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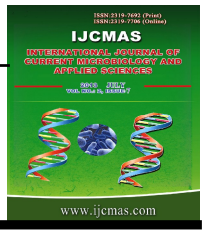

Original Research Article

Poultry waste management practices in selected poultry operations around Gaborone, Botswana

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Keywords

Dumping site; Gaborone; landfill; litter; manure; mortality.

A B S T R A C T

This study investigated poultry waste management practices in poultry operations around the City of Gaborone. Data were collected using a structured questionnaire that was administered to 25 randomly selected commercial poultry farmers in Kgatleng, Kweneng and South-East Districts. Data were also collected through direct observation and by reviewing secondary sources of data. Data were analysed using the Statistical Package for the Social Sciences (SPSS), Version 19. Results showed that 80% of the respondents disposed of manure and/litter by giving it away to other farmers, 16% used it as a fertilizer on their own fields, whereas 4% of the respondents disposed of manure/litter in the landfills/dumping sites. The three methods of mortality disposal were landfills (52%), incineration (20%) and burning (20%). With an estimated population of 908 200 chickens reared in the research sites in a year it is estimated that 20 441 tonnes of manure was produced in a year. The challenges in disposing of poultry waste were lack of transport, lack of farmers' knowledge of poultry waste management and insufficient space to enable construction of waste disposal pits on farms. This study showed that farmers' knowledge of poultry waste management was inadequate.

Introduction

The poultry industry produces large amounts of waste that include solid waste and wastewater. The solid waste consists of bedding materials, excreta (manure), feed, feathers, hatchery waste (empty shells, infertile eggs, dead embryos and late hatchlings), shells, sludge, abattoir waste (offals, blood, feathers and condemned carcasses) and mortality. In Botswana, ashes which result from the use of coal for chick brooding are also produced as waste in large quantities on broiler operations, especially in medium-scale and large-scale operations, and these need to be disposed of (Moreki and Chiripasi, 2011). Olumayowa and Abiodun (2011) stated that dead birds and hatchery waste are high in protein and contain substantial amounts of calcium and phosphorus due to high levels of mineral supplements in the diet. The approximated percentages of nutrient

intake excreted by poultry are: nitrogen (65.5%), phosphorus (68.5%) and potassium (83.5%), elements for soil fertility and increased crop production.

There are several ways of disposing of poultry waste including burial, rendering, incineration, compositing, feed for livestock, fertilizer or source of energy. The most predominant waste disposal methods in Botswana appear to be burial in the landfills, burning, incineration and as a fertilizer in gardens and arable lands. Other waste disposal methods include conversion of poultry waste to energy and use of poultry waste for treatment of heavy metal contaminated water (Moreki and Chiripasi, 2011). Sainsbury (1992) stated that energy recovery is a promising form of waste disposal which works by recycling some forms of waste into a fuel source for heating, cooking and powering turbines.

There is limited information on poultry waste disposal in Botswana (Moreki and Chiripasi, 2011). Therefore, a study was undertaken to investigate the poultry waste management practicesin poultry operations around Gaborone.

Materials and Methods

Description of the study areas

The study covered nine villages in three districts: Kgatleng district (i.e., Bokaa, Matebeleng, Oodi and Sikwane); Kweneng district (Gakuto, Gamodubu and Mogoditshane); South East district (Tlokweng, Phakalane and Notwane).

Sample design

A list of poultry operations was obtained from the Department of Animal Production, Ministry of Agriculture. From this list, 25 poultry operations were randomly selected using the "rank and index" function in excel software to avoid selection of a farm more than once. The selection of respondents was based on proportionally the number of poultry operations within the districts and the type of commercial operations (i.e., medium or large-scale). Six poultry operations in South- East district, six in the Kweneng district and 13 in Kgatleng district were selected.

Survey instrument and design

A structured questionnaire was developed with the help of relevant literature to collect data required. This helped to reduce the wide variability of responses and made it easier to compile and analyse data. The questionnaire was divided into two parts (i.e., A and B) to address the stated objective. Part A comprised information on the demographic characteristics of the respondents while Part B covered management of poultry waste on farms. Reliability of the instrument was established by conducting a pilot test with a similar group in Boatle, Mokolodi, Sebele and Notwane in South – East District.

Data collection

Personal interviews were used to collect data from some of the respondents in the study area. Questions were asked to respondents and responses recorded in the questionnaire with clarifications made where possible. Data were also collected through direct observation during visits to the poultry operations.

