Vaccinated Occasionally	35.70%	
	Vaccinated as per breeder prescription	21.40%	
Infectious Bronchitis (IB)			64.30%
	Vaccinated	28.60%	
	Not vaccinated	71.40%	
Gumboro disease (GD)			70.0%
	Vaccinated	21.40%	
	Not Vaccinated	78.60%	
Fowl typhoid (FT)			57.10%
	Vaccinated	14.30%	
	Not vaccinated	85.70%	
Mareks disease (MD)			-
	Vaccinated	21.40%	
	Not vaccinated	78.60%	

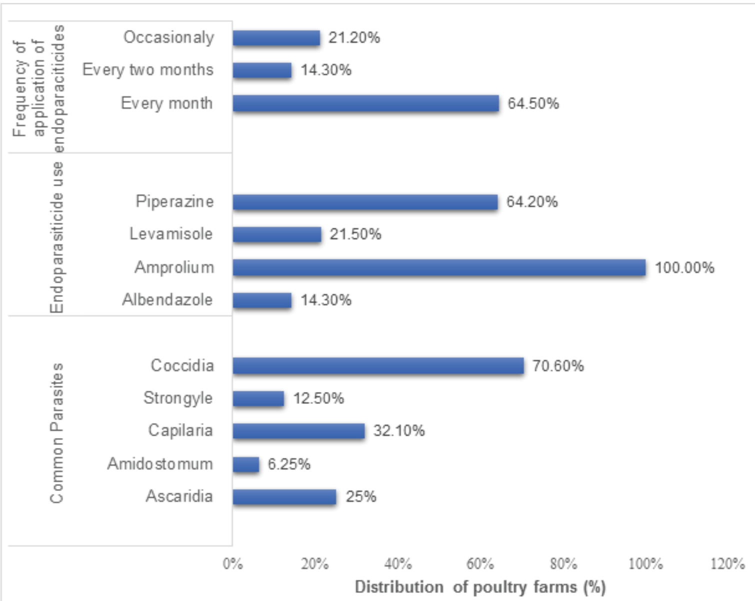

Figure2. Parasite prevalence and the control practices on layer poultry farms in Kampala

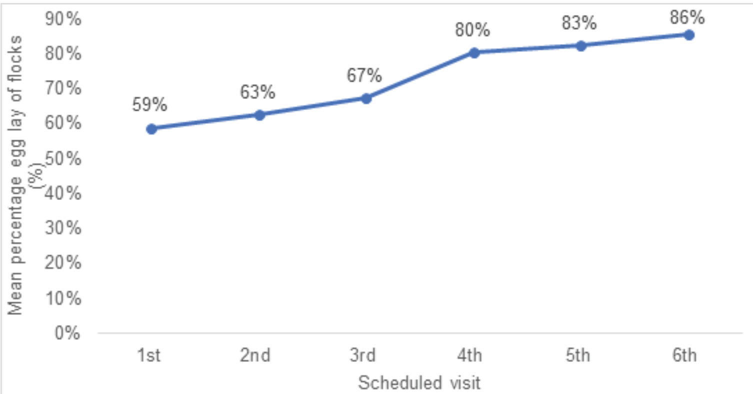

Figure3. Changes in egg production with repeated scheduled flock visits

Table 4. Association between daily egg lay, flock size, OPG and scheduled visits

Variable	β (95%CI)	P-value
Daily percent egg lay (Outcome)		
Flock size	0.000018(-0.0000104-0.000047)	0.21
Coccidian oocysts (OPG)	-0.000180(-0.00023- -0.00012)	<0.001
Effects of scheduled Visits		
1st visit (baseline/reference)		
2nd visit	-0.012(-0.12-0.094)	0.83
3rd visit	0.005(-0.10-0.11)	0.92
4th visit	0.090(-0.02-0.21)	0.10
5th visit	0.110(0.001-0.226)	0.049
6th visit	0.140(0.03-0.25)	0.015

CI -0.00023- -0.00012). Egg lay however, improved with scheduled flock health and productivity monitoring visits with at least a 10% increase in egg lay from the fifth visit onwards (**Figure 3**). Likewise, OPG markedly declined with repeated scheduled visits (**Figure 4**).

