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Prevalence, Perception and Implication of Solid Waste in Cattle Slaughtered in Eastern Cape Province, South Africa

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Abstract | Diseases of the fore-stomach, such as poly bezoars, traumatic reticuloperitonitis and rumenitis, are not often reported but impede the digestive functions of the fore-stomach, leading to the reduction in feed absorption, loss of animal weight and productivity, and mortality. The disease pathogenesis begins with the consumption of solid waste material (SWMs). This study determined the knowledge, types and solid waste management practices by farmers using structured questionnaires. The study also investigated the prevalence of SWMs in the stomach of slaughtered cattle (n= 7113) in two abattoirs in East London (BCM) and Queenstown (EMLM). The study showed that about 99.2% of the farmers had no municipal dustbins, but perceived recycling as an important (62.6%) and very important (30.4%) method of solid waste management. Waste treatment (59.7%) and waste disposal (44.4%) were not considered as important components of solid waste management. About 48.3% of respondents knew that open land waste disposal was deleterious to the environment and livestock and 60.8% always burnt their solid waste. Farmer's perspective in Queenstown and East London area significantly differs about waste minimization and recycling ($P< 0.05$) but do not differ ($P> 0.05$) regarding waste treatment and waste disposal. The most SWM's found in the stomach of slaughter cattle were plastics (58.0% and 17.8%), ropes (15.9% and 29.2%) and polybezoars (22.5 and 32.8%) at EMLM and BCM, respectively. Farmers in the study area showed an appreciable level of knowledge about proper solid waste management; however, the prevalence of SWM in cattle in the study area was high.

Keywords | Solid waste, Cattle, Indigestible foreign bodies, Abattoir, Fore-stomach

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INTRODUCTION

Solid waste accumulation is an inevitable consequence of human activity (United Nations Environmental Programme, 2009; Talalaj & Walery, 2015). However, it is the responsibility of the municipality to collect and dispose of household waste to a specifically designated area (Korucu and Erdagi, 2012). In South Africa, most municipalities do not meet the minimum standards for waste management which consider minimization, treatment and recycling before landfill disposal (Department of Water Affairs and Forestry, 2005). Failing to comply with such standards is evidence of poor solid waste management which leads to environmental pollution. Due to the harmful effects caused by environmental pollution according to communities should be given the opportunity to practice efficient solid waste disposal for their own benefit (Abdullah et al., 2014). Poor solid waste management has implications not only for human livelihood and the environment, but livestock health has also been a significant concern in developing countries (Mohammed and Fromsa, 2011; Negash et al., 2014; Mushonga et al., 2015). Livestock farmers in western Kenya perceived that ingestion of wastes such as plastics was among other causes of illnesses in cattle (Nyamanga et al., 2006). In Ghana, a study noted that livestock reared extensively tend to scavenge for food in areas such as waste dumps (Okai et al., 2007). The clinical impact of scavenging at waste dumps include but not lim-

ited to disruption of the digestive functions of the stomach, pain, rumenitis, polybezoars, reticulo-peritonitis, and abomasum impaction (Mushonga et al., 2015).

The Eastern Cape Province in South Africa is no exception in terms of poor waste management. For instance, in Raymond Mhlaba municipality there is one landfill with no waste recycling or treatment (ASPIRE, 2010). Furthermore, livestock and people are often found roaming the site scavenging for food. Likewise in Makana municipality, reports on poor waste disposal methods, inadequate public awareness and poor law enforcement governing waste management are common issues. In Enoch Mgijima Municipality also there is one landfill which does not serve about 40% of its urban residents (LMC, 2014). The report highlighted evidence of poor solid waste management at the municipal level. Hence the present study aims to evaluate the perceptions of solid waste management among farmers as well as to determine the types of solid waste materials affecting livestock in two towns of Eastern Cape Province.

MATERIALS AND METHODS

Ethical Considerations

The study design and methods were approved by the University of Fort Hare ethics committee with reference number JAJ011SNON01. The research was carried out within the limits of the accepted ethical standard.