Data analysis

Data were entered into a computer and analysed using the Statistical Package for

the Social Sciences (SPSS), Version 19. Tables and figures were used to summarise statistical information such as means and percentages.

Results and Discussion

Demographic characteristics of respondents

Data on demographic characteristics of respondents are presented in Table 1. Sixty percent of the respondents were males while the remainder was women. Furthermore, 32% of the respondents were single, whereas the remainder was married. All the respondents in this study had attended school with 56% having tertiary education.

Poultry farm descriptions

The majority (64%) of poultry operations in this study were small-scale followed by medium-scale (20%) and large-scale (16%) (Table 2). All the respondents (100%) were commercial farmers (96% broilers and 4% layers). The 25 poultry operations reared 401 733 (i.e., 279 400 broilers and 22 333 laying hens in a year.

Manure or litter removal from poultry houses

In this study, litter and/or manure was scraped off the floor using spades, made into heaps using rakes and thereafter collected into empty 50 kg bags, which were then taken to an isolated spot within or outside the farm premises awaiting collection by the Council workers. Layer farmers in the present study said they removed manure once a year using skid steer loader. Manure was then loaded into trucks and disposed of either at the farmers' fields or farmers collected it from the poultry operations. Thereafter, chicken houses were cleaned and rested for 7 to 8 days before restocking takes place. Only 20% of the respondents in Oodi and Matebeleng indicated that they used their own vehicles to transport manure and/or litter to the dumping site at Pilane. The removal of poultry manure and/or litter manually is a common practice for the floor systems. A study by Olumayowa and Abiodun (2011) in Nigeria showed that 93.1% of the farmers used shovels and spades to remove poultry manure from pen houses. Sims and Wolf (1994) reported that partial cleaning of wet crusted or caked litter normally occurs after each flock is removed from the house.

Disposal of methods of manure/litter

Eighty percent of the respondents said they disposed of manure and/or litter by giving it away to other farmers to use in their arable fields, 16% used it to fertilize their own fields, whereas 4% disposed of it in the landfills/dumping site. Using manure to fertilize the soil is a good way to dispose of litter or manure because manure and/or litter can add the nutrients that are lacking in the soil.

In agreement with the current results, Chapman (2007) stated that strategies that growers may use to properly dispose of poultry waste are local land application as a fertilizer; offsite marketing for use as fertilizer or soil amendments, feed additive or energy source; and chemical additives that will immobilize nitrogen and phosphorus in the manure or litter. The author argued that if properly followed, these strategies should be adequate to protect surface and underground water quality without adversely affecting the economics of poultry production.

Table.1 Demographic characteristics of poultry operators around Gaborone

Category	Frequency	Percent
Gender		
Male	15	60
Female	10	40
Total	**25**	**100**
Marital status		
Married	8	32
Single	17	68
Total	**25**	**100**
Educational level		
Primary	3	12
Secondary	8	32
Tertiary	14	56
Total	**25**	**100**

Table 2: Poultry farm descriptions in the study area

Category	Frequency	Percent
Type of poultry		
Broilers	24	96
Layers	1	4
Total	**25**	**100**
Type of farm		
Commercial	25	100
Total	**25**	**100**
Production scale		
Small	16	64
Medium	5	20
Large	4	16
Total	**25**	**100**

Soils in Botswana are poor in phosphorus; hence the application of manure or litter appears to be an ideal method of disposal (Moreki and Chiripasi, 2011). Poultry manure contains all the essential plant nutrients including nitrogen, phosphorous, potassium, calcium, magnesium, sulphur, manganese, copper, zinc, chlorine, boron, iron, and molybdenum (Amanullah *et al.*, 2010; Chastain *et al*., 2012). This makes poultry manure to be rich in nutrients than other manures (Amanullah *et al.*, 2007).

However, the amounts of nutrients in poultry manure can vary depending upon many factors including the age and diet of the flock, moisture content, age of manure (Amanullah *et al.*, 2010), the stage of growth and the well-being of the fowl producing it (Damerow, 1994). Amanullah *et al.*, (2010) stated that poultry manure increases the moisture holding of the soil and improves lateral water movement, thus improving irrigation efficiency and decreasing the general droughtiness of the sandy soils.

Additionally, application of poultry manure improves soil retention and uptake of plant nutrients, and increases the number and diversity of soil microorganisms, especially in sandy conditions thus enhancing crop health. Wood *et al.,* (2010) stated that long-term land application of manure, litter, and dead-bird compost generated during poultry (*Gallus, gallus*) production may oversupply nitrogen (N) and result in nitrate (NO_3-N) contamination of groundwater.

