Current manure management practices and hygiene aspects of urban and peri-urban livestock farming in Tanzania

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Abstract

The recent expansion of urban and peri urban livestock farming has resulted in close contact between animals and humans, sometimes with adverse human health effects. A survey involving 119 cattle keeping households in urban and peri-urban settings of Morogoro,

Tanzania revealed that manure management practices were different from traditional practices mainly due to lack of land. Manure was collected and conveyed by using tools by 94% of respondents, while others used water or bare hands. Seventy six percent of respondents collected manure from animal houses at least once a day, a feature that was associated with housing characteristics ($p<0.05$). Heaping was a common manure storage method although other cattle keepers directly spread manure on land. Manure was disposed of within residential area by 70% of respondents and this practice was associated with land area owned by or under control of the households ($p<0.05$). The current manure management practices did not protect either humans, animals or the environment against the risk of contamination with potential zoonotic pathogens and therefore there is a need for the formulation of guidelines on safe manure management practices.

Keywords: environment, hygiene, manure management, peri-urban, urban

Introduction

Manure is largely composed of animal excreta (faeces and urine) that is mixed up with water, beddings and secretions from nose, throat, vagina and mammary glands (Pell 1997). Recovery of pathogenic bacteria in freshly voided animal faeces shows that manure is a potential source of zoonotic pathogens contaminating the environment and represents a risk for further transmission to human (Losinger et al 1997, Pell 1997, Crump et al 2002, Guan and Holley 2003, Johnson et al 2003, Hutchison et al 2004, Hutchison et al 2005, Heuvelink et al 2007). Studies have reported cases of human gastroenteritis due to bacteria enteropathogens of animal origin following

consumption of contaminated food or water or direct contact with infected animals in farms (Kapperud et al 2003, Merritt and Herlihy 2003, Hendriksen et al 2004, Smith et al 2004).

In the last few decades urban and peri-urban farming in developing countries has been progressively increasing. Its emergence and expansion not only came as a survival strategy due to reduced income and living standards (Briggs 1991, Mlozi 1996, 1997a, Mvena 1999, DFID 2002) but also as a diversification strategy to spread livelihood risks in adverse situations (DFID 2002, Simon et al 2004). Some urban and peri-urban dwellers continue to keep livestock to maintain their rural cultural values (Mlozi 1996, Mvena 1999). As a consequence of the increase, both the number of animals kept and the number of households keeping animals has increased. Urban areas of Morogoro, Tanzania, for example had a cattle population of 2,618 in 1996 (URT 1997), which almost doubly increased to 4,170 in 2006 (URT 2007). In 1984 the city of Dar es Salaam urban had 1,763 crossbred dairy cattle (MALD 1988) but by the end of 1993 the cattle population in the urban wards of the city was reported to have increased to 14,721 (Mlozi 1997b). Rapid urban population growth and demand for animal protein has provided a boost to urban and peri-urban farming (Briggs 1991, Simons et al 2004).

Before the expansion of urban and peri-urban livestock farming, free open grazing practices required minimal effort to manage manure (DFID 2002, Powell et al 1995). Increased animal population has led to an increase in manure production in urban and peri-urban areas and hence a demand for proper handling practices. However, it is currently not known how the manure management practices have changed to adapt to densely populated areas where the space separating humans from animals and their wastes has decreased. Therefore this study aimed at determining the current manure management practices in urban and peri-urban areas of Morogoro region of Tanzania as a basis for developing strategies to improve urban and peri-urban farming practices that safeguard human and animal health.

Materials and Methods

Study area

This study was conducted in urban and peri-urban areas of Morogoro region of Tanzania. Morogoro region typifies the relationship between dense urban populations as potential market with expanding urban and peri-urban livestock farming as source of food and income. Three districts of Morogoro region constituted the study area and included Morogoro municipality, Morogoro rural and Mvomero. Morogoro region is located between latitude 5^{o} 58" and 10^{o} 0" S and longitude 35^{o} 25" and 35^{o} 30" E. Ambient temperature ranges between 18^{o}C and 30^{o}C. The annual rainfall ranges between 600 mm – 1200 mm (URT 1997).

