Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Faculty of Veterinary Medicine and Animal Science
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Uppsala
2015

Degree Project 30 credits within the Veterinary Medicine Programme

ISSN 1652-8697
Examensarbete 2015:52

Local poultry production in rural Zambia and the effect of light on poultry performance

Lokal fjäderfäproduktion på landsbygden i Zambia och ljusets effekt på fjäderfäns produktionsförmåga

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Degree Project in Veterinary Medicine

***Credits**: 30 hec*
***Level**: Second cycle, A2E*
***Course code**: EX0755*

***Place of publication**: Uppsala*
***Year of publication**: 2015*
***Cover photo:** Johanna Lindell*
***Number of part of series**: Examensarbete 2015:52*
***ISSN**: 1652-8697*
***Online publication**: http://stud.epsilon.slu.se*

***Key words**: Animal welfare, chicken, light, Zambia*
***Nyckelord**: Djurvälfärd, kyckling, ljus, Zambia*

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SUMMARY

Zambia is a country in Southern Africa where poverty is widespread and the traditional keeping of local poultry therefore plays a crucial role in improving nutrition. Meat and eggs from poultry are important sources of protein but also of income. Improving the poultry production is thereby a method to fight poverty. For poultry, the access to light is an important factor for both growth and egg production. In this paper, the focus is on the traditional village chickens used for both egg and meat production, how they are kept, their health and welfare and if the use of a solar lamp will influence their behaviour, growth and egg production.

Three studies were conducted in Chibombo and Choma Districts in Zambia were 17 farmers were interviewed regarding the village chicken management of which six farmers participated in a solar lamp experiment. The village chickens were divided into one control group and one experimental on each farm. The latter received a solar lamp that was on for two hours every evening after dusk. Both groups had access to feed during the time the solar lamp was on. After one month, the poultry were weighed. In the second experiment, twenty village chickens were divided into two groups, where the experimental group was given the anthelmintic piperazine. All of the village chickens were weighed before and after the experiment that lasted for one month. In a third experiment, the effect of the solar lamp on village chicken's behaviour was studied. Also, the poultry welfare was studied.

The results showed that village chickens are kept mainly free-ranging and scavenging during the days. They are usually given small amounts of feed, mainly maize. The production is low and the health management is poor. The village chickens in the study of behaviour did not show any aversion towards the solar lamps and the effect from the extra light hours on the food intake was insignificant. There was no apparent difference in weight gain between the groups in the deworming experiment. The solar lamp experiments did not give any reliable results due to different factors that are discussed in the thesis.

SAMMANFATTNING

I utvecklingslandet Zambia är fattigdomen utbredd och den traditionella hållningen av lokala fjäderfän spelar en viktig roll för att förbättra människans näringsförsörjning. Ägg och fågelkött är en viktig källa för protein såväl som inkomst. Därför är en förbättrad fjäderfäproduktion en metod för att bekämpa fattigdom. För fjäderfän är ljus en viktig faktor för äggproduktion och tillväxt. Syftet med denna uppsats var att studera hur lokala fjäderfän hålls på landsbygden i Zambia (1), deras hälsa och välfärd (2), huruvida en solcellslampa kan öka produktionen av fågelkött och ägg samt eventuell inverkan av lampan på fåglarnas beteende (3).

Studierna ägde rum i Chibombo- och Chomaområdena i Zambia där 17 bönder intervjuades angående hållningen av lokala fjäderfän. Sex av bönderna deltog i ett försök med en solcellslampa. Fjäderfäna, så kallade village chickens (används både för ägg- och köttproduktion), delades in i en kontrollgrupp och en försöksgrupp på varje gård, varav den senare erhöll ljus från solcellslampan under två timmar varje kväll efter skymning. Båda grupperna hade tillgång till foder under den tid på dygnet som lampan användes. Efter en månad vägdes djuren. I ett annat försök delades 20 fjäderfän in i två grupper, där försöksgruppen avmaskades med piperazine och jämfördes med icke-avmaskad kontrollgrupp. I en tredje studie utvärderades vilken påverkan solcellslampan har på fåglars beteende. Dessutom studerades djurvälfärden hos fjäderfän.

Resultaten visade att de lokala fjäderfäna i huvudsak vistades fritt strövande utomhus och pickandes efter föda på dagarna. Oftast fick de en mindre mängd majs som supplement. De hade en låg produktionsförmåga och hälsokontrollen var undermålig. I beteendestudien visade fåglarna inga beteendeförändringar då solcellslampan var närvarande och effekten av extra ljus på födointaget var försumbar. Det fanns inte heller någon skillnad i tillväxthastigheten hos fåglarna i avmaskningsförsöket. Försöken med solcellslamporna gav inga tillförlitliga resultat på grund av diverse problem som diskuteras i uppsatsen.

CONTENT

INTRODUCTION

Zambia is a country in Southern Africa where poverty is still widespread and the human diet is usually based on starch-rich crops like maize. The traditional keeping of local poultry therefore plays a crucial role in improving nourishment of the population. Meat and eggs from poultry are important sources of protein but also of income, not at least for women and children. Improving the poultry production is thereby a method to fight poverty.

For poultry, the access to light is an important factor for both growth and egg production. In Zambia, the daylight range between 11 (month of June) and 13 (month of December) hours (Time and date, 2013) and the idea to increase the production performances of poultry by increasing the access to light by help of a solar lamp (HiLight from HiNation) was therefore presented by a Zambian farmer and formed the basis of this study.

In this paper, the focus is on the traditional Zambian village chickens, how they are kept, their health and welfare and if the use of a solar lamp will influence their behaviour, growth and egg production.

LITERATURE REVIEW

Zambia

Zambia (Figure 1) is a republic situated in the southern part of East Africa and inhabits approximately 14.2 million people (Nationalencyklopedin, 2013). It is one of the poorest countries in the world. Sixty percent of the population live in poverty, according to the World Bank (2013). Almost one third of the people live in urban areas, of which the capital Lusaka is the largest city with 1.4 million inhabitants (Nationalencyklopedin, 2013). English is the national official language but seven of the indigenous languages also count as official languages. A majority (85 %) of the population are Christians.

Figure 1. Country map of Zambia (Nationalencyklopedin, 2013).

The average life expectancy (49 years) is one of the lowest in the world and applies to both men and women (Nationalencyklopedin, 2013). The access to health care is very poor and 14 % of the population between 15 and 49 years are estimated to be infected with HIV. The high number of HIV infected people has led to an increased number of orphan children and is also a cause of high infant mortality. Twenty percent of the

children younger than five years are malnourished. The poverty is most prevalent in rural areas of Zambia where only about two thirds of the inhabitants have access to clean water. Thirty-five percent of the total agricultural production consists of the livestock sector, which is important economically (IMF, 2007). Poultry is the largest livestock group and are bred over the whole country.

Taxonomy

Poultry are domesticated birds and the two taxonomic families that have been the easiest to domesticate, according to Rose (1997), are the *Phasianidae* family and the *Anatidae* family. The *Phasianidae* family is classified within the order *Galliformes* and include chickens, guinea fowls, turkeys and ducks. There are four species of the junglefowl which is the genus the domesticated chicken belongs to. The four species, as reviewed by Al-Nasser et al. (2007), are: *Gallus gallus* (red junglefowl), *Gallus varius* (green junglefowl), *Gallus sonneratii* (grey junglefowl) and *Gallus lafayetii* (Ceylon junglefowl). They differ in their geographical distribution and morphology, but they all originate from South-East Asia and India (Tixier-Boichard *et al.,* 2011).

