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Concerns Related to Health Hazards from Livestock Waste

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Abstract

Livestock rearing is an important component in the rural India and domestic and commercial livestock are cows, buffalo, sheep, goat, pigs, rabbits, poultry etc. Huge amount of livestock waste is mostly handled by traditional way. Waste from animal production sites can greatly affect the surrounding environment, leading to increases in greenhouse gas emissions and decreases in water and air quality. Waste management practices can also determine the health of the animals, affecting the spread of disease between animal production sites and from animals to humans. The knowledge about livestock faecal pathogens, livestock waste & environment and health concerns of livestock wastes is crucial for control and prevention of transmission of such zoonotic faecal pathogens. The rapid growth of livestock production highlights the urgent need for effective policies to regulate intensive livestock operations and support environmentally and economically sustainable approaches to handling waste.

Keywords: Livestock; Waste; Environment; Quality; Health Hazards.

Introduction

Livestock rearing is an integral part of the Indian culture and is an important component of the agriculture and economic activities. The domestic and commercial livestock includes cattle, buffalo (heifer), sheep, goat, camel, pig, chicken, etc. In India, cattle and buffalo produce more than 70% of total excreta production annually. About 50% of cattle dung is used for the preparation of dung cakes used as fuel in rural India. The remaining 50% is a serious health hazard for the communities living in the vicinity and consuming contaminated water due to this large quantum of excreta.

India has topped a list of countries worst-affected by zoonotic diseases with widespread illness and death. Globally, 60% of all human diseases and 75% of all emerging infectious diseases have been found to be zoonotic. The International Livestock Research Institute (ILRI), Kenya and the Institute of Zoology, UK reported that most of these human infections were acquired from the world's 24-billion livestock. The study showed that 27% of livestock in developing countries like India showed signs of current or past infection with bacterial food-borne disease — a source of food

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contamination and widespread illness. While a lot of focus is being given on human excreta for the prevention and control of mortality and morbidity of humans, but very little attention or effort is paid for controlling and proper management practices for the animal excreta, which also pollutes the environment equally, if not more. It was therefore thought worthwhile to conduct a literature survey to understanding the health concerns of livestock waste and various diseases of zoonotic origin.

1. Wastes generated in Livestock farms

A waste is a resource remaining unutilized or a resource out of place. In India livestock waste is mostly handled by traditional way. India has vast resource of livestock and poultry, which play a vital role in maintaining and improving the socio-economic conditions of rural masses. The livestock sector utilizes large volume of agricultural byproducts including crop residues and converts these into nutrient rich animal products. Manure should promptly and completely be removed from the sheds so that it may not cause any disease. It should be well conserved so that it may not loose plant nutrients. Cattle dung has 77.5% water, 20.3% organic matter, 0.34% nitrogen, 0.16% phosphoric acid, 0.40% potash and 0.31% lime. Others are food waste like slaughterhouse waste, hatchery waste and dead animal carcasses pose threat on bio-security aspect of human and animal population.

Sr. No.	Species/animal	Total excreta /annum (million tons)
1.	Cattle	1152.76
2.	Buffalo	471.41
3.	Sheep	31.69
4.	Goat	50.52
5.	Pig	13.85
6.	Horse and Ponies	3.10
7.	Poultry	27.95
Total excreta production/annum (million tons)		1750.35

Non-green food waste:

Dead animals, dead poultry, slaughter house waste (birds and animals), hatchery waste, dead fishes and fish processing waste are non-green food waste, which are rich in nitrogen and adequate care should be taken to handle. The bio-security aspect of handling such waste is of serious concern. Improper handling of waste leads to obnoxious odor, fly problem and spread of diseases.

2. Livestock Faecal Pathogens

The main livestock are dairy and beef cattle, swine, sheep and poultry. Faeces from each livestock species contains a varied population of normal gut flora and pathogens, and represents risk to human health.

Cattle: Cattle, both dairy and beef, are present in high numbers around the world. The cattle pathogens likely to cause risk to human health are: E. coli, Campylobacter, Salmonella, Cryptosporidium parvum, and norovirus.

Swine: The enteric pathogens most likely present in swine manure include Clostridium perfringens, pathogenic E. coli, Salmonella, Campylobacter, Cryptosporidium, Giardia and norovirus. Of these, E. coli O157:H7 is most likely to survive manure storage and contaminate water. Campylobacter and Giardia have the greatest die offs in manure and would be less likely to contaminate water.

