Animal Waste Management Practices and Perceptions on Public and Environmental Health Risks

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Abstract: *A study was conducted to assess the practices with respect to management of animal wastes and awareness of livestock keepers on the environmental and public health risks associated with improper management of animal wastes in 66 livestock-keeping households in Morogoro Municipality, Tanzania. A semi-structured questionnaire was used for data collection, complemented with review of secondary data and researchers' observations. Majority of respondents (91.0%) heaped the wastes near the animal shed and none of them treated the waste before disposal. Main methods for waste disposal were spreading as manure on crop farms (62.1%) and burning (10.6%), and about 24% respondents disposed the wastes on any available open space. It was also observed that 40.9% of the respondents were aware of environmental risks caused by improper disposal of animal wastes while 59.1% were not aware of such risks, and the risk mentioned was air pollution. About 57.6% of the respondents were aware of the public health risks and they mentioned skin infections, helminthosis, diarrhea, allergy and respiratory infections. Majority of the respondents (87.9%) were not aware of the existence of legislation governing animal waste management. It can be concluded from the study that the limited knowledge on proper management of animal wastes in the study area as well as lack of enforcement of legislation predisposes the environment and public to health risks. It is recommended that responsible authorities should initiate programmes to educate livestock keepers and the general public on appropriate waste management technologies in order to minimize public and environmental health risks.*

Key words: animal wastes, environment, public health

INTRODUCTION

Urban and peri-urban livestock keeping is an important source of food and income for resource-poor families. Since 1980s, urban and peri-urban livestock keeping in Tanzania has grown substantially as a means of supplementing income of urban dwellers (Sawio, 1998). The major livestock types found in urban and peri-urban areas are dairy cattle, pigs broiler, and layer chickens (Mlozi, 1997). Shortage of land in urban and peri-urban areas has necessitated intensification of animal production systems characterized by increased confinement of animals. Increased

livestock numbers has resulted in increased generation of animal wastes in the form of faeces, urine, litter or bedding, feed remains, wastewater contaminated by animal manure litter or bedding as well as material from washing or cleaning pens and animal processing facilities (FAO, 1990). Production of large quantities of animal wastes in space-constrained livestock units in urban settings causes serious environmental and public health problems if not properly managed or disposed (Morse, 1995; Hammond, 1997). Waste collection, treatment, storage and disposal methods have been described well for other types of wastes such as domestic and industrial wastes for which there are elaborate municipal by-laws on their management. However, there is limited attention to animal wastes, which, have a very high potential of causing environmental and public health hazards in various ways if not well managed.

The organic matter in animal wastes is the cause of non-point pollution source (NPS) which has substances that promote growth of biological systems (Kuberle, 2005). The overall effect on the aquatic environment is that it accelerates the growth of some undesirable biological systems. The run-off of animal wastes, constituting soluble nutrients in manure may reach drainage channels, ditches and eventually flowing waters. The nitrogen, phosphorus and potassium content of the manure causes hypertrophication and leads to masses of algae (Anderson et al., 2002; Nonga, 2011). These blooms can block out all the available light to the water and interfere with the decomposition process leading to a high biological oxygen demand (BOD) thereby causing depletion of oxygen in the water. Animal wastes contribute to the increase in suspended material in the water solution and together with decomposition of organic matter can cause the water body to have a strong unpleasant odour, taste and/or colour. The Environmental Protection Agency of the United States (EPA) documented that 41% of non-point source pollution is a result of agriculture, and animal waste from feedlots contributes to approximately one-third of this pollution (EPA, 2007).

Air quality can be adversely affected by animal waste because animal wastes produce noxious gases and odours which result from decomposition processes of microorganisms (FAO, 2007b). The gases formed depend on whether degradation is aerobic or anaerobic. For instance, odour from anaerobic poultry manure includes ammonia, hydrogen sulfide, 2, 5-carbon organic acids, skatole, diketones and merchaptans which are the major malodourous components (Burnett and Dodendro, 1969; Sangodoyin, 1996).). Fermentation of wastes in poorly ventilated areas can result in accumulation of these gases in high concentrations leading to a toxic, oxygen-deficient or even explosive

environment (Mackie et al., 1998). Continuous generation of potentially deadly gases such as ammonia, carbon dioxide, hydrogen sulfide and methane into the atmosphere have adverse effect on human health (Copeland, 2007). Both carbon dioxide and methane are odourless gases that at high concentration cause suffocation (Kuberle, 2005).