Local poultry production in Zambia

The domesticated chicken of today that is known as "village chicken" in Africa is derived from the indigenous red junglefowl (Kitalyi, 1997) that naturally lives in forest vegetation. The village chickens count for over 50 percent of the total poultry population in Zambia (Hameenda, 1996: see Phiri *et al.,* 2007). According to Simainga *et al.,* (2010) 99 % of the households in Zambia kept poultry of which 80.1 % were chickens, 2 % ducks and 2.6 % guinea fowl (Simainga *et al.,* 2010). Rural poultry is defined as a flock of less than 100 birds, of unselected or selected breed (Sonalya & Swan, 2004). In addition to the village chickens, small-scale chicken production also includes production of layers and broilers (CTA, 2004). The broilers and layers are often kept in an intensive system indoors in poultry houses or in cages under controlled conditions. The semi-intensive system means that the poultry are kept in an enclosure outdoors but are both fed and scavenging. In many African countries, women and children play a key role in the management of village chickens (Simainga *et al*., 2010).

Accordingly, village chicken production has a significant role for the economy of a developing country. It means an income for the poorer part of the population but also an improvement of human health by its high nutritional value (Abubakar *et al.,* 2007). In the 1990's it was reported that over 70 % of the poultry products and 20 % of the animal protein intake in most African countries came from the village chicken production (Kitalyi, 1998). On average, each person in Zambia then consumed 1,6 kg of chicken meat and 15 eggs every year (Daka, 1992: see Kaluba, 1992). Compared with the developed countries the intake of animal protein is low. Eggs and chicken meat are valuable complements to the staple food (Kitalyi, 1998) that mainly consists of maize and cassava (FAO, 2009).

The village chickens, kept both for egg and meat production for own consumption as well as for generating an income to the household (Siamainga *et al.,* 2010), are characterized by a poor production performance and a low feed intake. The sexual maturity is late among the laying hens. They reach sexual maturity at 24 to 36 weeks of age (Guèye, 2000). In addition, the village chickens have a slow growth rate and are small in size. A village chicken in Zambia weighs about 1.2 to 1.5 kg at 22 weeks of age or later and lays about 70 eggs per year

(Songolo *et al*., 2001). Important reasons for why the egg production rate is low are both the nutritional deficiencies and the low genetic potential (Pym *et al*., 2006).

According to a study by Simainga *et al.* (2010), 97 % of the village chickens are on free-range and the majority of the chickens has moderate to poor body condition, which indicates a lack of health, management and poor feeding. The village chickens are usually free-ranging outdoors within the village at daytime (CTA, 2004) eating for example household wastes, seeds, worms and insects. During the nights they are usually held indoors.

Meat and eggs from village chickens are considered to be tastier than eggs from layer hybrids and meat from broilers (Sonalya & Swan, 2004). Therefore, many consumers are willing to buy the village chicken meat and eggs even though it's more expensive per bird.

The effect of light on poultry

The avian eye and vision

The avian visual system is more advanced than that of other vertebrates (Sjaastad *et al*., 2003) and is presumably the dominant sense (Prescott *et al*., 2003). The eyes of a bird are relatively larger than in mammals and the eye shape varies between species. In most species they are round or flattened and laterally positioned (Sjaastad *et al*., 2003). Owls and birds of prey usually have tubular eyes and a narrower visual field than 180 degrees per eye. Instead they have a more flexible head. Since chickens and other species have a blind zone in front of the beak, they tilt the head to the side when looking at anything that is in this zone.

Studies have shown that poultry are more capable of distinguishing between light wavelengths than humans, which means that they have a better colour vision (Nuboer, 1993: see Manser, 1996). This is mainly due to the fourth cone cell in the avian retina by which light of UV wavelength is included in the light perception. The additional cone also implies that the avian vision is better in bright than dim light (King-Smith, 1971).

Birds can perceive light as flickering at higher frequencies than humans and flickering light may induce feather pecking, cannibalism and nervousness. According to Lisney *et al.* (2011) some birds perceive 100 Hz as flickering, but it is likely that they perceive lower frequencies as flickering. Therefore, wavelength as well as frequency of an artificial light source should be considered before being introduced to poultry.

The effect of light on health and behaviour

Light intensity, which is measured in the unit lux, affects the birds' behaviour and activity. A low light intensity is likely to reduce the risk for feather pecking (Appleby *et al.*, 1992).

Light has a great impact on the health of chicks, as reviewed by Manser (1996). Newly hatched chicks that do not get enough light can have trouble finding the feeders and a reduced activity, which can lead to an increase in mortality due to malnutrition. A low light intensity can cause eye abnormalities, leg problems and breast blisters in growing birds.

Short day lengths and food restriction during the rearing period delays the sexual maturity of the hen (Leeson *et al.*, 1988). In Sweden, the hybrid layers get 14-16 hours of light per day

(Lovén Persson, 2009). A study by Savory and Duncan (1982) showed that the hens preferred to spend 80 percent of the day in the light. The rest of the time they were resting in the dark. Another study showed that poultry preferred to eat just before dusk, and if the darkness falls suddenly without a gradual dusk, it can be hard for them to find their resting place (Tanaka & Hurnik, 1991).

Too many hours of light per day can cause eye malformations, which several studies have shown (Oishi & Murakami, 1985). The advantage of a longer daily light period is that daily food intake and in turn growth rate may increase, resulting in slaughter weight being reached earlier and thereby with less total energy required for maintenance (Renden *et al.*, 1991: see Manser, 1996). Also the egg production in layers may increase by help of a longer light period. If the daily exposure to light is less than twelve hours it can lead to a reduced feed intake.

The reproductive organs of hens

The ovary and the oviduct of a hen are only evolved on the left side - the right side is regressed (Sjaastad *et al*., 2003). The ovary is situated between the left lung and the left kidney and contains a number of follicles in different stages of development. Large follicles contain yolk, which in turn contains proteins, lipids, water, vitamins and minerals. It takes nine to eleven days for a follicle to develop enough for ovulation to occur. After ovulation, the oocyte is transported from the ovary, through the infundibulum to the magnum. The albumen is formed in the magnum, which synthesizes the proteins. Progesterone and oestrogens stimulate the secretions of proteins that are deposited around the oocyte.

Two shell membranes are formed around the albumen in the isthmus, which is the next part of the oviduct. After that, the egg reaches the shell gland (uterus) where the eggshell and the cuticle are formed. After about 25 hours, which is the time it takes for an egg to form, it is rapidly transported through the vagina to the cloaca (Rose, 1997). Domestic chickens lay their eggs mainly in the morning.

The ovulatory cycle

Light stimulates the hypothalamus to increase the secretion of gonadotropin-releasing hormone (GnRH), as reviewed by Schaper *et al.* (2012). GnRH induces a release of luteinizing hormone (LH) and follicle stimulating hormone (FSH) from the pituitary gland. In hens, FSH stimulates the growth of immature follicles while a rapid increase in LH leads to the ovulation. The ovulation, i.e., the rupture of a follicle, occurs 4-8 hours after the peak of LH release (Sjaastad *et al.*, 2003). When LH levels increase in plasma it triggers a release of progesterone from the granulosa cells in the follicles of the ovary. Through a positive feedback between LH and progesterone, the plasma concentration of LH increases further and the LH peak makes the largest follicle ovulate (Etches, 1996).