Study Site Description

The study was conducted in Queenstown under Enoch Mgijima Local Municipality (EMLM) and East London under Buffalo City Municipality (BCM). Queenstown is about 71.3 km^2 with an altitude of 1081 m above sea level and located at 31°54'S 26°53'E. It lies on the Komani river close enough to the Wild Coast and Karoo Heartland. The climate is characterized by often extreme temperatures with figures as high as 35°C in mid-summer and as low as -2°C on a cold winter day (LMC, 2014). About 36% of the households do not receive municipal services or dump waste themselves (LMC, 2014). Most households are engaged in land-based activities such as crop plantation and livestock rearing and this increases towards rural areas (Evans, 2012). Goats and cattle are known as major livestock for investments (LMC, 2014).

East London is the second largest city in the ECP, located 32°59'S 27°52'E and is about 156.7 km^2 housing 267 007 people, of which 70% of this population are Black African. East London receives an annual rainfall of about 593 mm per year, mostly occurring in summer. The climate is humid subtropical with low temperatures of 3°C and highest being 42°C (Buffalo City Metropolitan Municipality: IDP 2011/2016). About 53% of people in BCM are poor, and 70% of the solid waste generated is disposed of by authority, the remainder is either disposed by community members or personal removal or not removed (Buffalo City Municipality, 2017).

Study Design

The study was conducted in two parts. The first part consisted of a structured questionnaire survey conducted on farmers (n= 600) to test their perceptions of solid waste management and implications on livestock. The second part involved the survey of slaughtered cattle at two selected abattoirs in the Eastern Cape Province. In the second survey, the prevalence of solid waste materials in slaughter cattle at Queenstown abattoir (n= 1652), and East London abattoir (n= 5361) were determined. The data for both studies was collected alternatively for six months from June-November 2016.

Sampling Procedure

Questionnaire survey: The pilot study for the questionnaire survey was conducted in the two communities in Alice namely, Khumashe and Ntselamanzi locations. The questionnaire was designed based on the research carried out elsewhere (Adane and Muleta, 2011; Lebersorger and Beigl, 2011; Gamberini et al., 2013; Miezah et al., 2015; Sholto-douglas et al., 2015). Six semi-urban villages near Queenstown and six near East London were randomly selected for the study. These were: MacBride, Ekuphumleni, Ezidulini, Imvani, Ezola and Indlovukazi for Queenstown and ESilimela, Mncotsho, KwaGaxa, Ezikhweba, Kwabathanga and Khwetyana for East London. From each of the selected villages, 50 livestock owners were randomly selected and interviewed with the structured questionnaires. The questionnaire was composed of three sections, including; demographic background of the interviewees, perceptions on solid waste management and implications on livestock health. Questions such as what are the perceptions of solid waste management among the farmers? How much waste is generated and what are the major components of this litter? What are the implications of the problem of solid waste on the health of livestock? Is the problem of solid waste increasing or decreasing in terms of livestock health?

The villages were visited twice a month. Before the commencement of the interview, farmers were given the right to indicate their willingness to participating in the interview. The consent form also indicated that farmers at any time they feel like can discontinue the interviews. Questionnaires were administered using a snowball sampling technique where the first farm owner in a particular community would point the next to visit until the sample size was reached. In this manner, it was easier to identify the

target group. In some communities interviews conducted on farmers days where a large group of farmers were interviewed. In total 600 farmers participated in this study.

Abattoir inspection: Queenstown and East London abattoirs were selected purposively. The two abattoirs are high through-put export abattoirs. Both abattoirs receive the bulk of the domesticated livestock species from surrounding villages as well as commercial farms. Animals included in the study were selected using a method purposeful sampling technique as described elsewhere (Jaja et al., 2016). Since a large number of animals was slaughtered per day and the constraint associated with abattoir work conditions, this sampling method was suitable. In total 1652 and 5361 cattle were observed at EMLM and BCM, respectively. After slaughter, the contents of the fore-stomach were removed; carefully sifted through and any foreign material found was washed, identified and recorded according to the location and age of the cattle. Age was estimated using dentition (Turton, 2009). In the two abattoirs surveyed, three personnel working in offal floor areas were trained (without compromising their work at the abattoir) to assist in accessing the prevalence of solid waste materials in slaughter cattle. Cattle were chosen because of their poor selective grazing habits, and they are more likely to ingest SWM's compared to sheep or goats (Sanon et al., 2007). The abattoir personnel's were required to record the nature of the SWMs, the location of the SWMs with reference to rumen, reticulum, abomasum and omasum.