A large number of microorganisms such as bacteria, fungi, viruses, and intestinal parasites are found in animal excreta (Defra, 2006; Murdoch, 2007). Pathogenic organisms present in the excreta can be a source of infection to people involved in waste handling or come into contact with wastes in various ways. Discharge of untreated animal waste into surface or ground waters creates a health hazard to humans and animals using the water and thus animal units may be a source of and discharge pathogens into the environment without the animals showing any signs of infection (Sangodoyin, 1996; Defra, 2006). There are many zoonotic diseases which can be acquired from animal wastes because animals harbour pathogenic micro-organisms in their guts as normal flora. Such microorganisms are passed out in faeces and urine, and human beings can be infected through ingestion of food and water contaminated with the excreta (FAO, 2007a). Bacterial diseases that may be acquired through handling of animal wastes include salmonellosis, collibacillosis, campylobacteriosis, tetanus, leptospirosis and anthrax (Murdoch, 2007; Defra, 2006; FAO, 2007c). Protozoan diseases that can be transmitted through animal wastes include giardiasis, toxoplasmosis and cryptosporidiosis (CDC, 2007a, 2007b).

Animal wastes can also include nuisance substances, which are neither toxic nor harmful but for aesthetic reasons they make the environment objectionable. For instance, the presence of decomposing animal wastes such as faeces and carcasses in the surrounding is unaesthetic, in addition to, attracting flies and other nuisance-causing insects that may also serve as mechanical carriers of disease pathogens (Van de Wel., 1995).

On the other hand, animal wastes can be beneficially utilized in various ways such as spreading on cropland to furnish plant nutrients and to improve soil structure. Manure can also be utilized as biofuel because during anaerobic digestion, much of organic nitrogen is converted to ammonia and held in solution. The methane gas so formed is used for heating purposes (Mackie, 1998). Such waste utilization options have the potential for increasing food production for improving human nutrition and ensuring food security, and reducing dependence on firewood as a source of energy, the effect of which results in deforestation.

Animal manure can also be utilized as animal feed because it contains the same classes of chemical compounds as those found in feeds (McGann, 2004). For example, poultry manure can be processed and be incorporated into feeds for cattle or be used in fish ponds (Taiganides, 1977). Some form of processing of wastes before use as animal feed is desirable in order to increase the availability of nutrients and to minimize bad odour and transmission of diseases pathogens (McGann, 2004). In certain parts of Tanzania, freshly voided cow dung is used for smearing on walls of residential houses and storage facilities for grain.

Legislation, rules and guidelines have been developed in other countries to facilitate the management of animal wastes. For example, in the USA, guidelines for effluent discharge require that run off be retained and not to discharge into streams (EPA, 2007). Laws and regulations in Greece demand that animal production units must be built away from towns, villages, roads and tourist establishments in order to reduce the adverse effects of animal wastes to the environment and public health (Taiganides, 1977). In other countries, regulations or by-laws have been established to govern the construction of animal units and address issues concerning public health and environmental protection (Van de Wel, 1995).

In Tanzania, The Town and Country Planning Ordinance: Urban Farming Regulations 1992, section 78 stipulates a number of regulations on urban farming including animal husbandry (Sawio, 1998). The regulations include the empowerment of the Medical Officer of Health to supervise arrangements for removal of animals from the urban environment as he/she shall consider necessary and to take appropriate legal action to those who do not adhere to the regulations. Towns and municipal authorities in Tanzania have enacted by-laws to regulate animal keeping in urban and peri-urban areas although enforcement is ineffective.

Unless regulations and procedures for proper management are adhered to, animal wastes will continue to present risks to public and environmental health in urban and peri-urban areas of Tanzania, thereby negating the beneficial effects of this farming system to food security and income resource-poor urban dwellers. Therefore, the aim of this study was to assess and document practices with respect to collection, storage, treatment and disposal of animal wastes in livestock production units in Morogoro Municipality, Tanzania and to assess the perceptions of livestock keepers on the public and environmental health risks associated with improper animal waste management practices.

MATERIALS AND METHODS

Study location

This study was conducted in Morogoro Municipality, which is located in Morogoro region, Tanzania that lies between latitudes 5o 58' and 10o S and longitudes 35o and 25o 30'E. The study involved 66 randomly selected livestock keeping households in six wards in the Municipality, namely; Mbuyuni, Mazimbu, Mlimani, Kichangani, Boma and Kihonda. In all the units, livestock were raised in land plots that were initially planned to be for residential purposes only. Thus, animals were confined into small areas and activities related to animal keeping resulted into generation of a lot of wastes, necessitating extra demand in terms of management and disposal.