With a photoperiod of eight hours of darkness and 15 hours of light, LH is only secreted during the dark period (Sjaastad *et al.*, 2003). Because it takes more than 24 hours to produce an egg it will lead to that on the subsequent day the egg will be laid slightly later since the LH peak will appear later during that dark period. The hen will stop to lay eggs for one day when the LH peak has been put forward so much that it appears during the light period. LH cannot

be released during the light period. The release of LH only occurs during an "open period" each day and that period lasts for 8-10 hours (Rose, 1997). The open period starts when it is dark and ends after about one hour from the onset of the light period (Sherwood *et al.,* 2012).

It is the biological clock that controls the release of LH and the biological clock is in turn controlled mostly by light, but also by other environmental factors such as temperature, nutrition and the age of the hen. With an increased day length follows an increased LH secretion (Rose, 1997). The result is that the hen continues to lay eggs. In a natural environment, the hen would enter broodiness and stop to lay eggs when a clutch of eggs has been laid, and then start to incubate the eggs (Sjaastad *et al.,* 2003). Prolactin is involved in the brooding as it increases when the brooding starts and the high plasma concentration continues throughout the brooding period. A 'sequence' is the period when the hen is laying eggs, and the days when no eggs are laid are called pause days (Sherwood *et al.,* 2012).

Common poultry diseases in Zambia

Parasites

External and internal parasites cause problems in village chickens in Africa (Abebe *et al.,* 1997: see Chota *et al.,* 2010). The high cost of anthelmintics, its poor availability, the deficient disease control, mixing of animals and problems with resistance makes the parasites hard to control (Naidoo *et al.,* 2008). Bacteria, viruses and protozoa usually cause higher economic losses, but helminths also reduce the profit due to an increased mortality rate, lower egg production and weight gain, etcetera (Jordan, 1990: see Phiri *et al.* (2007).

A study conducted by Chota *et al.* (2010) on village chickens in Zambia showed that the control group weighed less than the experimental group that were dewormed with piperazine, which is a popular anthelmintic among small-scale farmers in Zambia (Ziela, 1999). However, the efficacy (geometric mean of worms in control group– geometric mean of worms in treatment group)/geometric mean of worms in control group) of piperazine turned out to be as low as 17 % with no significant difference between the control group and the experimental group that was dewormed with piperazine in another study (Ziela, 1999). The study also showed a high prevalence (93 %) of nematodes in village chickens in Zambia. The results are comparable to the results from an experiment by Phiri *et al.* (2007) where the majority (88 %) of the chickens had a mixed infection.

The weight gain will increase if infected birds are dewormed. However, it is not necessary that the whole flock is free from helminths, as the negative effects on the weight gain will be reduced also if the population level of the infection is reduced (Phiri *et al.,* 2007).

Newcastle disease

Newcastle disease is a highly contagious disease among poultry and is caused by paramyxovirus type 1 (SVA, 2013a). The virus is spread over the whole world. Newcastle is the disease with the largest impact on production of poultry in Zambia (Spradbrow, 1990: see Alders *et al.,* 1994). It causes symptoms such as lethargy, a decreased number of laid eggs, diarrhoea, high mortality rate (up to 100 %), dyspnea with or without cough and central nerve system symptoms (SVA, 2013a). The virus is mainly spread through direct contact between birds. Even though vaccines are available on the Zambian market, Newcastle disease kills

more birds than any other disease in Zambia (Mweene *et al*., 1996). Vaccination, hygiene and slaughter of infected birds are important control strategies.

Fowlpox

Fowlpox is a slow-spreaded viral disease with a worldwide distribution (OIE, 2008a). The disease is endemic in Zambia according to Mweene *et al.*, (1996). It is caused by a DNA virus of the genus *Avipoxvirus* that can cause a cutaneous form (dry form) or a diphteretic form (wet form) (OIE, 2008a). The mortality rate is higher in the latter form (up to 50 %). The disease can cause a decreased growth rate, especially in younger birds, but also a drop in the egg production. A commercial vaccine is available.

Gumboro disease

Gumboro disease, also called Infectious bursal disease, is caused by a virus that is a member of the genus *Avibirnavirus* (SVA, 2013b). The virus is found over the whole world among domesticated poultry and is transmitted by direct or indirect contact. Gumboro disease only affects young birds clinically, since the virus attacks the bursa of Fabricius, and can cause a high morbidity and a low mortality rate (0-3 %) (OIE, 2008b; SVA, 2013b). The virus can cause several symptoms such as anorexia, inability to move and inappetence. In Zambia a vaccine against Gumboro disease is available at the market.

MATERIAL AND METHODS

Study area

The studies were conducted between the beginning of September and the beginning of November 2013 in Chibombo and Choma Districts in the Central respectively Southern Provinces of Zambia. Chibombo is located 98 km North of Lusaka, the capital of Zambia, and Choma is located 290 km Southwest of Lusaka (Google Maps, 2013). The Choma District was selected since the organization GART's (Golden Valley Agricultural Research Trust) Livestock Development Centre (GART, 2013) is situated 30 km from Choma town. During September and October it is approximately twelve hours of daylight per day (approximately between 6 am to 6 pm). From mid-September to mid-November it is warm and mainly dry with an average daily high temperature of above 30 degrees Celsius (WeatherSpark, 2013) in Lusaka. Occasional rains may occur from mid-October.

General study design

The study of poultry in Zambia comprised both broilers and village chickens. The results from the studies of village chickens are presented in this thesis. The results from the broiler experiments are presented in a thesis by Andersson (2014).

A. Interviews

Fifteen village chicken farmers in the Choma District and two village chicken farmers in the Chibombo District were visited and individually interviewed. All the farmers had low income and lived on the countryside. The interview followed a questionnaire (Appendix 1) that was designed in advance in consultation with the supervisors. The farmers were asked the same questions regarding their poultry, sometimes with the help of an interpreter in cases where the

farmers did not speak English. The most common answers of the seventeen interviews were compiled.

B. Solar lamp experiment

Four of the farmers in Choma District and the two farmers in Chibombo District that were interviewed were selected to participate in the solar lamp experiment. The farmers were chosen based on suitability mainly with respect to the number of village chickens, access to poultry houses and reliability. A couple of criteria that the farmers had to live up to in order to participate in the solar lamp experiment were that they must be small-scale (with approximately 20-30 poultry) and lacking electricity. The farmers participating in the solar lamp experiment were given instructions on how the experiment would be conducted.

Depending on the total number of village chickens on the farm, ten, twenty or twenty-four village chickens in each household were chosen and separated into two groups. The intention was that the two groups should be as similar as possible in weight, phenotype, age and sex. All of the birds were sexed but the age could not be determined, implying that many of the birds were sexually mature. Some of the hens were laying eggs at the time of the experiment. The ambition was that the experiments would last for at least one month. Half of the birds were marked with blue leg tags, the control group, and half of them received red leg tags, the experimental group. Each leg tag was marked with an individual number. All the chickens were weighed in a bag on an electronic scale before the study started and both oral and written instructions were given to the farmer. In cases where the farmers did not speak English the instructions were translated into the current language. The instructions given to each farmer participating in the solar lamp experiment were as follows:

- Divide the chickens with the blue and the red leg tags into two groups every night. They must not be mixed with each other during the evening/night.
- The chickens with red leg tags will have access to light from the solar lamp every evening for two hours between 6 and 8 pm, when it is dark outside.
- The chickens with blue leg tags will not have access to light from the solar lamp, or any other lamp.
- Give both the chickens with blue leg tags and red leg tags feed every evening during 6-8 pm when it is dark outside. The two groups must be given the same amount of feed.
- Make notes if any of the chickens dies or disappears and the number of laid eggs by the chickens with blue and red leg tags respectively. Also make notes if you experience any problem with the solar lamp.
- At the end of the experimental period all of the village chickens with leg tags will be weighed a second time.