Poultry: Chicken and turkey manure contains a variety of microbes potentially pathogenic to humans. Most important as pathogens are: Salmonella, Campylobacter, and Clostridium perfringens. Cryptosporidium is not detected in poultry manure. Poultry litter (manure) contains faecal coliforms in concentrations (up to 9.5 x 108 CFU/g wet weight) greater than in the other livestock species. Manure is stored and often dried prior to application to agricultural fields. The process of storage and drying can reduce microbial concentrations in manure. Application of dried turkey litter to fields resulted in lower E. coli concentrations in field runoff than if cow manure was applied.

Sheep: Sheep production has an important place in animal agriculture. The zoonotic pathogen most likely to be present in sheep manure is Campylobacter, Salmonella, E. coli O157:H7. Cryptosporidium parvum and Giardia are not frequently isolated from sheep manure.

3. Livestock waste and the environment

Water quality

Animal wastes are spread as slurry over crops and pastures to fertilize the ground and enrich the soil with various forms of nitrogen. If an excess amount of animal droppings are applied to crops that are unable to fully utilize the nitrogen, the residual large nitrate content may leach through the soil to the ground water after harvesting and causes problems. One of the main pathways of field nitrogen loss is through leaching and runoff losses to ground and surface water (Rotz, 2004). The resulting leachate and runoff enters the ground water and subsequently the drinking water sources of both human and livestock are polluted by high concentration of nitrates. According to international standards, nitrate concentration in ground and surface water that can be used for the preparation of drinking water should not exceed 50 mg per litre (i.e. 11.3 mg nitrate-N per litre) (EEC, 1980; CEC, 1991). In addition, a target concentration of 25 mg nitrate per litre has been established (EEC, 1980; CEC, 1991) and nitrate content exceeding 50 mg per litre is unacceptable (Van Der Meer and Wedin, 1989).

Soil contamination

Nitrogen and phosphorus may pollute the soil after manure application. Inorganic fertilizer (e.g. nitrogen) is lost by ammonia volatilization, depending on the rate and period of application, weather conditions and soil type. The volatility of nitrogenous source is important when selecting the mode of application of animal dropping. After volatilization, about 30% of the ammonia returns as wet or dry deposition to soils and vegetations within 5000 m of the source. A large part of the remaining 70% reacts in the atmosphere with SO2 and NOx and is transported over a distance of 5 to about 1×106m (Lekkerkerk et al., 1995). High rates of N deposition cause ecological damage to forests and nutrient-poor natural ecosystems (Heij and Schneider, 1995). These vegetations absorb and accumulate this N effectively with a resultant undesirable floristic changes, loss of biodiversity and physiological problems to trees, such as increased susceptibility to abiotic and biotic stress and deficiencies of other nutrients. Besides, deposition of NHx potentially contributes to soil acidification which may also affect vegetation. This acidifying effect only occurs after nitrification of NHx in the soil, particularly when part of the nitrates produced is lost by leaching (Lekkerkerk et al., 1995). It has been reported that when animal droppings are applied to the soil surface only about, ½ of the nitrogen and other components are available for the plant to use (FDACS, 1999). The excess phosphorus presents special problem, as a result of its low solubility in the soil, contaminates surface water and cause erosion.

Heavy metal contamination

Intensive livestock farming generally contributes to the accumulation of heavy metals in soils. Some heavy metals, in particular copper (Cu), and zinc (Zn) are essential minerals for farm animals. Although the requirement of these metals by most livestock categories can be completely or almost completely met by the feed ingredients, it is a common practice to supplement them via mineral mixtures, thereby resulting in excess supply. Other heavy metals, like cadmium (Cd), chromium (Cr), mercury (Hg), lead (Pb) and nickel (Ni) are nothing but pollutants. Livestock farms import heavy metals via purchased feeds, chemical fertilizers, sewage sludge and other types of waste. Large fractions (generally > 90%) of the heavy metals in livestock diets are excreted in manure. A study on soil-crop balances of the heavy metals Cd, Cr, Cu, Hg, Ni, Pb, and Zn in agricultural soils in The Netherlands showed surpluses of all the metals studied (Delahaye et al., 2003). This is a point of concern, because accumulation of heavy metals in the soil increases their availability and uptake by plants as well as leaching to groundwater and surface water. A prerequisite to sustainable agriculture is to control inputs of heavy metals in such a way that soil and water functions and product quality will not be impeded in the future (Moolenaar et al., 1998; Moolenaar,1999). Consequently, the concentrations of heavy metals in manure strongly depend on their concentrations in the feeds consumed and the subsequent use of such manures on soils leads high concentration of the metals. Other toxic substances that require attention in livestock production are antibiotics, hormones, and veterinary medical residues. These elements may have negative effects on food quality and human health as well as on the health of aquatic ecosystems.