Statistical Analysis

All statistical analyses were performed using Statistical Package for Social Sciences (SPSS) version 23. The Pearson Chi-Square test was used to calculate the mean scores of respondents in the two towns. Means separation on solid waste management and methods of waste disposals were used to determine statistical differences. Data was analysed using Microsoft Excel 2010 and descriptive analysis such as frequency tables, charts and bars were used to show differences among variables.

RESULTS

Demographic of Respondents and Response to Questions on the Importance of Solid Waste Management

Summarised results on social characteristics of farmers in the study are illustrated in Table 1. From the table, most respondents were males (69.2%), married (65.2%) and started farming at the age of twenty-one. The findings also indicate that few respondents had obtained tertiary education (11.7) and the overall unemployment rate in the study was 40.0%. In Table 2 findings depict that farmers held adequate knowledge with regards to waste management methods. Respondents indicated that recycling is important (46.2%) and very important (42.0%). They also indicated that waste minimisation is important (62.6% and very important (30.4%). On the other hand, many respondents incorrectly indicated that waste treatment (59.7%) and waste disposal (44.4%) as not important. Farmers' knowledge of the importance of waste minimisation and recycling significantly differed ($P< 0.05$) for both municipalities. However, there was no statistical significance ($P> 0.05$) for waste treatment and waste disposal.

Table 1: Demographic background of farmers (n=600) in selected areas of the Eastern Cape

Demographic characteristics	Category	Percentage (%)
Gender	Male	69.2
	Female	30.8
Age	21-30	17.5
	31-40	21.7
	41-50	25.0
	51-60	21.7
	>60	14.2
Marital status	Single	31.7
	Married	65.2
	Divorced	0.0
	Widowed	38.3
Occupation	Civil servant	16.7
	Public servant	28.3
	Self- employed	16.7
	Unemployed	38.3
Educational level	No school	16.7
	No grade 12	31.7
	Grade 12	40.0
	Diploma/Degree	11.7

Types of Solid Waste Material, Methods of Disposal and Clinical Signs in Animals

The results showed that 60.8% of the respondents always burn their litter. The statistical analysis suggested that both Enoch Mgijima Local Municipality (EMLM) and Buffalo city municipality (BCM) residents rely on burning litter. In composting solid waste, the majority (54.2%) indicated that they never dig for their litter and 38.3% indicated that they sometimes they dig. Respondents who dispose of SWM in the back yard always were 35% whereas those who dispose their waste sometimes were 45.8%. There was no significant difference between composting, and open land disposal (Table 3). The farmers reported that their litter is often composed of plastic, paper, rubber, glass, metals and sometimes these materials are deposited with spoilt or unwanted food (organic waste). About 62% of the litter

Table 2: Response percentages and mean scores of importance of solid waste components as perceived (n= 600)

				EMLM-BCM	
Component	**Not important (%)**	**Important(%)**	**Very important (%)**	**Mean ± Standard deviation**	***p*-value**
Minimization	10.8	46.2	42.0	2.38 ± 0.67-2.23 ± 0.65	0.00*
Recycling	7.0	62.6	30.4	2.31 ± 0.52-2.16 ± 0.58	0.00*
Treatment	59.7	25.8	14.5	1.53 ± 0.72-1.56 ± 0.74	0.67^{ns}
Disposal	44.4	28.2	27.4	1.91 ± 0.83-1.75 ± 0.81	0.15^{ns}

Note: *Significant; N.S (Not Significant) at $P<0.05$ using T-test

Table 3: Response percentages and mean scores on methods of waste disposal (n=600)

				EMLM-BCM	
Disposal method	**Always**	**Sometimes**	**Never**	**Mean±Standard deviation**	***p*-value**
Burning	60.8	32.5	6.7	1.36 ± 0.57-1.56 ± 0.65	0.00*
Composting	7.5	38.3	54.2	2.53 ± 0.67-2.40 ± 0.61	0.10 ^{ns}
Backyard disposal	35.0	45.8	19.2	1.87 ± 0.75-1.82 ± 0.68	0.39 ^{ns}
Open land disposal	34.2	17.5	48.3	2.09 ± 0.91-2.19 ± 0.88	1.88 ^{ns}