Figure 2. The HiLight.

The solar lamp used in the experiments was the HiLight (Figure 2), manufactured by the Swedish company HiNation (HiNation, 2013). This lamp is a portable solar powered lamp with a LED diode (1 W super LED) of 2,5 MHz that can either provide light with an energy of 0,5 W for 20 hours, or 1 W for 10 hours. The lamp has USB and micro-USB ports and may also be used for charging mobile phones and to provide electricity for example a cooling fan, radio and battery charger.

C. Deworming experiment

The experiment took place during the period September 26 to October 25 at GART's facility in Batoka outside Choma town to study the effect of helminthosis on weight gain. A total of twenty village chickens supposedly aged three to four weeks, were bought from one of the village chicken farmers that was participating in the solar lamp experiment. The chickens had not been dewormed, vaccinated or treated with any medicine. The chickens were divided by the farmer into two groups with five hens and five cocks in each group. Chickens in the first group were given yellow leg tags with individual numbers. This group was the experimental group and was dewormed with piperazine given during two days in the drinking water in agreement with instructions in the Piperazine manual. The other group, marked with blue leg tags with individual numbers, were not given any anthelmintics when the chickens arrived two days later. All of the poultry were weighed on an electrical scale before the experiment started and then once a week until it ended after approximately one month.

The village chickens were free-ranged indoors all day in a spacious poultry house (approximately 10 x 5 meters) with a natural airflow system as ventilation (Figure 3). Other poultry had been kept in the house earlier, i.e. before this experiment, but it was unknown when the poultry were kept there and if the poultry house was sanitised afterwards.

On the second day of the experiment all of the chickens were vaccinated against Newcastle disease. The vaccine was administered per os in the drinking water when the chicken had been out of water for approximately two hours. The vaccine was bought in a local veterinary shop.

The chicken always had access to water and got fresh water approximately twice a day in three drinkers. The feed that was given was based on mainly soy beans and was recommended as feed for village chicken. This feed was changed after a couple of weeks to a more nutritionally balanced feed that was commercially produced (Broiler Grower, Choma Milling Factory) and maize, since the mortality suddenly increased to 15 % The feed was suspected to be more nutritious than the feed that was given before. They had free access to feed divided into two feeders.

At the beginning of the experiment the chickens did not have perches or a shelter, but that was built after approximately one week (Figure 4). At that time the floor was swept and a footbath with disinfectant (Virukill, ICA Laboratories) was introduced for use at entry and exit, and also the floor and walls inside the poultry house were sprayed with Virukill, in order to enhance the bio-security. Mortality rate was calculated and a post-mortem examination was performed on all dead birds.

Figure 3. Interior of the poultry house where the deworming experiment took place. Photo: Johanna Lindell.

Figure 4. The village chickens outside their shelter on the 14th day of the deworming experiment. Photo: Johanna Lindell.

D. Solar lamp and effects on bird behaviour

During eight days the behaviour of approximately forty grown up village chickens of unknown age were studied at GART's facility in Batoka. Most of the chickens were female and they were housed in the poultry house when the observation started. The poultry house was designed in the same way as for the village chickens in the deworming experiment (Figure 5). The village chickens were indoors during night time and outdoors during daytime. The first three days, at the time of sunset, the behaviour of the animals was observed in the poultry house. The remaining five days the behaviour was observed while four solar lamps were lit inside the building. The solar lamps hung from the ceiling approximately one meter from the ground, scattered in the house, mainly placed over the feeders.

During the observation, that took place around six to seven or eight o'clock in the evening and lasted for one to two hours depending on the activity of the chickens, the village chicken had free access to feed. The behaviours that were observed were drinking, eating and mating. The study was performed through direct observations by two observers positioned inside the poultry house. The village chickens were in one group inside the house. The observers were sitting on a bench opposite the poultry and watching all of the chickens while taking notes every time there was a change in the behaviour, which means every time the chickens were not sitting still. If all the chickens were sitting still for approximately thirty minutes the observations were terminated.

Figure 5. The village chickens during the behaviour study.
Photo: Johanna Lindell.

E. Poultry welfare

Poultry welfare in Zambia was studied through sporadic observations of handling and management of poultry, both in the villages and at sales markets. The interviews with the village chicken farmers also provided information regarding animal welfare.

RESULTS

A. Interviews

Flock size and breed

The flock sizes ranged from eight to two hundred village chickens (Figure 6). According to the 17 farmers the chickens were of no particular breed and defined as "village chickens" or "local chickens" which also included species such as Guinea Fowl and Naked Neck. Some of the farmers also had broilers, hybrid layers, ducks, turkeys, pigeons or other poultry. All but one of the farmers kept village chicken both for meat and egg production. That single farmer kept only village chicken cocks for meat production since cocks become larger than hens.

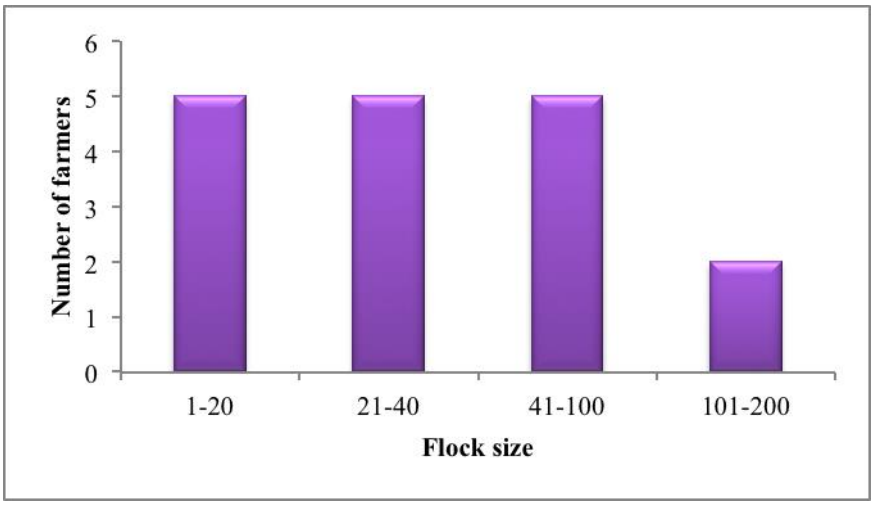

Figure 6. Flock size distribution among village chicken farmers.

Market prices of chickens and eggs

Ten of the farmers bought the chickens from nearby villages or from friends. Seven farmers had each received a cock and four hens from Sida (Swedish International Development Cooperation Agency) through GART in an HIV/AIDS project. Later the chickens multiplied and made it possible to rear chickens without buying any. The cost of a one-month-old chicken was (personal observation Sep 2013) approximately seven Zambian Kwacha, which is about nine Swedish Kronor. The price for an adult chicken ranged between twenty and forty Kwacha, depending on customer and size of the chicken.

The chickens were usually sold at markets, by the road or to friends and neighbours. Most of the farmers sold chickens when they were in need of money, for example when they needed to buy soap or pay for the children's education. Not all of the chickens were sold; some were slaughtered for family consumption.