Air quality

Most gaseous pollutants from the livestock industries originate from the breakdown of fecal matter and the concentration of such gases in part depend on the ventilation efficiency and rate of emission, as well as stocking density. Aerial pollutants include organic and inorganic dust, pathogens and other micro-organisms as well as gases such as ammonia, nitrous oxide, carbon dioxide, hydrogen sulphide and methane (Harry, 1978; Okoli et al, 2006). When the pH of livestock waste increases, the ammonium ion is converted to ammonia gas which easily volatilized to air. Ammonia volatilization contributes strongly to the high rates of atmospheric N. Ammonia emissions from wet animal droppings were found to coincide with odours, which are nuisance in area of intensive livestock production (Chavez et al., 2004).

Decomposition of organic materials in livestock manure results in the generation of malodorous and low molecular weight compound (Merril and Haverson, 2002). O' Neil and Philips (1992) reported that 60% of the compounds with the lowest odour thresholds in animal manure contain sulphur. The environment in the animal house is a combination of physical and biological factor which interact as a complex dynamic system of social interactions, husbandry system, light, temperature and the aerial environment. The high stocking density in modern animal house may lead to reduced air quality with high concentration of aerial pollutants (Ogbuewu et al, 2012)

4. *Health concerns of Livestock Wastes*

Animal manure is principally composed of organic material, moisture and ash. Decomposition of animal manure can occur either in an aerobic or anaerobic environment. Under aerobic conditions, CO2 and stabilized organic materials (SO2) are produced. Under anaerobic conditions, CH4, CO2 and SO2 are produced. Zoonosis means spreading of various diseases to humans either directly through excrement or by animal products. 27% of livestock in developing countries like India showed signs of current or past infection with bacterial food-borne disease — a source of food contamination and widespread illness.

India has topped a list of countries worst-affected by zoonotic diseases with widespread illness and death followed by Ethiopia, Nigeria and Tanzania. The first-of-its-kind global study mapping human-animal diseases has pinpointed an "unlucky" 13 zoonoses that are responsible for 2.4 billion cases of human illness and 2.2 million deaths per year. The 13 zoonoses were identified as most important. At least one-third of global diarrheal diseases are because of zoonotic causes. From cyst-causing tapeworms to avian flu, zoonoses present a major threat to human and animal health. 80% of pathogens — with a high potential for bio-terrorism — are zoonotic (Sewak, 2016). Cattle dung is a serious health hazard for the communities living in the vicinity and consuming contaminated water due to this large quantum of excreta. The operation of large farms housing high numbers of animals in one location often creates problems. Such diseases include parasitic diseases (e.g. helminthoses), viral diseases (e.g. rotavirus infections) and a variety of bacterial diseases.

Further bacterial endotoxins and exotoxins may spread through aerosols and cause respiratory problems. There is a potential risk to humans from exposure to livestock pathogens via the food chain or through direct or indirect contact with the environment, animals and animal manure. Storage of manure may not ensure elimination of these pathogens.

Table 2: Selected Faecal-Oral Pathogens and their Transmission Routes.

Pathogen	Important Reservoir/ Carrier	Transmission			X in Food
		Water	Food	p-to-p	
Campylobacter jejuni	Variety of animals	+	+	+	+
Salmonella typhi	Man and animals	±	+	±	+
Vibrio cholera	Man and animals	+	+	±	-
Cryptosporidium Parvum	Man and animals	+	+	+	-
Giardia lamblia	Man and animals	+	±	+	-

X in food = multiplication in food
p-to-p = person to person
+ = yes ± = rare - = no (Sewak, 2016)

Table 3: Prevalence of Enteric Pathogens in Humans and Cattle.