Note: *Significant; N.S (Not Significant) at $P<0.05$ using T-test

Table 4: Responses on general questions regarding solid waste and livestock

General observations	**Rank**	**Male (n=415)**	**Female (n=185)**	**Overall (n=600)**
Do you have access to municipal dustbins?	Yes	0.0	2.7	0.8
	No	100	97.3	99.2
Are there Recycling programme in your area?	Yes	6.0	5.4	5.8
	No	94.0	94.6	94.2
Are you willingness to recycle?	Yes	72.3	56.8	67.5
	No	27.7	43.2	32.5
Solid waste has implications on livestock production	Strongly disagree	4.8	8.1	5.8
	Disagree	19.3	16.2	18.3
	Agree	37.3	43.2	39.2
	Strongly agree	38.6	32.4	36.7
Have you seen animals grazing on litter?	Yes	57.3	45.9	53.8
	No	41.5	54.1	45.4
Does littering have effects on animal health?	Yes	72.8	60.0	69.0
	No	27.2	40.0	31.0

Note: All figures are in percentage

was a combination of plastic/paper, glass and metal, 10% were plastic and paper bags, and 1% were metals (Figure 1).

Table 4 shows the awareness of the farmers about the problem of solid waste, general questions were asked. When asked if SWM's have implications on livestock, more females (8.1%) than males (4.8%) strongly disagreed. About 99.2% of the farmers mentioned they have no municipal dustbins. Farmers also revealed that there were no recycling programmes and the majority of them (67.5%) were willing to recycle. Interestingly, this study uncovered a negligible proportion of valuable recyclables such as metals (1%). When asked if they have seen animals consuming litter, 57.3% (males) 45.9% (females) said they had encountered such incidents and the overall response is 53.8%. When asked whether they suspect that ingestion of SWM's has effects on livestock health, the majority (69.0%) agreed that there might be health issues associated with consumption of SWM's. The majority (24.2%) pointed out that pain, poor condition and swollen stomach as clinical signs they usually notice. Other farmers (16.7%) claimed that loss of condition is sometimes a sign of presences of SWM's. Some farmers reported abnormal respiration (4.2%) and anorexia/dehydration (7.5%) as apparent clinical signs.

Prevalence of solid waste material by abattoir, fore-stomach compartment and age

Plastics, wire, nails, rope, bones, stones, cloth, hair and polybezoars were the main foreign bodies prevalent in affected slaughter cattle. In Queenstown abattoir, plastics (58.0%) were the most abundant SWM's followed by polybezoars (22.5%). In East London abattoir, polybezoars (32.8%), and ropes (29.2%) were highest SWMs found in the fore-stomach of cattle. Nails were the least recorded SWM's Queenstown (3.3%) and East London (4.3%) abattoirs. The prevalence of other SWMs such as wires, bones, cloth were 7.3% respectively, and hairs, stones were 10.6% respectively, and the prevalence of ropes was 15.9% (Figure 2). The majority of SWMs were found in the rumen of cattle at EMLM (71.7%) and BCM (72.4%), then in the reticulum (28.2% and 19.4%), at EMLM and BCM respectively. Stones and bones were occasionally encountered in the abomasum (4.6% and 5.5%), and intestines (2% and 2.5%), at EMLM and BCM respectively (Figure 3). The highest occurrence of SWM's in Queenstown was in cattle of age between 3-5 years (47.0%) while in East London, the highest occurrence (42.3%) in cattle above five years of age (Figure 4).