Data collection

Primary data were collected using a pre-tested semi-structured questionnaire which was administered to randomly sampled livestock keeping households in the six wards. Households were informed one day before the visit about the exercise and one respondent available on the day of the visit in each of the 66 study households was interviewed. Information on methods for animal waste collection, treatment, storage and disposal was gathered. The questionnaire was complemented with researchers' observations during the visits to the farms. The awareness of the respondents on the risks to the environment and public associated with handling of animal wastes was also assessed. Secondary data was gathered by reviewing information from published and unpublished reports available in various offices in the Municipality and other sources of information. The collected data was entered and analyzed using the MS Excel 2007 programme.

RESULTS

Characteristics of respondents

A total of 66 respondents in different wards in Morogoro Municipality were interviewed comprising of 43.9% household heads and the rest (56.1%) were not household heads (Table 1). Sixty-five percent (43) of the respondents were males while 34.8% were females. Majority of the respondents (37.9%) were in the 16-25 age category followed by the 56-65 years (21.2%) and 46-55 years (15.1%) as shown in Table 1. Majority of the respondents had attained primary education (59.1%) and secondary (33.3%) education. A few of them had other levels of education (Figure 1).

The study showed that 77.3% of respondents did not undertake livestock keeping as the main occupation while for 22.7% of them; livestock keeping was the main occupation. Respondents who did not

undertake livestock keeping as the main occupation comprised of civil servants (72.7%), businessmen (13.6%) and crop farmers (9.1%). Those with other occupations represented 4.5% of the livestock keepers. Ten of the 11 respondents for whom livestock keeping was the main occupation started the livestock projects in the 2000-2005 period while others started livestock keeping projects before 1990s.

Table 1: Characteristics of respondents in the livestock keeping households involved in the study in Morogoro Municipality, Tanzania

Characteristics	Respondents (n = 66)	
	Number	Percent
Household leadership		
Household head	29	43.9
Not household head	37	56.1
Sex of respondents		
Male	43	65.1
Female	23	34.8
Age group		
16-25	25	37.9
26-35	9	13.6
36-45	8	12.1
46-55	10	15.1
56-65	14	21.2

Of the 66 livestock keeping households visited, majority of them (77.2%) kept dairy cattle, followed by chickens and pigs while other types of animals kept were few (Figure 2). It was also observed that in all the study households, all types of animals were intensively managed with the exception of seven households that kept local chickens under the free ranging system. The intensive system of keeping animals resulted in generation of large amounts of animal wastes.

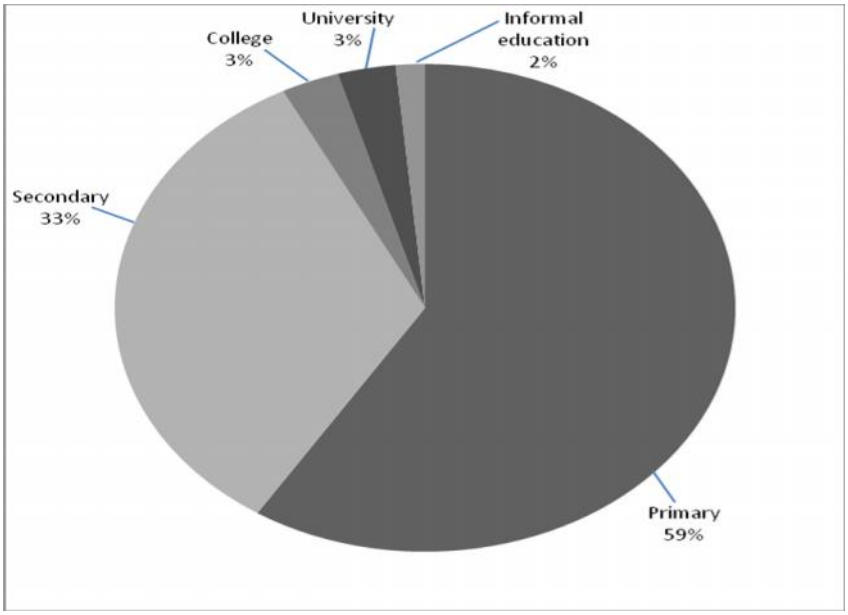

Figure 1: Level of education of respondents in the study households in Morogoro Municipality, Tanzania.