The eggs were used for own consumption, sale or brooding. One farmer that kept both hybrid layers and village chickens reported that eggs from village chickens are smaller in size but considered to be tastier than the eggs from the hybrid layers. The eggs were sold for 0.5 to 1 Kwacha per egg. When the hens were producing they laid one egg per day. They laid approximately ten to fifteen eggs before they started to brood. According to two farmers hens

stopped laying eggs if they did not get enough feed to eat. The amount of feed needed for egg laying to be maintained was not specified. Neither was the cost of different types of feed.

Seven farmers had nests for the hens, but one farmer said that her hens laid eggs inside the living room. Regardless of how many village chickens they had, the farmers agreed that the income from the village chickens was not enough to live on; another source of income was needed as well. However, for two farmers (with 15 and 20 village chickens), the income from the village chickens was their only income, while others said that they in addition to keeping village chickens grew vegetables, had other animals or were employed.

Housing and management

Fourteen of the farmers responded that their village chickens were kept outdoors scavenging on the yard during daytime. This made it possible for them to come in contact with birds and other animals from other households and also with wild animals. One farmer kept his village chickens outdoors in a fenced area with a roof for protection against sun and rain. However, the fence was not high enough, which allowed the larger chickens to fly over it. Another farmer kept his chickens in a house during the first month, mainly for protection against predators. When they had reached a certain age they were let outdoors with a shelter that was open on the sides. Two of the farmers' poultry were kept indoors all day and were never let out. One of the poultry houses was very small with poor ventilation and light.

Almost two thirds of the farmers let the village chickens stay in poultry houses during night time. Three farmers had shelters but no walls, and two farmers had no shelters at all. In the latter the chickens slept in the trees and were an easy catch for predators. The extent of the problem with predators varied among the farms. Some of them experienced problems with predators quite often - in some households chickens disappeared as often as daily. In other households poultry were never taken by predators. The common predators were eagles, owls, bush babies (*Galagos*) and other small predators. As protection against predators they had dogs guarding the animals, but the shelter also served as protection. In addition, a family member was always at home to watch the birds.

Feeding

In general the village chicken were free-ranging and scavenging which means that they ate whatever they could find including leftovers like the maize porridge "nshima". Most of the farmers were feeding their poultry with a restricted, often minor, amount of feed such as maize but also sunflower, soy beans and feed for broilers (Broiler Finisher) once or twice a day. The majority of the farmers did not suspect that the feed had ever caused disease in the poultry. Two farmers thought that feed of poor hygienic quality, e.g., rotten feed, might cause diseases.

Figure 7. Village chickens drinking water.

Photo: Johanna Lindell.

Whether the poultry were regularly given any feed ration or not, depended on the economy of the family. All of the farmers answered that their village chicken were given water to drink once or twice daily. However, it was observed that both water and feed were missing during most of the visits. The water was generally supplied in buckets, bowls (Figure 7) or car tyres and were taken from a well or hand pump. One farmer brought water to the chicken from a pond whereas the water for the family was from another source. The rest of the farmers answered that the water consumed by humans and chickens was of the same origin. In some villages the water was chlorinated for a better water quality.

Health management

The most common and well-known disease that caused real problems appeared to be Newcastle disease. Thirteen farmers responded that they sometimes vaccinated against Newcastle disease. Some of the farmers said that they vaccinated only once during the poultry's lifetime and others answered that they vaccinated two times per month. The vaccine, bought in veterinary shops without prescription, was administered in the drinking water. Some of the farmers vaccinated when they thought it was time for it, if it was some months since last time they vaccinated, or if they had heard there had been an outbreak of Newcastle disease in a nearby village. The symptoms were usually weakness, eye problems, holding the head backwards, coughing and sudden death.

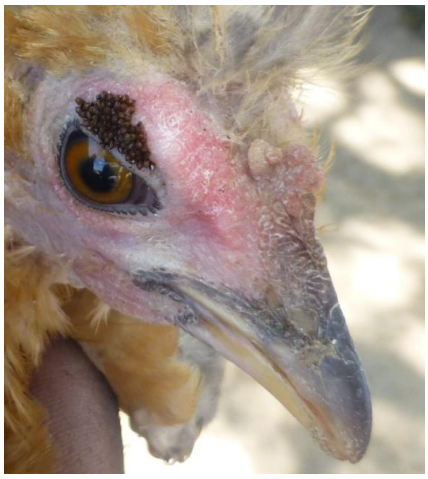

Figure 8. A village chicken suffering from fleas.

Photo: Johanna Lindell.

Fowlpox (called chicken pox by the farmers) is another disease that was quite common among the village chickens and was seen as small red spots on the head. Coccidiosis, fleas (Figure 8) and worms were also reported by the farmers as common. Only one farmer (having 40 animals) gave oxytetracycline regularly, twice per year, in the drinking water as prophylaxis against coccidiosis. Worms were treated with piperazine and some farmers used a spray with unknown substance against fleas. Only one farmer treated his poultry with gumboro vaccine every two months.

Traditional medicines from tree leaves and herbs against fowlpox and worms were also used by some farmers that believed that it was working. The ground outdoors where the poultry had been kept was swept every day to every third day. The farmers did not use disinfectants. The poultry were between three months and seven years old, with an average of two years, when they were sold or slaughtered. Hens with good production performances were sometimes kept for some years. All of the respondents cut the poultry's throat without stunning at slaughter.

B. Solar lamp experiment

During the revisit to the farmers it was found that only three of the six farmers had followed the given instructions. These farmers are from now on referred to as Farmer 1, Farmer 2 and Farmer 3. However, the village chicken groups were heterogeneous with adult cocks, laying hens and younger poultry, which mean that the results are not representative for the growth

rate. None of the farmers took notes of the number of laid eggs in the two poultry groups, and since the individual numbers on the leg tags disappeared on the poultry for Farmer 3, but not for Farmer 1 and 2, the individual weight gain for each bird could only be calculated for the animals of Farmer 1 and 2. The three farmers excluded from the trial had either not followed the instructions regarding daily access to feed, had used the solar lamp for too many hours or kept their poultry inside a dark poultry house all day without access to natural light at all.

Farmer 1

A total of ten village chickens, divided into two groups, participated in the study that lasted for one month (30th September to 30th October). The village chickens were together in one group with some other poultry as well. According to Farmer 1 the village chickens with the red leg tags, the experimental group had had the solar lamp on every evening for two hours between 6 and 8 pm. The experimental group had been in a separate poultry house. The first four days the experimental group did not eat during the time the solar lamp was on. Both groups had been fed with maize bran during the time the solar lamp was on, at 6 pm and in the morning, but the lamp was only on during the evening. The experimental group ate all of the feed every evening, but the chickens in the control group ate some of the feed and left some. In the morning the control group usually had eaten all of the feed before they were given more feed. Sometimes there was a small amount of feed left. During daytime all of the chickens were mixed and free-ranging. The farmer believed that the experimental group were fatter than the control group. Since Farmer 1 did not have electricity but used candles, the lamp had been used inside the home after eight o'clock in the evening. The solar lamp had only been used sometimes for charging mobile phones since they had a solar panel for mobile phone charging. The individual weights before and after the experiment are presented in Table 1. It is unknown if any of the hens were egg-laying during the experiment.