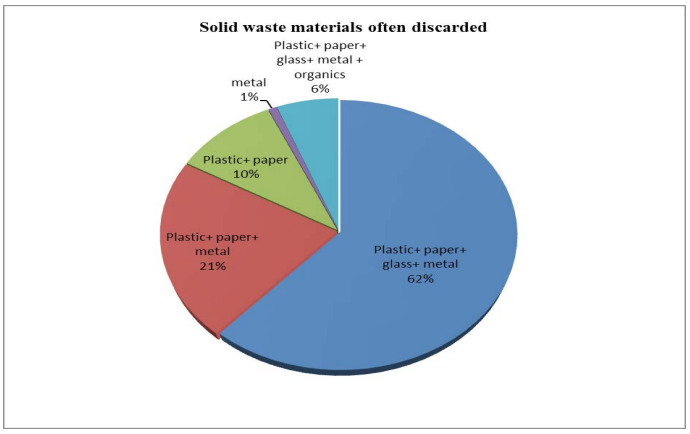

Figure 1: Percentage distribution of SWMs discarded by farmers

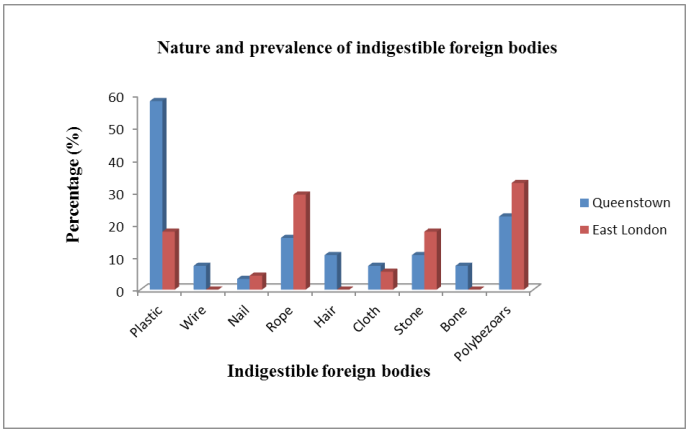

Figure 2: Nature and prevalence of SWM's.

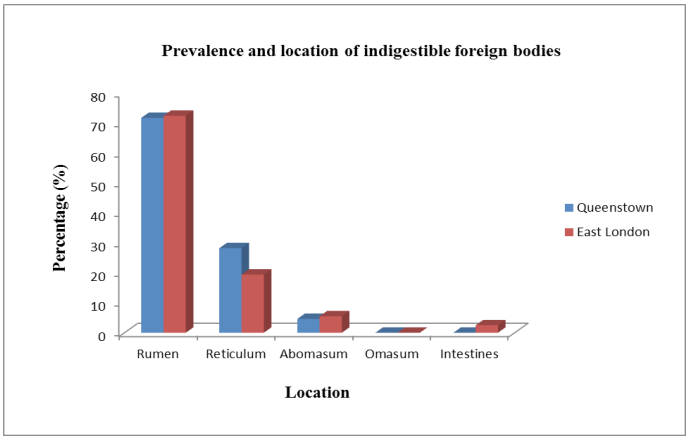

Figure 3: Prevalence of SWM's according to location

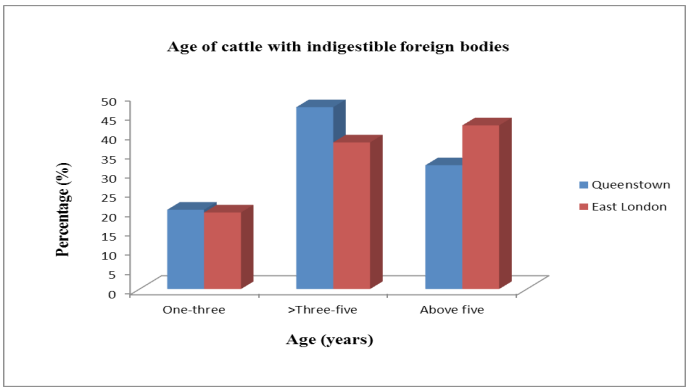

Figure 4: Prevalence of SWM's in cattle according to Age

Table 5: Clinical signs associated with consumption of SWM's in stomach of livestock as reported by farmers

Clinical sign	Percentage (%)
pain + poor condition + swollen stomach	24.2
anorexia/ dehydration	7.5
swollen stomach + protruded objects	8.3
abnormal respiration	4.2
loss of condition	16.7
never seen abnormality in their animals	39.1%

DISCUSSION

Farmer's responses to waste management practices suggested that they were aware that reducing solid waste is the best practice in avoiding pollution. Although, some respondents indicated that the lack of recycling programs in their areas favours increased waste. However true waste minimization happens when solid waste production decreases (Zhang et al., 2010). Farmers in EMLM and BCM were aware that reducing waste is good practice; however, at the same time when they have litter, they have to discard it. This exists because irrespective of waste minimization, treatment and recycling; some waste will always have to be disposed of hence the need for landfill (Department of Water Affairs and Forestry, 2005).