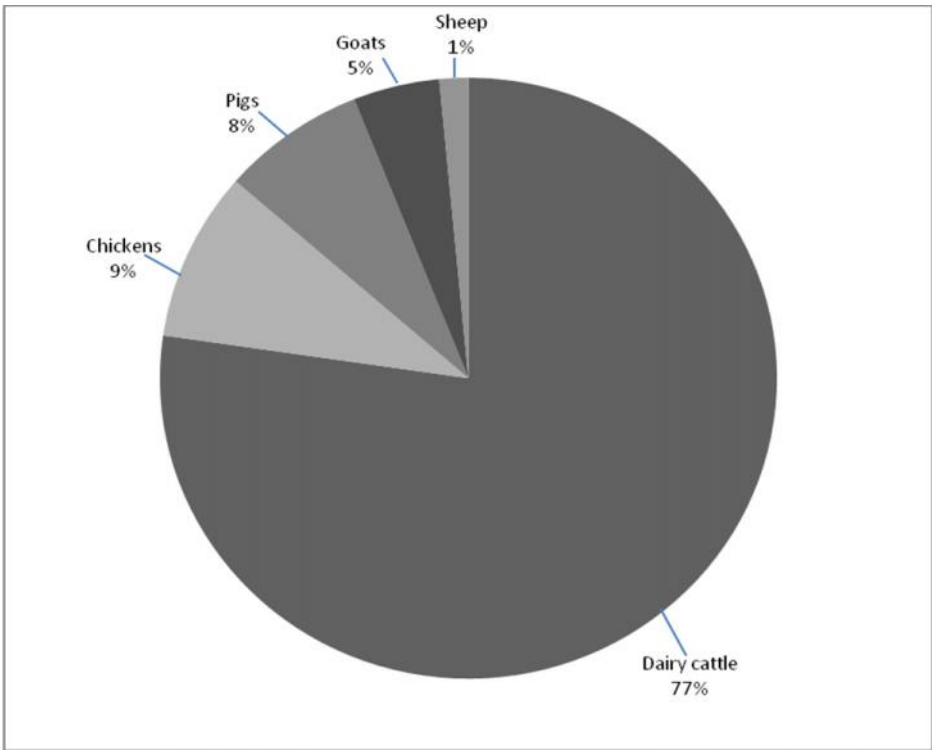

Figure 2: Types of animals kept in households involved in the study in Morogoro Municipality, Tanzania.

Practices with Respect to Management of animal Wastes

Respondents were asked about their understanding of what constitutes animal wastes, and all of them defined animal waste as a mixture of faeces, urine and feed remains. About ten percent (9.9%) also considered bedding to be part of animal waste. It was also observed that in most (79%) of the study households, the activities related to animal waste management were undertaken by hired male labourers and the wives (8%) while the participation of other members of the family was minimal (Figure 3).

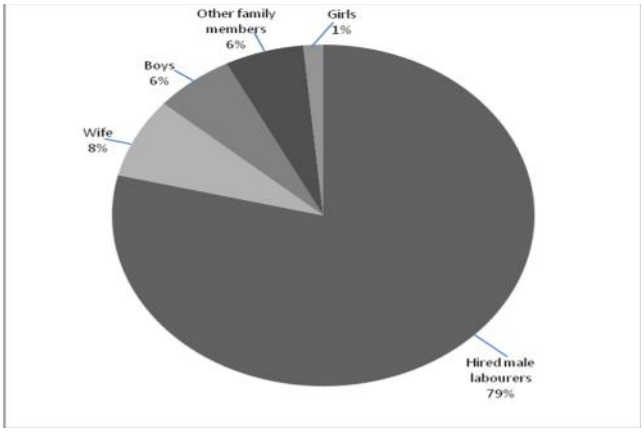

Figure 3: Family members involved in waste management activities in the study households in Morogoro Municipality, Tanzania.

The study revealed that animal wastes in all the livestock units were collected using a spade and wheelbarrow and that in all cattle, goats and sheep sheds the wastes were collected once per day. Of the 17 pig-keeping households, 15 of them collected wastes once per day and in two units wastes were collected once per week. Chicken keepers collected wastes once per month. The main reasons given for collection of animal waste were to maintain proper house hygiene (73%), replacement of beddings (20%) as indicated in Figure 4. The study also revealed that 86.4% of the respondents used protective gear during handling of animal wastes while 13.6% of them did not.