Study design and selection of households for the study

A cross-sectional survey was conducted from February to September 2010. The study involved 119 cattle keeping households. Participants were selected from a list of 367 cattle keeping households obtained from the District Livestock Development Offices. Simple random sampling of the households was carried out by use of “rank and index” functions in Excel software. This

method assigned a unique random number to each of the listed households and selected a required number of households without repetition. Five out of 119 cattle keeping households that withdrew from the investigation were replaced by a random selection of new households within the list of cattle keeping households.

Data collection and analysis

Interviews with cattle keepers using semi-structured questionnaires and personal observations using a guide were the main tools to gather information on herd and manure management practices in the selected urban and peri-urban livestock keeping areas of Morogoro. Additionally, face to face interviews with District Livestock Development Officers about herd and manure management practices were carried out. The developed questionnaire aimed at gathering information on (1) herd characteristics and management, taking into account labor division, herd size, presence of animal species other than cattle, type of animal house roofing, floor, feeding system and history of cattle treatment; (2) manure management practices, including means, frequency and form of manure collection, storage, means and distance of manure disposal and household area and (3) awareness on zoonotic enteropathogens. Moreover, the guided interviews with District Livestock Officers from Morogoro Municipality, Morogoro Rural and Mvomero focused on existing guidelines and their monitoring of manure handling practices in their respective areas. Some of the officers produced information materials e.g. "Environmental Sanitation By-Laws" and "Animals in Urban areas By-Laws" that give directives on animal keeping in the areas and how to deal with wastes including manure.

Data were analyzed using SPSS 15.0 such that means for continuous variables and frequency of occurrence of variable factors for categorical variables were computed. Associations between all possible combinations of categorical variables were analyzed by Pearson's Chi-square test at significance level of 5%.

Results

Herd characteristics and management

From the observation and questionnaire, 119 research participants owned a total of 806 cattle (minimum = 1, maximum = 36, mean= 7, median= 5, SD = 5.85). Among the respondents 95.8% kept animals other than cattle within the same premises including chicken (80.7%), dogs (62.2%), goats (50.4%), pigs (27.7%), ducks (23.5%), cats (21.9%), sheep (10.9%), guinea fowls (9.2%), turkeys (5.9%), guinea pigs (1.7%) rabbits (1.7%) and monkey (0.8%).
It was noted that two different groups of people, namely family members and paid labourers were engaged in management of manure. The proportion of cattle keeping households in the study area that used paid labourers to handle manure and execute other routine farm activities such as feeding cattle, cleaning cattle houses and milking slightly exceeded the proportion in which only family members took care of cattle (Table 1).

A large proportion of animal houses were roofed, either by thatch grass or corrugated iron sheets compared to the less popular open cattle pens (*kraal*) (Table 1). In the open cattle pens rainwater

wet the soil and animals spent the nights in mud until the sun dries out the soil. This was the case in a few animal houses whose floor was made of earth in contrast to a large percentage of animal houses with concrete floor (Table 1). Only three respondents were observed to put grass on the floor of animal house as bedding material, among them, one had a house with earthed floor (Table 1). All respondents kept their animals in a confinement near to their residential area for security reasons.

The cattle were fed in different ways with less than half of cattle being kept in-door and fed by a "cut and carry" method, while the others had to move around foraging (Table 1). A relative small fraction of cattle, mostly free range cattle used surface water such as rivers, ponds and wells while most of cattle were provided water from taps also serving the people (Table 1).