Table 1. *Farmer 1: Poultry weight before and after the solar lamp experiment*

Poultry ID	**Female/male**	**Weight before (kg)**	**Weight after (kg)**	**Weight gain (%)**
Experimental group				
1	F	0.96	1.36	41.7
2	F	1.18	0.88	-25.4
3	F	0.98	0.94	-4.1
4	F	0.99	1.35	36.4
5	F	1.72	1.39	-19.2
Average		**1.17**	**1.18**	**1.5**
Control group				
6	F	0.59	1	69.5
7	F	0.7	1.1	57.1
8	F	0.61	0.94	54.1
9	F	0.5	0.72	44
10	F	1.72	1.9	10.5
Average		**0.82**	**1.13**	**37.4**

Farmer 2

The experiment at Farmer 2 included the same number of animals and lasted during the same dates as Farmer 1. Farmer 2 turned on the solar lamp at 6 pm and turned it off at 8 pm every evening. Both the experimental group and the control group had feed all the time, according to the farmer. The experimental group ate almost all of the feed but sometimes there was some feed left in the morning. During the first week they did not eat at all during the period when the lamp was on. The control group did not eat when it was dark outside and they did not eat all of the feed. Farmer 2 thought that the solar lamp was working very well and that the animals/individuals in the experimental group grew faster than the other chickens. She also believed that the experiment was interesting and would like to continue with it on her own. The solar lamp was also used in the family house since there was no electricity. Farmer 2 saved money on charging her mobile phone with the solar lamp instead of in town (3 km away) where the cost was two Kwacha per mobile phone. She was hoping that she could sell the village chickens more expensively than usual since they were bigger. At the time of the second weighing, individual number 7 was egg-laying. The individual weights before and after the experiment are presented in Table 2.

Table 2. *Farmer 2: Poultry weight before and after the solar lamp experiment*

Poultry ID	**Female/male**	**Weight before (kg)**	**Weight after (kg)**	**Weight gain (%)**
Experimental group				
1	F	1.1	1.56	41.8
2	F	1.06	1.48	39.6
3	F	1.87	1.8	-3.9
4	F	0.96	1.24	29.1
5	M	1.96	2.38	21.4
Average		**1.39**	**1.69**	**21.6**
Control group				
6	F	1.72	1.94	12.8
7	F	1.58	1.39	-13.6
8	F	0.64	0.89	39.1
9	M	1.8	2	11.1
10	F	0.92	1.39	51.1
Average		**1.33**	**1.52**	**14.3**

Farmer 3

The experiment lasted for five weeks and three days and included 24 village chickens with 12 chickens in each group. The chickens were mixed with chickens when being outdoors in the daytime that were not participating in the experiment. The solar lamp had been on every evening for two hours between seven and nine o'clock. Both of the groups were fed the same amount of maize bran every evening, but the amount of feed was not weighed. In the beginning of the experiment the experimental group did not want to eat but as the time went by they began to eat. Gradually they ate more and more when they got used to the lamp. The

control group did not eat when it was dark outside because they were sleeping, which led to that they had some feed left in the morning that they ate in the morning. All of the village chickens ate in the morning around 7-8 pm when both of the groups were together outdoors.

It was difficult and time consuming to divide the village chickens into two groups every evening. The chickens never learned to go to the right house every night, so the farmer let some of the chickens in the control group sleep in the trees during the night. Especially the oldest chickens needed directions every evening to go to the right poultry house. An observation made by the farmer was that the chickens behaved like they thought they were going to be slaughtered when they were directed to the houses. They seemed stressed, afraid and cautious, the farmer said. Still, Farmer 3 thought that the experimental group had grown more than the control group. The results actually showed that the control group had gained more weight (9 %) that the experimental group (4 %) when the experiment was ended. Farmer 3 meant that the experimental group laid more eggs than the control group. Five hens in the experimental group hatched chickens during the experimental period compared to two in the control group. In the beginning of the experiment none of the hens were in egg laying. Except for using the lamp to the chickens, the lamp was used inside the house and for charging mobile phones every second to third day.

C. Deworming experiment

At the first day of the experiment the dewormed village chickens, the experimental group, weighed 254 g on average. The ones that were not dewormed, the control group, weighed 201 g on average. Three chickens died (one in the control group day 6 and two on the experimental group day 7) and the observed symptoms were lethargy, closed eyes, wheezing and mucous feaces with some blood in it. Coccidiosis was suspected, since that was a previously known problem at GART's facility. Therefore all birds were treated with a coccidiostat containing sulphachloropyrazine sodium. The medicine was given in the drinking water for four days, each time after two hours of no access to water.

At the same time, the feed was changed from a mainly soy based feed to a commercially produced feed (broiler grower). A shelter was built in the poultry house since there was a shift in temperature with lower temperatures during the nights and higher during the days. On the last weighing, one month after the experiment started, the experimental group weighed 752 g (Figure 9) on average (weight gain of 197 %). The control group weighed 711 g on average (weight gain 254 %).

The mortality rate for the experimental group was 20 % (two birds) and for the control group ten percent (one bird). The dead birds were subjected to post-mortem examination, which showed that the two chickens from the experimental group had colibacillosis. The post-mortem on the chicken from the control group did not give any clear diagnosis.

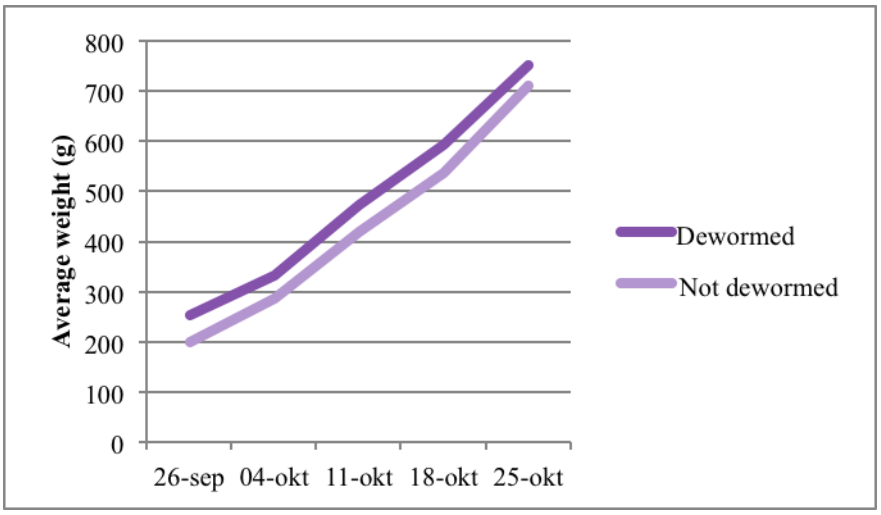

Figure 9. Average weight of the dewormed and not dewormed poultry.

D. Solar lamp and effects on bird behaviour

The solar lamp did not have any noticeable effect on the bird's behaviour. During the three days when no solar lamp was on, the birds went to sleep when it became dark. During the five days when the solar lamps were on the birds did not show any signs of change in behaviour. However, it was observed that the poultry ate more and made mating attempts. The birds went to sleep when it became dark outside even though the lamps were on.

E. Poultry welfare

Several observations of the handling of poultry were obtained during the study period in Zambia. The poultry were lifted up and carried almost exclusively in the wings, either in one or both wings. They were often carried with swinging movements during the buyer's walk from the market to the village. This handling was also true for broilers weighing two to three kilograms, which was observed in GART's facility where broilers were bred and then sold at markets directly to the consumers. When the broilers were lifted with a handgrip around the body and not the wings they also made a sound, but not as loud as when they were lifted in the wings (Figure 10).