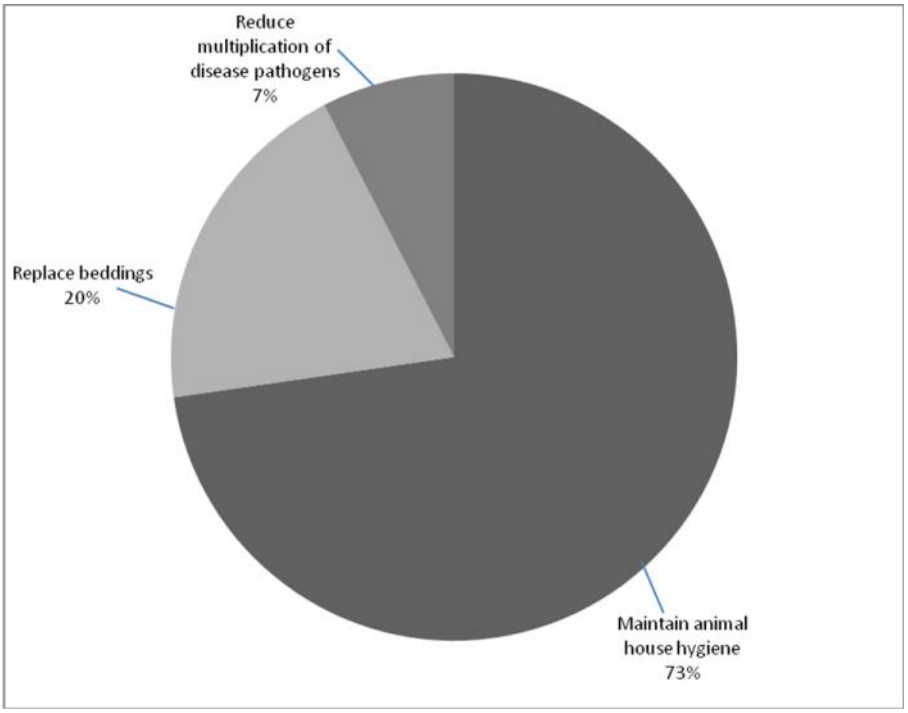

Figure 4: Reasons for collection of wastes from animal sheds as stated by respondents in the study households in Morogoro Municipality, Tanzania.

The types of protective gears used were gumboots, gloves and nose masks with gumboots being the most commonly used gear (Table 2). Those who did not have protective gears mentioned the lack of funds as the main reason for failure to acquire the gear.

The study revealed that the majority of livestock keepers (91.0%) stored animal wastes as a heap near the animal sheds (Table 2). All the respondents did not treat the wastes before disposal, and wastes were left to decompose naturally. The disposal methods for the wastes included direct spreading on crop farms (62%) and throwing at any open space or by the roadside (24%) as shown in Figure 5. It was also observed that all carcasses were disposed by burying. There were a number of reasons given for disposal of animal wastes in a particular way. Those who spread the wastes on crop farms (62.1%) aimed at improving soil fertility. Burying the waste in the ground (3.0%) was adopted to reduce transport costs while lack of plots or farms forced some people (34.8%) to throw waste at any open space.

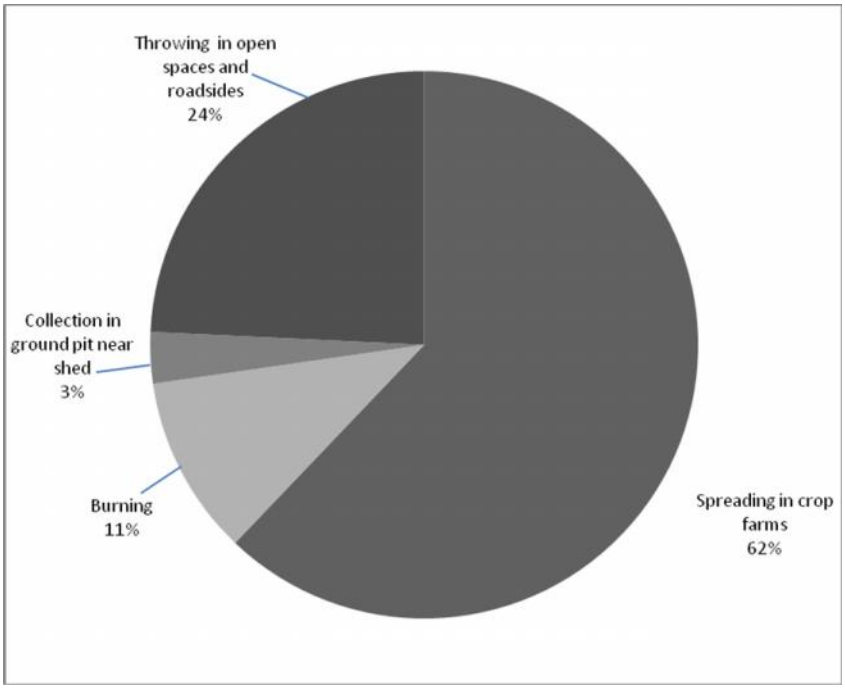

Figure 5: Methods of disposal of animal wastes practiced by respondents in study households in Morogoro Municipality, Tanzania

Majority (83.3%) of the respondents stated that they had adequate land for waste disposal while 16.7% of them stated that they did not have enough land. It was further observed that those who had sufficient land had farm sizes between 0.25 - 5 acres and most of the farms were located more than one kilometer from the livestock units. However, although land was available for waste disposal, livestock keepers failed to take wastes to the farms because of high transport costs. Therefore, a lot of waste was left to accumulate near animal houses within the residential areas. Livestock keepers who did not have adequate land disposed the animal wastes at any open space and along the road sides.