Table 1. Herd management practices among 119 urban and peri-urban cattle keepers

Variable	Category	Frequency (%)
Manure responsible person	Family member	55 (46.2)
	Paid laborer	64 (53.8)
Animal species other than cattle	Present	114 (95.8)
	Absent	5 (4.2)
Animal house roofing	Roofed	100 (84.0)
	Un-roofed	19 (16.0)
Animal house floor	Concrete	85 (71.4)
	Earth	34 (28.6)
Bedding	Present	3 (2.5)
	Absent	116 (97.5)
Animal feeding system	Zero-grazing	56 (47.0)
	Out-door	63 (53.0)
Animals' water source	Tap	71 (59.7)
	Surface water	48 (40.3)

Manure collection, conveyance, disposal and knowledge on enteropathogens

During the night all cattle were kept in enclosures with accumulation of manure. Before discard, manure was collected by bare hands by a few respondents with direct contact to the manure. However, the majority of respondents used utensils such as spades, hand hoes and rakes to collect manure into a pile within the animal house. It was also observed that some respondents used a water hose to collect manure (Table 2). Irrespective of the manure collection method, people did not use any protective measures such as special clothes or gloves and were observed to have direct skin contact with manure. The majority of respondents collected manure at least once a day (Table 2).

After collection into a heap, manure was moved to storage area either by bare hands or water splash by a small number of respondents while the majority used utensils such as spade, bucket, wheel barrow, plastic bag or raw hide (Table 2). Storage of manure in heaps for sometime before disposal was a common practice among many respondents although it was observed that a few of them directly spread manure from animal houses into the surrounding environment (Table 2).

Some cattle keepers used manure as fertilizer, especially those owing large piece of land while others did not use manure as fertilizer at all. However, in both cases, most respondents spread manure direct on land as the preferred way of disposal (Table 2). Respondents who did not

spread manure on land opted for burning or giving it away to friends in plastic bags. Most cattle keepers disposed the manure either as fertilizer or waste within a radius of 10 m from their residential house (Table 2).

The use of rubber boots was an observed practice by less than a half of respondents while the remaining fraction wore ordinary shoes e.g. sandals while handling manure (Table 2). There was a tendency for a large proportion of livestock keepers to allow effluent from animal house to spread freely on the surrounding land except for a few respondents who directed the effluent into a pit (Table 2). The size of the area owned and used by households is of interest from hygiene perspective as human and animals shared such land. It was observed that respondents who had more than 1000 m^2 of land were in large number compared to those living on less land (Table 2)

When asked about their knowledge on pathogens associated with manure respondents revealed that they have never heard about such pathogens except for a few respondents who were aware that there could be enteropathogens in manure that may cause enteric diseases (Table 2).

Table 2. Manure management practices among 119 urban and peri-urban cattle keepers

Variable	Category	Frequency (%)
Manure disposal method	Spread on land	108 (90.8)
	Not spread on land	11 (9.2)
Manure collection means	Hand picking	5 (4.2)
	Use of utensils	112 (94.1)
	Water splash	2 (1.7)
Frequency of manure collection	Once a day	72 (60.5)
	More than once a day	19 (16.0)
	Weekly	28 (23.5)
Manure conveyance means	Hand picking	3 (2.6)
	Use of utensils	115 (96.6)
	Water splash	1 (0.8)
Use of rubber boots	Yes	70 (58.8)
	No	49 (41.2)
Manure treatment	Heap	99 (83.2)
	Direct spread on land	20 (16.8)
Disposal distance	Within 10m	83 (69.7)
	Outside 10m	36 (30.3)
Effluent treatment	Direct spread on land	95 (79.8)
	Pit	24 (20.2)
Household area	> 1000 m^2	87 (73.1)
	≤ 1000 m^2	32 (26.9)
Ever heard of pathogens in manure	No	113 (95.0)
	Yes	6 (5.0)