The study by Moore and Miller (1994) suggested that treating litter prior to field application could significantly reduce the amount of soluble phosphorus in runoff from litter-amended pastures. Therefore, chemical additions to reduce soluble phosphorus in litter may be the best management practice in situations where eutrophication of adjacent water bodies due to phosphorus runoff has been identified.

Although arable farmers collected manure/or litter from poultry operations, monitoring is not done to ensure that farmers do not use manure to feed livestock, especially during the drought season when grazing is poor. In Botswana, it is not allowed to feed or include poultry excreta, meat and bone meal or any other protein of animal origin in livestock diets except poultry (Diseases of Animals (Stock Feed) Regulations, 2004).Because of lack of monitoring, the application rate of manure or litter by farmers might be incorrect resulting in the alteration of soil fertility status by either raising or lowering the soil pH. If not handled properly, manure or litter will contribute to air pollution and may also give rise to high fly populations. According to Ni *et al.*, (2010), ammonia (NH_3) is an important gaseous pollutant generated from manure in commercial poultry farms and has been an environmental, ecological, and health concern. Poultry manure also releases carbon dioxide (CO_2), which is a greenhouse gas often used as a tracer gas to calculate building ventilation. Bolan *et al.*, (2010) reported thatthe major challenge facing the poultry industry is the large-scale accumulation of wastes including manure and litter which may pose disposal and pollution challenges unless environmentally and economically sustainable management technologies are evolved.

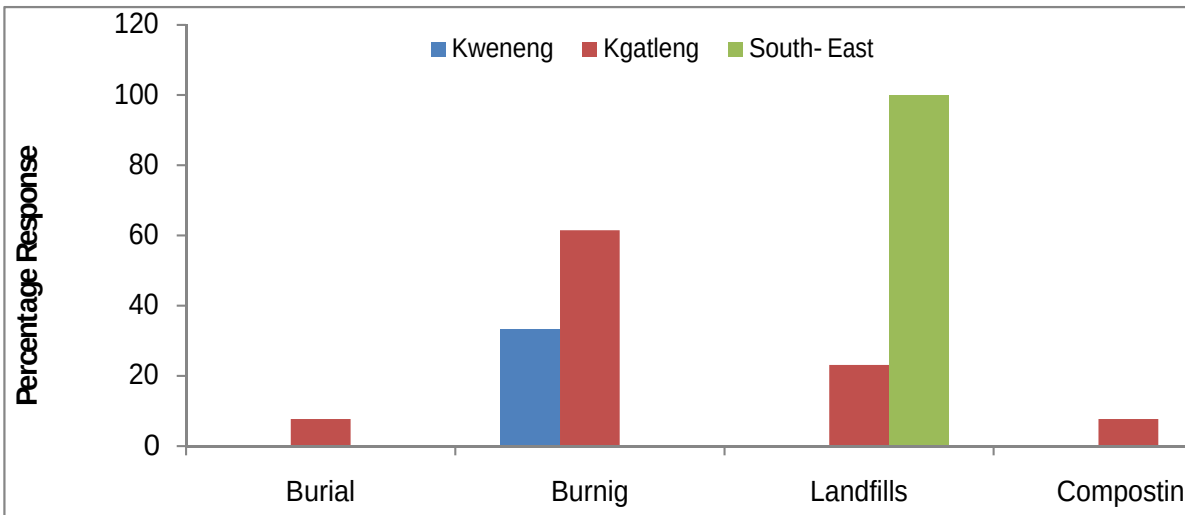
Disposal of mortality

According to Figure 1, the common methods of mortality disposal in this study were through landfills (100%), burial and composting (61.5%), and burning (33.3%).

Table.3 Population of chickens in the study area

District	Broilers	Layers	Total
Kgatleng	570600	0	**570600**
Kweneng	124300	0	**124300**
South –East	764300	70000	**834300**
Total	**838200**	**70000**	**908200**

Figure.1 Disposal of poultry mortality



Sainsbury (1992) stated that sanitary landfill disposal is convenient but may experience a lot of growth and requires manpower to maintain.