Regarding problems encountered during the management of wastes, only 10.6% of the respondents stated that they encountered problems while 89.4 % stated that they did not encounter any problem. Those who encountered problems mentioned lack of facilities for handling animal wastes such as wheel barrows, lack of protective gears and lack of transport for ferrying waste from the site of generation to the crop fields. Conflict between livestock owners and their neighbours was mentioned as another problem by 4.5% of the respondents. The source of the conflicts was the excessive accumulation of animal wastes and the offensive odour from decomposing manure heaps, both of which were considered to be sources of nuisance and public health risks to the neighbours.

Table 2: **Handling and storage of animal wastes in livestock keeping households in Morogoro Municipality, Tanzania**

Methods handling and storage of animal wastes	Respondents (n = 66)	
	Number	**Percent**
Use of protection gear		
Practised	57	86.4
Not practised	9	13.6
Types of protective gear used		
Gum boots	66	100
Gloves	14	21.2
Nose masks	7	10.6
Method of storage of wastes		
Heap near animal house	60	91.0
Transport to crop farm	4	6.0
Collect in ground pit near animal house	2	3.0
Problems encountered during waste management		
Lack of protective gear and transport facilities	63	95.5
Conflicts with neighbours	3	4.5

Table 3 shows the different options for utilization of animal wastes in the study households. Majority of the respondents (98.5%) stated that they were aware that animal wastes were useful while 1.5% of the respondents did not consider animal wastes to be useful. The use of animal wastes mentioned by majority of the respondents was as organic manure (97.0%) and biogas production (3.0%). The manure was used especially for maize and banana plots because these were the main crops grown in the urban and peri-urban areas of Morogoro Municipality. It was also observed that that only 10.6% of the respondents sold the animal manure while the majority (89.4%) of them did not. In some households, poultry manure was packed in 100 kg bags for sale. The price of the manure varied, with two of the seven farmers selling at TZS 15,000.00 per tonne, three farmers sold at TZS 5,000.00 per 0.5 tonne and two respondents sold at TZS 500.00 per 100 kg.

Table 3: Practices with respect to utilization of animal wastes in livestock keeping households in Morogoro Municipality, Tanzania

Methods handling, storage and disposal	Respondents (n=66)	
	Number	**Percent**
Awareness on usefulness of animals wastes		
Aware	65	98.5
Not aware	1	1.5
Means of utilization of wastes		
Organic manure	64	97.0
Biogas	2	3.0
Sale of manure		
Manure sold	7	10.6
Manure not sold	59	89.4

Awareness on legislation governing animal waste management

Majority of the respondents (87.9%) were not aware of legal instruments such as legislation, rules and by-laws governing animal waste management, while only 12.1% of the respondents stated to be aware of such instruments. However, the ones who responded that were aware of the legal instruments failed to mention the specific by-laws or guidelines governing animal waste management. All the respondents admitted that it was their responsibility to ensure that animal wastes were properly managed in order to safeguard the environment and public health.

Perceptions on public and environmental health risks associated with animal wastes

The study also revealed that 54.5% of the respondents were aware of public health risks associated with animal wastes, while 45.5% of them were not aware of such risks. The main public health risks mentioned included skin infections like dermatomycoses (78%) and contamination of food and water predisposing people to helminth infections and diarrhea (17%) as shown in Figure 6. Other respondents mentioned allergy and respiratory problems due to inhalation of dust and hair particles from beddings as well as penetration of disease pathogens through wounds or abrasions, predisposing people to diseases like tetanus.

The study revealed that 59.1% of the respondents were aware of environmental risks caused by improper management of animal waste while 40.9% were not aware of such risks. All the respondents that were aware of environmental risks caused by animal wastes mentioned air pollution as manifested by bad smell as the major risk caused by improper disposal of wastes on the environment. Although some of the livestock units (7.6%) were very close to water sources, yet respondents did not single out water pollution as one of the risks caused by animal wastes on the environment.

The study further revealed that all the respondents did not receive any training on animal waste management. A few respondents stated that they received some training on the potential role of animal wastes in transmitting zoonotic pathogens such as Campylobacter and Salmonella through contamination of meat and eggs.