In terms of waste disposal methods, the study uncovered that burning of litter was the commonest method (60.8%) used in disposing waste. This finding complements one study conducted in KwaZulu Natal, South Africa which reported that due to lack of waste disposal facilities in rural areas, residents are forced to practice open burning of solid waste (Khumalo, 2016). This can be further attributed to the fact that there is no organized form of solid waste management in semi-urban and rural areas of South Africa. The burning of litter materials such as plastic leads to contamination of the atmosphere due to the release of poisonous chemicals such as dioxin (Gopal et al., 2014; Kumari et al., 2017), but because of lack of such knowledge, rural dwellers cannot be deterred from practising burning of litter.

The respondent indicated that they rarely dig to dispose of their waste because the practice is laborious and time-consuming. Farmer's actions suggest that litter is either burnt or thrown out in the open. The finding of this study buttresses the finding in another livestock was noted to ingests SWM's due to grazing close to households (Mushonga et al., 2015). The differences in the knowledge and use of waste composting, open land disposal and backyard disposal among farmers in EMLM and BCM could be due to multiple reasons. Some of those reasons include, the multidimensionality of solid waste management, public interest and participation, legislation, infrastructure, lack of resources and services greatly affect municipal solid waste management decisions (Mcallister, 2015; Olukanni et al., 2016; Omran et al., 2017).

Farmer's in the present study acknowledge that some litter (6%) was mixed with organic foodstuffs. The presence of organic waste in a litter is one of the factors favouring ingestion of SWM's by ruminants. In consuming such litter, animals are unable to adequately separate SWMs and the food item in the litter. Studies conducted in Ethiopia Ghana and Rwanda corroborates animal consumption of litter mixed with SWMs and food items (Ramaswamy, V. & Sharma 2011; Miezah et al., 2015; Mushonga et al., 2015). Respondents also noted that materials such as plastics, glass, and paper were common in the litter. One study which looked at solid waste generation and collection for recycling in South Africa found similar materials (Nwokedi, 2011). Plastics, however, were noted as the most occurring in the environment. The two main reasons for the widespread presence of plastics in the litter could be because plastics are light in weight which makes them easier to be blown by the wind to various places, and their wide use despite the introduction of the plastic levy in South Africa. A survey on the usage of plastic bags suggests that the low price and easy availability of the plastic bag were the main reasons for the wide utilization of such materials (Adane and Muleta, 2011). Hence, the plastic levy in South Africa needs to be reviewed and other means of limiting the usage of the material should be explored.

Although metallic objects in this study were found in small quantity (1%), they are considered more fatal to animals than any other ingestible objects. This is because they do not only cause blockages in the gastrointestinal tract of ruminants but also can protrude through tissue walls causing inflammatory conditions such as peritonitis, and rumenitis (Chase et al., 2017). Cattle deaths at 3% were reported to have been caused by ingestion of metallic objects (Bisaglia and Romano, 2017). Such findings further show the consequences of solid waste materials consumption by livestock. In desert countries, animals frequently eat household trash and graze close to homesteads (Mushonga et al., 2015). In South Africa, this can be related to periods of nutrient scarcity (winter droughts). Some of the farmers explained that their animals sometimes become sick suddenly and die. Post mortem examination of the dead animals often reveals the cause of death as SWMs in the stomach. Therefore, these findings highlight the serious livestock health problems associated with indiscriminate waste disposal.