Estimated manure/litter production

The estimated number of birds kept in the poultry operations in the study areain a year was 908 200 (Table 4). Mortality in these operations was estimated to be 132 930 (broilers 130 830 and layer 2 100) *per annum*. Tao and Mancl (2008) estimated daily manure production by a broiler to be 0.09 kg and 0.18 kg for a laying hen. Assuming that five cycles were produced in a year and that broilers are reared for up to six weeks of age, it is estimated that 838 200 broilers will produce approximately 15842 tonnes of litter *per annum* and 70 000 laying hens 4599 tonnes of manure annually. Food and Agriculture Organisation (2012) stated that the knowledge of the quantity of poultry manure or litter produced on a farm is essential for the design of effective waste management programme.

Seventy-six percent of the respondents indicated that poultry waste was not properly managed. Furthermore, 36% of the respondents said Councils were responsible for educating farmers on poultry waste management, 32% said extension agents were responsible for educating them on poultry waste management, whereas 32% said farmers should share information on waste management. The study by Ofuoku (2012) in the Delta State of Nigeria recommended *inter alia* that the extension agents should provide follow up appointments for farmers, more extension agents should be trained and employed, farmers should be encouraged to share information on poultry waste management with other farmers and that the communication skills of the extension agents and farmers should be sustained.

Challenges to poultry waste disposal

Sixty percent of the respondents said transport was a major challenge in disposing of poultry waste from farms. In agreement with the present result, Adedayo (2012) in Metropolitan Lagos in Nigeria revealed that poultry waste is poorly collected, packaged and transported. The current results showed that dumping sites and/or landfills are situated far from poultry operations resulting in infrequent collection of poultry waste by Councils making it difficult for farmers to maintain hygiene on farms, thus compromising biosecurity. As a result, farmers were forced to find alternative ways of disposing of waste from their operations such as burning and construction of disposal pits within some farms. The location of landfills and/or dumping sites far from poultry operations contributed to high production costsresulting in lower profit margins.

The respondents mentioned that delayed collection of poultry waste by Councils contributed to outbreaks of houseflies and production of unpleasant odours which were a nuisance to neighbours. Axtell (1999) stated that the populations of pests such asmoths, dermestes hide beetles, house fly and several related filth fly species cockroaches, and rodents are largely determined by the housing, waste, and flock management practices. The author suggested that an integrated pest management approach, tailored to the different production systems, is required for satisfactory poultry pest control. A study by Dogra (2010) revealed that poultry farms are associated with high fly

density and high infectious morbidity suggesting that monitoring and regulations for poultry manure management practices and insecticide use practices have to be strengthened.

Sixteen percent of the respondents in the current study complained that Land Boards allocated them small plots which left them little or no space to reserve for disposal of waste. It was observed that small-scale farmers (64%) did not have slaughter facilities which had properly constructed drainage systems resulting in water being disposed of on the bare ground or in constructed pits located within farms which also produced unpleasant odours. In this study, small-scale farmers slaughtered birds under trees or shades made from corrugated iron sheets and waste water was allowed to flow on the ground providing breeding sites for flies and mosquitoes. This practice is inconsistent with Livestock and Meat Industries Act (2008) which stipulates that processing of poultry should be done hygienically. However, medium and large-scale farmers (36%) had slaughter facilities within farms or outside farms. For instance, poultry operations in Oodi, Matebeleng and Gakuto slaughtered their broilers at the abattoir located in Tlokweng while a farm in Phakalane (Gaborone) used the slaughter facility at Notwane (Gaborone). Moreki (2010) stated that the main challenges of the poultry industry in Botswana were lack of slaughter facilities for small-scale broiler producers, unorganized supply of poor quality feeds and stock, delayed allocation of land by the Land Boards and inadequate extension service.

In the present study, ash was another form of waste produced on farms. Sixteen percent of the farms used *mbaula* system (burning coal or fire wood to warm chicks) resulting in the production of ashes, which also had to be disposed of. Like poultry wastes such as abattoir waste, manure and/or litter, ashes were also disposed of in the landfills and dumping sites. The burning of coal and wood produced smoke which contributed to air pollution.

In this study, poultry manure and/or litter was disposed of as a fertilizer (96%) and at landfills/dumping site (4%). On the other hand, the common methods of mortality disposal were through landfill (52%),incineration (20%) and burning (20%). The challenges in the disposal of poultry waste were lack of transport, lack of farmers' knowledge of poultry waste management and insufficient space to allocate for waste disposal on farms, especially mortality. This study suggested that farmers' knowledge of poultry waste management was inadequate, indicating inadequacy of technical support from the Ministry of Agriculture.

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