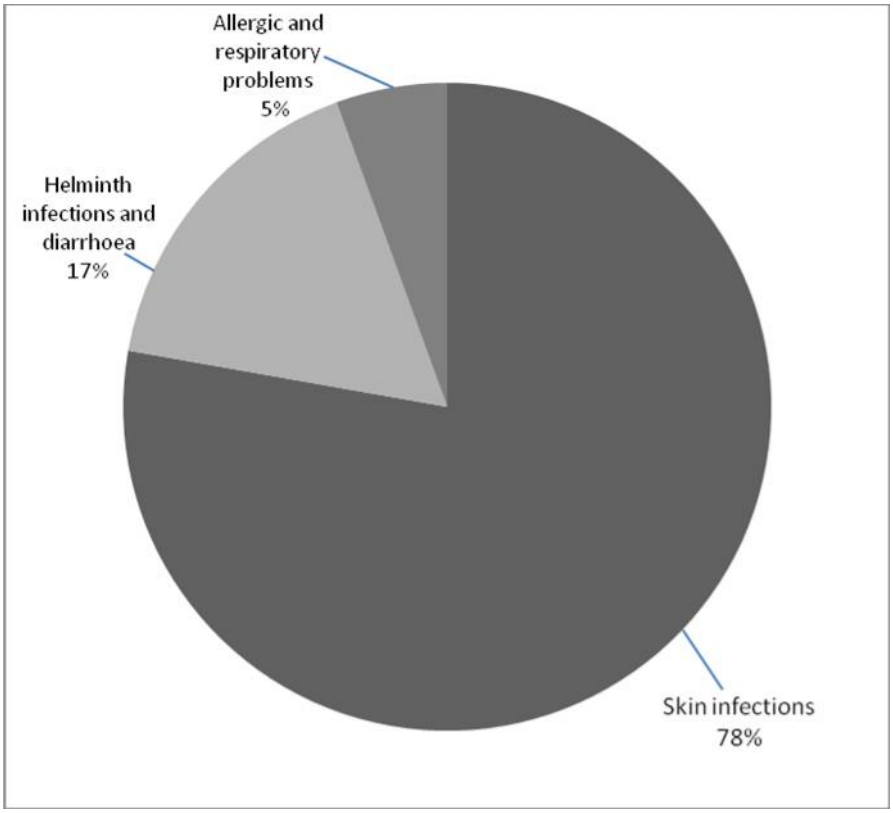

Figure 6: Types of health risks associated with handling of animal wastes as stated by respondents in the study households in Morogoro Municipality, Tanzania.

DISCUSSION

The present study has shown that livestock keeping in the study area is undertaken under a space-constrained environment because the urban plots were originally earmarked for residential purposes only. Large amounts of animal wastes are generated in the livestock units and because of shortage of land; problems of waste disposal have arisen. Collection of animal wastes in the study area was done manually by using a spade and wheel barrow, and in majority of livestock keeping households wastes were piled on the ground near the livestock and residential houses because of lack of space for disposal of wastes. This practice was also reported to being common in the Dar es Salaam City (Sawio, 1998). The problem of management and disposal of animal wastes has been also reported in other countries (Taiganides, 1977; Hammond, 1997).

As observed in other studies, the capacity of most livestock keepers to collect, recycle and compost waste is inadequate leading to accumulation of untreated waste in the environment (Sawio, 1994). This,

in turn, results into environmental pollution as well as nuisance in the form of offensive smell to urban residents (Mackie et al., 1998). Other workers have reported that animal wastes can be a source of water pollution (Van de Wel, 1995; Kiyonori, 2007). Some livestock units in the study area were built close to water sources and these posed a risk of contamination when wastes are washed or drain into the water sources. The release of animal wastes into water bodies promotes algal growth, limiting light penetration and encouraging growth of aquatic vegetation. This, in turn, reduces oxygen levels in the water thereby adversely affecting the life of fish and other aquatic organisms (Williams, 1995; Copeland, 2007). Accumulation of organic matter in water causes pollution and this form of pollution can be a factor in eutrophication of water bodies (Kuberle, 2005).