Association between Percentage Mortality and Flock Size, OPG, and Egg Production

The effect of flock size, OPG and mortalities on egg production is summarised in **Table 5**. Flocks with high daily percentage egg lay had relatively low percentage mortality of flocks

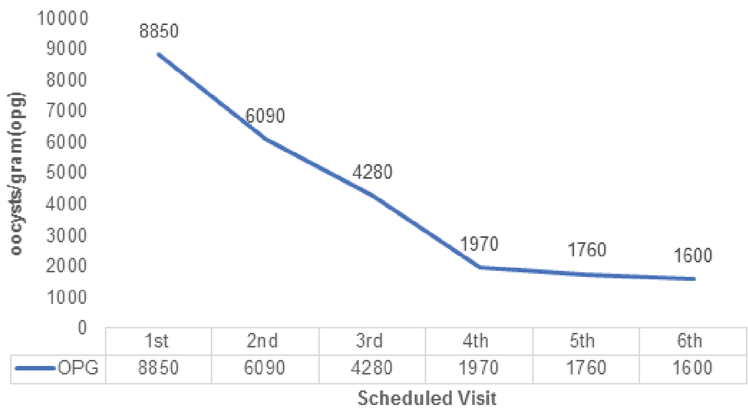

Figure4. Changes in mean oocyte count (OPG) with repeated flock visits

Table5. Association between percentage mortality and flock size, OPG, and egg lay

Variable	β (95%CI)	P-Value
Flock Percent mortality (Outcome)		
Flock size	-0.0003(-0.001-0.0004)	0.55
Coccidian oocysts per gram (OPG)	-0.0004(-0.003-0.002)	0.76
Daily egg lay percentage (%)		
≤63.5%	Reference	
>63.5%-87%	-4.81(-8.26—1.36)	0.007
>87%	-4.67(-8.42—0.192)	0.015
Daily percentage egg lay (%) on OPG		
≤63.5%	Reference	
>63.5%-87%	0.005(0.001—0.009)	0.012
>87%	0.005(-0.006—0.016)	0.344
Constant	5.49(2.26-8.73)	0.001

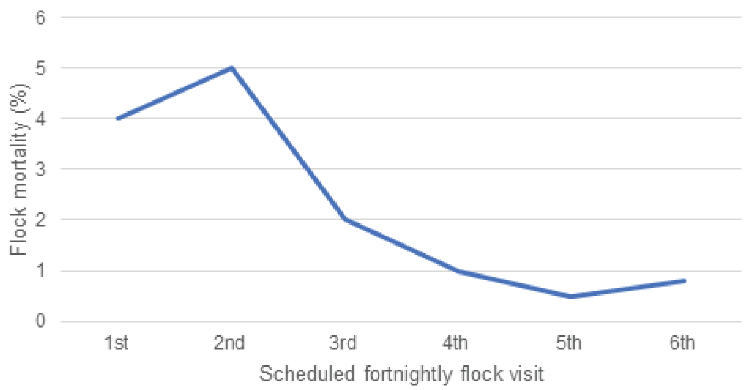

Figure5. Changes in flock mortality with repeated scheduled flock visits

i.e., there was reduced mortality on poultry farms with daily percentage egg lay above 63.5% compared to those laying less (r = -0.953). However, a unit increase in OPG was associated with 0.5% mortality especially in flocks with daily percentage egg lay above 63.5% (β=0.005, 95%CI 0.001-0.009). Generally, flock mortality decreased with repeated flock health and productivity monitoring visits (**Figure 5**).

Discussion

Most flocks (93%) were of the Isa Brown layer breed. A recent survey in Ethiopia reported that 96% of smallholder farmers keep Isa Brown as preferred layer chicken breed [19]. Isa Brown is indeed the most popular layer breed in the tropics today [17]. In Africa, Isa Brown is also widely used to crossbreed with indigenous chicken in major genetic improvement programmes

[19,20]. The popularity of Isa Brown flocks stems from the fact that they relatively have low maintenance cost and are adaptable to extremes of climatic conditions, Furthermore, Isa Brown flocks have high prolificacy with a hen producing over 300 eggs a year [17]. Because of this dominance, Isa Brown gene and traits could soon become the most dominant in both commercial and backyard poultry production systems in Africa [21]. Therefore, this trend should be monitored by concerned research and planning authorities in view of directing policy on poultry genetic resources improvement and/or conservation.