Figure 10. Broiler handling.

Photo: Johanna Lindell.

At several occasions village chickens were brought on to buses – sometimes transported in the luggage trunk inside a plastic bag with its legs tied together. Poultry were also transported in the back of cars with poor ventilation. Immobilised chickens lying on the ground in the sun was observed trying to walk. Day old chicks were sold in shops in Choma town and at one occasion several paper boxes with a high stocking rate of chicks were stacked on each other (Figure 11) with presumably poor ventilation and without feed and water until they were sold. At one occasion a paper box with chicks was observed inside a parked car in sunlight.

Figure 11. Chicks for sale.

Photo: Johanna Lindell.

Village chickens were often sold at markets. Wooden cages with a high stocking rate of chickens without water or food, often in direct sunlight, were noted. Poultry were also sold by the roadside, where the seller held the chicken up in the air to be seen by people in the passing cars.

The chickens had their legs tied together for immobilisation. A number of chickens that had been transported in the sun seemed apathetic (Figure 12).

Figure 12. Transport cage.

Photo: Johanna Lindell.

Also during the interviews with the 17 farmers, observations regarding animal welfare were made. This time of the year was the hot season with a dry landscape. Since most of the poultry were free-ranging and scavenging many of them were assumed to be undernourished, especially if no supplementary feed was given. During some of the interviews, neither feed nor water was available for the poultry. It happened that the farmers forgot to give them the water and feed they were supposed to have. This applied particularly to poultry that was kept indoors all day.

At a visit to one of the village chicken farmers, a number of hens were found trapped with their legs attached to the ground so they could not move (Figure 13). They did not have access either to water or feed. The farmer said that he was punishing (the owner used this word when describing it) the hens so they would stop brooding. The punishment was three days of starvation. The farmer did not consider the treatment bad from an animal welfare point of view.

Figure 13. Village chickens being punished for brooding.

Photo: Johanna Lindell.

Some farmers keep their village chicken indoors all day and never let them outdoors. The ventilation and light were poor in some poultry houses. Farmers that did not have any shelters for their chickens let them sleep in the trees during the night, but hens with small chicks had problems to get up in the trees and could be an easy prey for predators.

Broilers with symptoms of disease at GART's facility were isolated in another part of the broiler poultry house. The sick individuals had dirty water and had a hard time to reach both the water and the feed since they were either too weak to move or lame. They were not given any treatment and were obviously smaller in size than the other ones. One broiler was found dead and another one had a bone fracture. The number of sick animals was not recorded.

The slaughter method used by all of the farmers that were interviewed was cutting the chicken's throat without prior stunning and this was done at home.

DISCUSSION

A. Interviews

The farm visits and interviews provided a valuable overview of how village chickens are kept in Zambia. However, there were some difficulties, for example with the language as not all of the respondents spoke English, which meant that an interpreter was necessary. The intention was to ask as open questions as possible but the responses from most respondents were a few words only. It was sometimes unclear whether they understood the question correctly and if they answered honestly. They could not answer some of the questions, such as what drugs they used for the chickens. It was not easy to get a correct answer to questions like for how long period the hens were laying eggs. According to Songolo *et al.* (2001), the village chicken lay about 70 eggs per year. Hence one egg per day is not likely during a longer period, as some of the respondents answered.

All of the respondents felt that the income from their village chicken was not enough to live on, but a couple of them said that they had no other income. It is uncertain whether they understood the question correctly. Similarly, when they were asked how many chickens that disappears because of predators each week, one farmer answered that 40 village chickens disappears every month out of 150, which is not likely be correct.

The poultry houses had at some farms poor lighting and ventilation, and the birds got an insufficient amount of feed, which would have had a negative impact on growth and egg production, as described earlier in the literature review. The production rate would increase if this was changed, but would also lead to higher costs.

Bio-security was substandard when people were mixed with animal species including wild animals. Besides sweeping there was no other cleaning of the poultry space such as disinfection. There was also a general lack of knowledge about poultry diseases. Most farmers knew that Newcastle disease exists and that you can vaccinate against it, but not that it cannot be cured by spraying medicines. Another farmer replied that she sold her village chickens one time when some chickens in the flock suffered from Newcastle disease, which indicates poor bio-security awareness.

B. Solar lamp experiment

There were several difficulties with the set-up of the solar lamp experiments. The biggest flaw was probably in the instructions to the farmers since many of the farmers did not understand them correctly The instructions were given orally and in paper in English. Perhaps a drawing would have helped them to understand the instructions better. It was not known whether all of the farmers could read or not. The farmers did not write down the number of eggs laid by each group, which resulted in a lack of results regarding the solar lamp's effect on egg production. If all six farmers had followed the instructions, more reliable results would have been obtained. However, also more homogeneous groups of animals in the same age would have been desirable. If young chicks had been chosen they would probably have had a better growth potential. The number of animals in the groups should have been smaller to reduce the workload of the farmer who had to divide the chickens into two groups each evening. However, larger groups would have provided a more reliable result and the loss of sick or egg-laying chickens would not have as big impact on the results. The marker pen used on the leg tags was not resistant enough and should have been replaced by a different type of marker.

The length of the experimental period should have been longer to give more reliable results. Also the number of hours the lamp was on could have been longer. If the solar lamp had been used in the morning instead of the evening, perhaps the birds would have eaten more if they were more hungry and rested. However, to get compliance by the farmers in a very early morning regime was unlikely.

Another flaw in the instructions was that the farmers were not given any instructions on how much feed that should be given to the control and the experimental group. No one had weighed the amounts of feed and because the feed was not removed when the lamp was turned off, the chickens had the opportunity to eat the feed in the morning the day after, which was also true for the control group, but none of them had free access to feed during the day.

More optimal would have been if the village chickens were fed with the same feed at all the farms and in the same amount, and possibly a more nutritious feed for them to gain as much weight as possible. At Farmer 1 the control group increased more in weight than the experimental group but the farmer himself thought that the experimental group had become fatter than the control group, which was an incorrect observation.

A few farmers said that it took some time before the experimental group began to eat. However, this was not something all farmers observed. It is unclear if the poultry reacted negatively on being divided into two groups and housed each evening or if the lamp itself made the chickens cautious. Perhaps a short period with the lamp for the chickens to get used to before the experiment began would have been a good idea. It is possible that light from the experimental group leaked over to the control group, or that the light from a single lamp was too weak to have any effect.

All the farmers were interested in keeping the solar lamp. Later it turned out that many already had solar lamps but probably not the same quality. The conclusion is that farmers save time and money by not having to pay to recharge mobile phones, but the lamp is probably too expensive to make a profit. The effect on production cannot be assessed by this study, but even if the chickens gained weight with the help of the solar lamps, it is unlikely that the farmers will be able to earn so much money that they are willing to invest in a lamp. If farmers associations are involved and a microcredit system could be used, maybe it would be more feasible. Instead of extra light hours, the farmers may simply provide additional feed to the poultry.

C. Deworming experiment

The deworming procedure turned out not to have any effect on the growth of the village chickens in this experiment. However, some changes in the experiment could have contributed to a more reliable result.

The control group and experimental group could have been more homogeneous in regard to the weight. At the beginning of the experiment, the experimental group weighed over 50 grams more than the control group, which could mean that they were older and had a lower growth rate and presumably a better health. Another explanation is that the experimental group were infected with other diseases than the control group, but this is less likely since they were housed in the same building.