Relationship between animal keeping and manure management practices

There were associations between herd characteristics and management and the way that manure was handled. For instance, the type of animal house roof was related to the type of animal house floor such that roofed animal houses had concrete floors while roofless houses had floors made of earth ($p<0.001$). These animal house characteristics were significantly associated with the frequency of manure collection from the animal houses, i.e. manure was collected at least once a day for roofed animal houses that had a concrete floor ($p<0.001$). On the other hand, manure storage practice was associated with the size of land under control of the household. Households with an area equal or less than 1000 m^2 had to keep manure in heaps before disposal whereas

respondents with land areas more than 1000 m^2 spread manure from animal houses directly onto the surrounding land ($p=0.015$). The source of water for cattle was found to be significantly associated with the type of animal feeding system. Zero grazed cattle were given tap water that was also used by humans while cattle foraging outdoor used surface water such as ponds, river and boreholes ($p<0.001$). When herd size was transformed into a categorical variable, it was found that herds with more than five cattle were mostly grazing outdoor while herds with five or less cattle were zero grazing ($p=0.009$).

Discussion

The diverse manure management practices of the cattle keepers in the study area were determined by customs and convenience. Some farmers said that they handled the manure by the same methods since childhood; others opted for a particular manure management method because it was easy to execute. A number of farmers did not use protective measures and equipment to handle manure because of the associated costs. The differences in manure management practices and lack of hygienic protective measures among cattle keepers underlines the need for disseminating information on proper handling of animal wastes to guide farmers on safe collection, conveyance, storage and disposal of manure. For instance, according to Morogoro Municipal Council (2002, 2010), manure is regarded as solid waste that is treated like any other household waste, but there does currently not exist any guidelines or regulations on proper manure management in Morogoro region or elsewhere in Tanzania .

Manure management guidelines in other parts of the world have centred on reduction of environmental pollution, in particular eutrophication of aquatic recipients, and improvement of nutrient availability to crops. Guidelines have so far not addressed the health of personnel who handle manure at farm level or those living in areas with urban livestock. A guideline of manure management in Asia by IAEA (2008) aims at making manure handling easier, decreasing odours and water and air pollution as well as promoting production of biogas and more valuable organic fertilizer. Also manure management guidelines by Ohio State University Extension (2006) and Nova Scotia (2006) inform farmers on how to utilize manure as valuable fertilizer and energy source while at the same time protecting the environment. In general there does not seem to exist guidelines in neighboring African countries that provide livestock keeper's information on sustainable manure management, in particular for urban livestock keeping. The guidelines developed for Asian, European or American farmers are of little relevance and not addressing the problems and challenges faced by livestock keepers in urban and peri-urban settings of developing countries like Tanzania (Mlozi 1996).

The current manure management practices seen in Morogoro differ from the way manure was handled a few decades ago. Before urban and peri-urban livestock farming intensified and became more commercial manure management did not require much effort by the farmers. For instance in a neighboring city of Dar es Salaam, animals spent daytime foraging and dropping manure everywhere, while manure accumulated during overnight confinement was left to decompose in house compounds, live hedges or open spaces or thrown in streams or along road sides for it to be washed away by rain or sometimes applied on crop plots (Shauri 1989, Mlozi 1997b, DFID 2002). This practice happened before transition from specialization (free open

grazing) to integration (confined zero grazing and crop growing), where by the former did not call for special manure handling practices compared to the later farming system (Powell et al 1995). Reports by Mlozi (1996 and 1997b) revealed that an increased manure production in populated urban and peri-urban areas of Dar es Salaam has led to scarce area for disposal, such that decomposing manure produced odour and favoured breeding of pathogens and flies. These detrimental effects of manure handling practices in urban and peri-urban areas come as a result of land scarcity and poor manure handling infrastructures because urban and peri-urban livestock farming was not integrated in planning process of towns like Morogoro, Dar es salaam, Dodoma and Mbeya (Mvena 1999).