In most (78%) of the participating farms, the average flock size was 1217 (range 385-4565) layer chicken. Conversely, in an earlier survey in peri-urban Kampala, a much smaller flock size of 30-500 (average 283) layer birds was reported [3]. A related study in Ethiopia also reported that peri-urban smallholders keep between 50 -500 commercial layer birds [22]. The difference in the observed flock sizes in the current study and the previous ones could be in the study designs. The current study purposely targeted commercial poultry producers while Sabiiti and Katongole [3], gave a general non-purposive assessment of urban and peri-urban agriculture in Uganda. However, this study, like others before have demonstrated that commercial poultry production in Uganda is predominated by small to medium scale producers. Given that economic efficiency and profitability is higher in large flock sizes [18], a deeper study would be necessary to estimate the optimal flock size desirable for profitable commercial production in peri-urban husbandry conditions of Uganda.

Reportedly, most (85%) farmers sourced day-old chicks directly from local hatcheries within and around Kampala. This agrees with an earlier report that Uganda is today a leading producer and exporter of poultry products, including day-old chicks within East Africa [4]. It was also earlier reported that up to 69% of commercial day-old chick stocks in Rwanda are imported mainly from Uganda [23]. Our finding thus, shows that there is established hatchery capacity in Uganda for production of good quality day-old layer chicks for local rearing and regional exports. Therefore, national planning efforts should take cognisance of this capacity such that it is deliberately consolidated as a key component of import substitution but also improving the national balance of payment deficits.

We observed that most (93%) commercial smallholder layer flocks were managed on the deep litter production system. Similarly, Mbuza et al. [23] reported that commercial poultry flocks in neighbouring Rwanda are predominantly kept on deep litter. They argued that deep litter poultry production if preferred because it is cheaper and easier to operate compared to other commercial poultry systems. This is different form from the practice in developed and highly mechanised layer production systems where layer chicken is mainly managed in the battery cages [24]. Given that, in the current study, up to 7% of farmers were using battery cages, it is probable that the system could get more popular as farmers gradually mechanise production. However, serious animal welfare concerns are associated with the battery cage system, thus it is being discouraged across most of Europe [25]. Therefore, poultry producers in Africa should be sensitized on the welfare concerns associated with battery cage production system but encouraged to perfect the rather cost-effective and animal welfare friendly deep litter production system.

On most (78.6%) of the farms, flocks commenced egg lay at between 20-24 weeks old with peak lay occurring five (5) weeks later (when birds are 25-30 weeks old). Ideally, commercial layer flocks should commence egg lay when they are 18 weeks old with the birds laying at peak from about 22-23 weeks old [7,17,26]. Delay in commencement of egg laying or late attainment of peak production is a manifestation of general challenges with layer flock management [27, 28]. Flock feeding both in terms of the quality and quantity of feeds is often the most challenging issue to smallholders [27, 29]. For instance, a low level of dietary calcium in pullets has been shown to delay the onset of egg laying in pullets, thus affecting general flock productivity [29]. Therefore, specific causes of delayed start or attainment of peak egg production of layer flocks in Uganda should be identified, preferably through a community action research programme in peri-urban Kampala, Uganda.

Regarding feeding, most (78.6%) flocks in the current study were fed on branded feeds from established commercial processors. This starkly contradicts an earlier report that, to cut production costs, peri-urban farmers use own formulated feeds instead of the more expensive branded feeds [6]. Relatedly, it has been reported that 92% of commercial poultry farmers in Rwanda fed chicken on home-mixed rations [23]. However, the nature of farmers targeted in the current study differs from the earlier studies. In this study, commercial poultry farmers (flock size above 500 chicken) were purposely targeted. Earlier studies were general householder surveys targeting all categories of poultry farmers [6, 23]. Commercial producers generally prefer branded and well-formulated feeds from reputable suppliers [30]. Though branded commercial feeds are popular with this category of farmers, there are still feed quality and policy challenges in Uganda [31]. The lack of quality regulation and certification could mean that poor-quality feeds are supplied to livestock farmers, hence poor productivity indices [31]. Therefore, a greater focus should be on development and enforcement of feeds standards in order to guarantee higher productivity of commercial poultry or other livestock in Uganda.

Poultry farmers (85.7%) in the present study did not follow any feeding frequency and did not measure the daily quantities of feed provided to laying birds. This finding agrees with a report from neighbouring Rwanda where poultry farmers were found not to follow recommended or standard feeding practices [5, 23]. For optimum performance, a laying chicken should receive about 115g of balanced layer's mash a day [26]. Ideally, a feeding frequency of 2-3 times a day of the desired amount of balanced feed is desirable for hens at peak lay [32]. This may be attributed to inadequate livestock extension support to smallholder farming communities [11, 23]. Knowledge on feeding frequency and regulation of daily feed intake are important in determining quality and quantity of eggs produced by a flock [26, 32]. This further calls for a capacity building program to standardize feeding practices amongst smallholder poultry farmers in peri-urban Uganda.