In order to minimize the negative effects of animal wastes on the environment, there is a need of promoting suitable composting technologies in order to enable farmers to transform the waste into a valuable agricultural input. Compost is a rich source of organic matter that provides nutrients to plants and improves the physico-chemical and biological properties of the soil (Anon, 2006; FAO, 2007b). This would also assist in reducing offensive odour originating from anaerobic decomposition of liquid slurry (Hobson and Robertson 1977). It was observed in this study that the livestock keepers used animal wastes as organic manure as also reported by workers in other parts of the country (Jackson and Mtengeti, 2005). Organic manure has many beneficial effects such as improving soil structure and holding capacity of the soil apart from furnishing plants with important nutrient such as nitrogen and phosphorous (Hammond, 1997). Animal wastes are also used in biogas production although biogas production in the study area was limited. It has been observed by Rutamu (1999) that utilization of biogas can alleviate work load for women because they will no longer collect fuel wood if they use biogas.

Disposal of animal wastes by burning causes environmental pollution by emission of noxious gases in the atmosphere. Incineration, if properly done tends to reduce the extent of air pollution caused by burning of animal wastes. Livestock keepers experienced conflicts with their neighbours because nuisance caused by noise and offensive smell from livestock units as well as drainage of wastewater from the livestock units to neighbours' plots. This observation has also been reported by workers in other countries (Mackie et al., 1998).

The study also demonstrated that high costs required for transportation of animal wastes to the crop fields constrained the farmers' efforts of

removing manure from residential areas. Jackson and Mtengeti (2005) reported that in the Southern Highlands of Tanzania, factors such as the distance of the crop fields from homesteads and high labour costs influenced the extent of manure utilization. Other problems reported by respondents were lack of protective gear when working with wastes such as masks. This probably reflects on lack of knowledge on the public health risks that may be associated with handling animal wastes and, which underscores the need for educating the livestock keepers on such risks (Mlozi, 1996; Mlozi and Hella, 2001).

It was established by the study that a considerable proportion of respondents (42.4%) were not aware of the public health risks associated with handling animal wastes. This implies that such people and their families may be at risk of acquiring infections originating or transmitted through animal wastes especially when appropriate precautions such as use of protective gear are not taken. It has been well established that animal wastes harbour a lot of pathogens that can cause disease to humans and animals (CDC, 2007a; 2007b; Adesiyun et al., 1996; Mudorch, 2007; FAO, 2007a). That cow dung is a potential source of tetanus is well-recognized in Tanzania (Mlozi, 1996). Therefore, all people involved in handling of animal wastes need to be aware of such facts if transmission of disease has to be prevented. Furthermore, this observation calls for the need to initiate training programmes for animal waste handlers in order to safeguard their health and that of the community.

The study revealed that only a small proportion of people involved in livestock production activities and handling animal wastes were aware of legislation governing livestock keeping and waste management in the country. Moreover, despite the knowledge of existence of such by-laws, most of the people did not adhere to them. Other studies have reported that there are by-laws enacted specifically for regulating livestock keeping in urban and peri-urban areas in Tanzania. For example, The Town and Country Planning Ordinance (CAP 378), Urban Farming Regulations, 1992 (Government Notice No. 10 of 05/02/1993) stipulates regulations for practising agriculture in urban areas of Tanzania. The Local Dar es Salaam City (Animals in the City Area) by-laws of 1989 stipulate the conditions and standards for keeping animals in the City area (Sawio, 1998). Other Town and City Councils also have by-laws that regulate urban farming. The legislation requires livestock keepers to take full responsibility in disposing the wastes from their livestock units (Sawio, 1994). Despite the existence of such by-laws, animal wastes are found piled up in residential areas implying that by-laws and regulations are not enforced by relevant authorities. This calls for more

education of the people on by-laws and ensuring that they are enforced by relevant authorities.

It can be concluded from this study that, animal waste management will remain to be a challenge in the study area because livestock keeping is still growing rapidly as a socio-economic activity and a lot of waste is generated. The lack of education on proper waste management methods and the potential risks of animals to environmental and public health was a contributing factor to indiscriminate disposal and unsatisfactory waste management. This was further compounded by ineffective enforcement of legislation regulating livestock keeping and waste management in urban and peri-urban areas. In order to minimize the environmental and public health risks posed by poor animal waste management, it is recommended that public education programmes be initiated to educate livestock keepers on proper animal waste management techniques and prevention of adverse impact on the environment and public health. It is further recommended that municipal authorities should establish and enforce legislation that regulates urban livestock keeping in order to safeguard the environment and public health. Promotion of the use of composting techniques would minimize nuisance emanating from animal waste in the form of offensive odour in addition to providing good quality organic manure for crop production. Livestock keepers should be encouraged to use animal wastes for biogas production, which is a useful alternative source of cheap energy as well as production of odourless slurry for manuring crop fields. It is also recommended that, more detailed studies be undertaken to quantify the impact of waste on the environment, particularly on contamination of water sources and its role in transmission of zoonotic diseases.

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