Animals such as cattle, sheep and goats have been reported as potential reservoir of zoonotic pathogens most of which reside in the gastrointestinal tract and are voided in faeces (Crump et al 2002, Mersha et al 2010, Cobbaut et al 2009). For instance, Kang'ethe et al (2007) isolated *E. coli* O157:H7 from cattle faeces in urban and peri-urban settings of Nairobi. Cases of human infection by pathogens associated with manure due to either contact with infected animals or consumption of contaminated animal products are common (Germani et al 1997, Crump et al 2002). Manure-associated pathogens may be introduced into different places in the food production chain. Nonga et al (2009) reported thermophilic campylobacter prevalence of 5.6% from faeces of slaughtered cattle, 9.3% of dressed carcases at abattoirs and 1.9% in beef sold in meat shops in the city of Morogoro. Other studies (Hiko et al 2008, Abdul-Raouf et al 1996, Benkerroum et al 2004, Kang'ethe et al 2007) have reported the isolation of a number of pathogens in food products of animal origin. The trend of pathogen contamination seems to build up through the food chain from animal at farm level to food products. It is evident from our results that lack of proper manure handling is associated with quite substantial faecal contamination of the environment and thus putting human and other animals at risk of infection particularly those associated with enteropathogens. Livestock keeping and manure management in peri-urban and urban areas with high densities of animals and humans demands development of guidelines and enforcement of regulations on proper hygienic manure management practices that reduce faecal contamination of the environment and protect human health

It was shown that a large proportion of respondents were not aware that manure may contain a variety of pathogens hazardous to human and animal health. Similar lack of knowledge was reported by Mlozi (1996) among livestock keepers in urban and peri-urban settings of Dar es Salaam where the farmers had little knowledge about pathogens and associated risks. Thus it is clear that the current manure management practices of cattle keepers in Morogoro region did not aim at preventing any transmission of pathogens between human, cattle and environment or other ways to protect human and animal health.

The study by Kang'ethe et al (2007) in urban and peri-urban areas of Nairobi reported that manure handling was a risk factor for human infection and pointed out that the use of protective gear during manure handling could reduce the infection risk. Thus it is likely that the cattle keepers in our study area were at increased risk of infection because they neither wore gloves nor protective clothing during manure handling. Our findings call for further research to document the occurrence of pathogens in cattle manure, occupational health hazards for livestock keepers, their families and others living in peri-urban and urban areas where livestock are kept to

establish effective guidelines and regulations that protect human health while at the same time recognizing the socio-economic benefits of urban livestock keeping.

The association between certain manure management practices and household conditions, as elucidated in this study, could be used to improve manure management practices. Improving the animal house by putting concrete floor and a roof was found important in relation to increasing the frequency of manure collection from the animal house to at least once a day. Additionally, it has been reported by Lekasi et al (2003) and Rufinol et al (2007) that improved animal houses such as that with a roof, concrete floor and good drainage reduce loss of manure and retain higher phosphorus and nitrogen content the same as when manure heaps are covered with polythene films. Therefore, improving animal housing infrastructures may not only ease manure handling workload, but is also likely to protect human, animal and environmental health while retaining the fertilizer value of the manure.

Conclusion

- The current manure management practices differ from those methods employed a few decades ago in both the actual practices and resource base available that is shared by human, animals and manure. Increased manure production in a shrinking space force cattle keepers to collect, convey, store and finally dispose manure. In the course of this process, human and environment are put at risk of pathogen contamination. Therefore there is a need to design manure handling practices that suits the available land resource at the same time safeguarding human, animals and the environment.

Acknowledgment

This study was conducted under the project “Opportunities and Challenges in peri-urban livestock farming in Tanzania” under the collaboration of Sokoine University Agriculture (Tanzania) and University of Copenhagen (Denmark). The authors wish to thank the Ministry of Foreign affairs of Denmark through the Danish International Development Agency (DANIDA) for financial support. We acknowledge the cooperation from offices of Regional commissioner Morogoro, Mvomero and Morogoro district commissioners, district Executive Directors for Mvomero, Morogoro rural and municipal councils. We acknowledge participation of cattle keeping households and extension staff in urban and peri-urban areas of Morogoro.

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Received 18 July 2012; Accepted 13 August 2012; Published 3 September 2012