According to Chota *et al.* (2010), over 90% of village chickens in Zambia are infected with nematodes. The majority of the village chickens in the experiment can be assumed to have had a mixed infection, as a study by Phiri *et al. (*2007) showed. The anthelmintic that was used, piperazine, showed low efficiency according to one study, which may have been a contributing factor to the outcome of the deworming experiment (Chota *et al.,* 2010) as well as explaining the result in the present study. Post-mortem investigations of a sample of euthanized village chickens from the same environment, done before the experiment started, could have provided important information of what kind of worms that was most common and another anthelmintic could have been chosen. In order to make sure if the chickens had infections of internal parasites or not, they should have been euthanized and autopsied when the experiment ended.

The environment is another factor that may have influenced the results. The experimental animals were kept indoors in an old chicken house and not in a natural environment outdoors. The movement from the farmer to the new poultry house could have caused some stress among the chickens. The infection pressure of various agents in the house compared to outdoors is unknown. The bio-security was relatively poor when an unclean house was used for the experiment and a footbath with disinfectant was introduced after some time. Staff went between several poultry houses and may have brought disease agents between the animals. This may be a contributing factor to that three of the birds died. In addition, the temperature varied with temperatures lower at night than during the day, which may have led to that the chickens became hypothermic since they did not have any shelter in the beginning of the experiment.

The trial period should have been longer than four weeks and with a larger number of village chickens in order to get a more reliable result. According to Chota *et al.* (2010), it is possible that when village chickens are fed high-quality feed like e.g., the Broiler Finisher feed in the present experiment; even birds with nematode infections may gain weight. Therefore, it might have been better if chickens were given the feed they usually get and not a feed with such a well-balanced nutritional content as in Broiler Finisher. An improvement in the nutrition can, according to Chota *et al.* (2010) boost the chicken's immunity. Depending on different factors such as the parasite species, host species, severity of infection and nutritional deficiency, malnutrition can lead to a more viable and easier established nematode infection (Koski & Scott (2001).

It would also have been interesting to conduct an experiment with solar lamps on these young village chickens to see the growth difference with and without lamps compared with dewormed and not dewormed chickens.

D. Solar lamp and effect on behaviour

The solar lamp turned out not to have a noticeable negative effect on the birds' behaviour. However, a longer trial period would have been preferable to get a more reliable result; perhaps the birds had become used to the light in that way and would have started to eat to a higher extent, which Farmer 1 and 2 meant that their animals did. If the lamps had been used in the mornings instead of in the evenings the village chicken may have been more hungry and rested and could have eaten more.

In addition, it would have been preferable if more solar lamps could have been used or if the poultry house had been smaller so that the whole house had been lit. As only four lamps were used in the observations, birds could choose to sit in the darkness and not in the light from the solar lamps. The number of lamps was restricted to four since more lamps would not have been realistic from an economic point of view. The birds showed clearly a habitual behaviour to go to sleep at about the same time every night regardless of light or not.

One problem with observing the behaviour was that it was difficult to see the birds when it was dark, even when lamps were used. The village chickens were not individually marked which meant that it could not be determined which bird that performed what behaviour. A

smaller number of individuals with some type of individual marker, that was easier to see, would have given more reliable results.

E. Poultry welfare

Apathetic village chickens sold by the road or in small cages in direct sun light without feed or water indicate poor animal welfare. It was an obvious discomfort for the poultry to be carried in the wings, with a high risk of fractures. The handling of poultry indicates a poor animal welfare where the animals are seen only for serving its purpose – to become food or as a source of income. The village chickens have to find most of their feed by themselves in order to survive. A lack of insight into animal welfare was seen also in the handling of other animals (personal observations). No study regarding the number of bone fractures due to the handling was done, but it is possible that the number of fractures were still moderate because of a lot of exercise for the free ranging chickens which strengthens bones and muscles.

When hens are punished with starvation it can result in a sudden stop in the egg production. According to Masiga & Munyua (2005) forced moulting is widely practised in Africa. Forced moulting means that the hens are shedding their feathers at a time when they are not usually shedding. The main objective is to stop the hens' egg production (Aygun, 2013). This can be done by withdrawal of feed and reduced day length for up to fourteen days, sometimes even longer (Masiga & Munyua, 2005). It can also be done by immersing hens into cold water. Forced moulting can be very stressful and causes loss of body weight and a higher mortality rate. For this reason researchers have found that some diets, such as alfalfa and oats, also induces moulting but without starvation as reviewed by Aygun (2013).

The animal caretaking is substandard in many cases and sick poultry are usually not treated by a veterinarian because it is too expensive. In the villages, the only slaughter method used is to cut the throat without stunning, which is a major welfare concern.

When it comes to slaughter, none of the interviewed farmers responded that the birds were stunned before they were killed. They thought that their slaughter method was obvious? and the only alternative. The slaughter method had no religious reason since most of the Zambian people are Christians.

The animal welfare could be improved by better education and information for adults and children regarding health care, handling and slaughtering.

CONCLUSION

The results showed that village chickens are kept mainly free-ranging and scavenging during the days. They are usually given small amounts of feed, mainly maize. The production is low and the health management is poor. The village chickens in the study of behaviour did not show any aversion towards the solar lamps and the effect from the extra light hours on the food intake was insignificant. There was no apparent difference in weight gain between the groups in the deworming experiment. The solar lamp experiments did not give any reliable results due to different factors that are discussed in the thesis.

ACKNOWLEDGEMENTS

I would like to express my thanks to SIDA, Gulli Strålfeldts fond and Veterinärmedicinska fakultetens stipendiesamfund for the scholarhips provided. Without your financial support this study would not have been possible.

I would also like to thank my Swedish supervisor Helena Wall for her patience and assistance during the study.

Special thanks to assistant supervisor Lisa Persson, who has been very helpful and has come up with many ideas. She also visited me in Zambia.

Thanks to Professor G. S. Pandey at UNZA who provided practical help in Zambia.

My gratitude also goes to GART's staff, especially Mr David Mubita, the manager for GART's Livestock Development Centre in Batoka, for kindness and generosity.

Thanks to HiNation for letting Cecilia and me get access to your solar lamps and spread light and joy in Zambia.

Last but not least, I would like to thank Cecilia Andersson for all her help. Together we had an unforgettable experience.

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APPENDIX 1 - QUESTIONNAIRE

Name of the farmer:
Village:

1. How many poultry do you have?
2. Which breeds do you have?
3. Do you have your poultry for egg or meat production, or both?
4. From whom/where do you buy your poultry?
5. Where are the poultry kept?
6. How many poultry disappear due to predators?
7. Do you have any protection against predators?
8. From where do the poultry get water to drink?
9. Do you think that the poultry ever have got sick due to the water?
10. What do your poultry eat?
11. Do you give your poultry any feed or leftovers?
12. How much feed do they eat?
13. How much feed to you give them?
14. From where do you get the food?
15. Do you think your poultry have ever become sick because of the food?
16. How often do you clean after your poultry?
17. How do you clean?
18. How many eggs do the hens lay every day?
19. Do the lay the same number of eggs all year around?
20. Where do the hens lay their eggs
21. What do you do with the eggs?
22. Which poultry diseases have you had among your poultry?
23. What do you do with birds showing signs of disease?
24. Do you give your poultry any medicine or vaccine?
25. For how long to you keep your poultry before they are sold/slaughtered?
26. How do you slaughter your poultry?
27. Have you noticed behavioural problems among your poultry?
28. Is the income from your chickens enough to live on?