At baseline, farmers reported outbreaks of diseases including Newcastle, infectious bronchitis, gumboro, fowl typhoid and mareks in their flocks but most (93%) vaccinated against Newcastle only. Several earlier reports have highlighted the apparent high incidence of infectious diseases, especially Newcastle in poultry flocks in Uganda [33, 34, 35]. Newcastle diseases are endemic in Uganda, with an increasing incidence despite vaccinations [33]. Most outbreaks are thus attributed to vaccination failure [36, 37]. Vaccination failure could be attributed to several causes include comorbidity, especially with other viral infections but often it's a result of poor cold chain management or non-observance of recommended vaccination schedules by farmers [36,37]. They recommended that for effective control of major poultry diseases, distribution, handling and administration of vaccines should be strictly undertaken by veterinarians and not the farmers themselves. For peri-urban poultry in Uganda, a participatory programme is needed to identify and address specific causes of diseases outbreaks in vaccinated commercial poultry flocks.

Laboratory assays detected coccidia oocytes in 70.6% of the faecal samples besides capillaria, ascaridia, strongyles and amidostomum. Similarly, Byaruhanga et al.2017 [35], reported that besides viral diseases, coccidiosis is an important disease affecting poultry production in Uganda. They attributed the high incidence of coccidiosis poor or total lack of biosecurity measures on poultry farms. Often, farmers look at implementation of biosecurity protocols as additional production costs, though many are ignorant of the measures [38]. There is thus, a tendency by farmers to depend almost solely on parasiticides such as amprolium to control parasitic infections. Unfortunately, overzealous, and continuous use of a parasiticide leads to development of parasite resistance against the used chemical product [39]. Considering the costs of continuous use of prophylactic drugs and given that they are often ineffective, altering parasitic diseases control strategies on smallholder poultry farms could significantly reduce parasite, especially coccidiosis burden and the serious production losses that they cause.

On the study flocks, the mean flock percentage egg lay (58%) was strongly but negatively correlated (r = -0.953) to the mean coccidian oocyst count (8850 OPG). This finding further confirms the generally accepted assertion that coccidiosis is the most important disease that cause production loses in poultry flocks [40, 41]. Unlike other diseases such as Newcastle that cause high flock mortalities, coccidiosis is largely sub-clinical in occurrence, thus often inapparent to the poultry farmer [42]. Because of this insidious occurrence, farmers tend to overlook its control, yet associated production loses are enormous [43]. Unfortunately, even with the strictest biosecurity and other rigorous control measures, the burden of coccidiosis in a flock can just be supressed, not eliminated [42]. Indeed, coccidia will remain omnipresent in poultry production facilities worldwide and will continue to present a challenge to the effectiveness of current and future control measures [43]. From this account, it is apparent that, effective control of coccidiosis is a challenging responsibility that smallholder farmers on their own cannot manage without continuous extension support. Indeed, our pilot flock health and productivity monitoring programme for smallholder farmers in peri-urban Kampala, Uganda, was in light of this. Actually, following our scheduled fortnightly visits, mean egg production significantly increased with decline in flock burden of coccidiosis (OPG). It is the first time a herd-health approach [10,11] has been demonstrated as an extension approach to improved health and productivity of layer chicken in the Ugandan smallholder production systems. However, besides coccidiosis, other confounders such as stress, malnutrition or inapparent comorbidities are equally important in causing significant drop in layer egg production [42].

At baseline, mean flock mortality was about 5% but generally decreased with repeated health and productivity monitoring visits. The observed mortality of 5% in the current study is higher than 0.5-1.5% mortality generally expected of layer flocks that are free of stress or diseases [44]. In small holder farms, high mortalities are associated with endemic infections often resulting from neglect of biosecurity or disease control measures [45]. The common endemic infections of poultry in Uganda include coccidiosis, Newcastle disease, infectious bronchitis, infectious bursal disease, and fowl typhoid and mareks disease [35]. Much as the current study also reported on some of these diseases, a more specific study is warranted to discern the specific cause of mortalities in smallholder flocks.

Conclusion

Overall, we concluded that smallholder layer poultry in Uganda are performing below production potential. However, productivity could be significantly improved through tailored flock-health and productivity monitoring programmes as the model extension approach to support of smallholder farmers.

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