A variety of other health issues including poor body condition, swollen stomach and protruded objects were of concern to farmers in this study. Such health issues are commonly associated with the ingestion of both penetrating and non-penetrating SWMs. Some researchers have reported ruminants with SWM's showing similar signs. For instance, in one study conducted in Egypt, cattle's were reported of showing signs of painful swelling due to metallic objects (Semieka, 2010). In Ethiopia, animals with loss of body condition had more SWM's than normal animals (Mohammed and Fromsa, 2011). In Iran, a case of abdominal pain due to reticulo-cutaneous fistula in a cattle after swallowing a metallic rod was reported (Omid, A. & Mozaffari et al., 2014). These studies buttress farmers observation that animals with a swollen and painful stomach are often associated with SWMs.

In Queenstown (EMLM) and East London (BCM) abattoirs, 60% and 20% of plastics were recovered from stomachs of slaughter cattle. A similar result was obtained in Ethiopia, where 59.6% and 46.1% of plastics were found (Mohammed et al., 2011). The main reason why animals consume used a plastic bag because of its salty taste (Okai et al., 2007). Although farmers in this study indicated that they do not encourage open land disposal, but the lack of organized solid waste management in rural areas, presupposes that animal ingestion of such materials could be higher than anticipated.

Polybezoars and rope were found in 30% of cattle surveyed in the current study. However, unlike in this study, a much lower prevalence of polybezoars (1%) in cattle of Harama-

ya municipal abattoirs in Ethiopia (Negash et al., 2014). A polybezoar is a stone-like material caused by ingestion of IFB's such as plastic, rope or hair combined with plant materials along with salt deposits. The differences between both studies could be the age of the animal. Livestock of rural farmers in South African are kept for multi-purposes and tend to be kept longer (Musemwa et al., 2008; Katiyatiya et al., 2014). Therefore, early exposure to SWM's could lead to the formation of more polybezoars. Metallic SWM's were also found in study animals although in small number. The presence of metal in the ruminant stomach has also been linked to farm machinery during feed processing (Pritchett-Corning et al., 2015). However, unlike in commercial farming with various production processes, in rural areas livestock graze free in natural pastures; thus there are few chances of encountering such objects. Similar findings have been extensively documented elsewhere (Hailat et al., 1997; Anwar et al., 2013; Berrie et al., 2015; Mushonga et al., 2015; Mekuanit et al., 2017).

Most of the SWM's were recovered from the rumen and the reticulum. This is similar to the 77.1% of SWM found in the rumen, and 22.9% of SWM found in reticulum (Teshome et al., 2017). The high prevalence of SWMs in the rumen likely because the rumen is the first chamber in the alimentary canal of ruminant animals and partly digests feed, before passing it to the reticulum. Interestingly, some SWM's were found in the abomasum and the intestines. The literature on the occurrence of SWM's in the abomasum and intestines is scanty. However, abomasal impaction has been caused by gravel in beef suckler cows, dairy, and feedlot cattle (Radostits et al., 2006). Furthermore, animals grazing in overgrazed pastures exposes them to consuming soil and stone particles (Akinbobola et al., 2016). The present study revealed that most SWM's were found in older cattle (>3 years). In one study investigating indigestible foreign bodies in rumen and reticulum of ruminants, the highest prevalence of SWM's was in cattle of more than seven years of age. The study previously mentioned, also noted that animals less than four years of age had fewer SWMs (Teshome et al., 2017). A higher occurrence of SWMs in older animals suggests the ingestion of SWM's over a long period. Therefore, solid waste materials poorly disposed of can be consumed by livestock and can be retraceable at animal slaughter.

CONCLUSION

Based on the findings of this study, farmers held proper knowledge of solid waste management methods and were aware of the problems posed by solid waste. Even though farmers demonstrated knowledge on proper solid waste management, animals slaughtered in high throughput abattoirs in the province harboured a significantly high amount of SWMs. Therefore this study concluded that livestock in semi-rural and rural areas are exposed to the impacts of poor solid waste management which could hinder their productivity. Since this is the first study in South Africa on the subject, it is recommended that future research on direct and indirect effects of solid waste on livestock production be carried out.

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CONFLICT OF INTEREST

Authors declare no conflict of interest.

AUTHORS CONTRIBUTION

VVN carried out the research; LZ and KN, conceived and designed the experiments, IFJ, supervised the research, analysed the data and edited the manuscript for publication.

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