Pathogens	Human	Cattle
Salmonella spp	1%	0-13%
E.coli O157:H7	1%	16%
Campylobacter jejuni	1%	1%
Yersinia enterocolitica	0.002%	1%
Giardia lamblia	1-5%	10-100%
Cryptosporidium spp	1%	1-100%

(Sewak, 2016)

Table 4: Source of pollution vis-a vis Ratio of Faecal Coliform Bacteria to Faecal Streptococci.

Ratio	Indication
>4	Evidence suggests that the pollution is of human origin
2-4	Good evidence of predominance of human waste along with domestic animal waste
1-2	Good evidence of predominance of domestic animal waste along with human waste
<0.7	Stong evidence of domestic animal waste origin

These ratios are valid only for recent (within 24 hour) pollution.Such diseases include parasitic diseases (e.g. helminthiases), viral diseases (e.g. rotavirus infections) and a variety of bacterial diseases such as haemolytic uraemic syndrome from some of the following microorganisms contained in livestock waste.

Escherichia coli	Streptococcus agalactiae
Mycobacterium bovis	Leptospirosis
Pasteurella multocida	Pseudotuberculosis
Erysopelothrix rhusiopathiae	Brucella suis
Salmonellosis	Tularemia
Yersinia	Campylobacter fetus
Brucella abortus	Listeria monocytogenes

Enterococci (Streptococci) like:

- S. faecalis
- S. faecium
- S. avium
- S. gallinarum

Aerobic Sporeformers like

- Bacillus anthracis
- C. tetani
- C. botulinum

Some such pathogenic organisms may cause diseases in animals as well as in human. Further, bacterial endotoxins (produced and retained within them) and exotoxins (produced and released into the medium) may spread through aerosols and cause respiratory problems. Pathogenesis of livestock wastes depends upon the type of livestock waste, animal species, health status of the animal and characteristics of the manure and manure storage facilities. To reduce pathogens, animal manure may be treated aerobically via composting or in anaerobic or aerobic lagoons. Temperature and treatment time are the two most important process parameters, when evaluating process variables for the reduction of pathogens in solid manure and liquid effluent. During composting of solid manure, aerobic decomposition of organic matter and impeded heat transport cause heating of the material, often to 60-70°C. This heating process effectively kills most pathogens and weed seeds. At low temperatures, the reduction rate of pathogens is slow. Thus, after a lagoon treatment period of more than 120 days, the concentration of microorganisms remaining in the effluent from lagoons in Europe were high, viz. 105 per 100 ml for faecal coliforms and faecal streptococci and 104 per 100 ml for clostridia. But because of higher ambient temperatures, storage of liquid effluents in lagoons may be a more efficient and reliable treatment in Asia than in Europe. Hence, the efficiency of storage on pathogen reduction should be assessed before using as the sole treatment measure.

The continual addition of effluent to a lagoon will affect the effective retention time. Fresh additions of slurry may short-circuit the nominal retention time to much less than the hydraulic retention time, thereby greatly reducing affectively of the treatment. Therefore, the storage and treatment of the liquid effluent may be more effective as a batch operation, which will ensure that the real retention time and treatment retention time are similar.Composting may facilitate production of hygienic solid manure that may be applied to land with minimal risk from pathogens. Sediment or sediment solids and poultry manure can be treated this way, as well as slurry mixed with straw or other porous organic solid residues. During composting, the temperature of the material should exceed 55-65°C for at least one week to give a good reduction in pathogens and weed seeds. These conditions are generally achieved during normal composting.

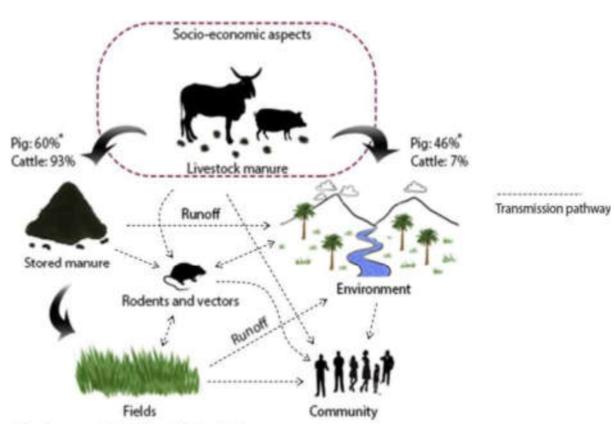

Diagram showing manure management and effect on public health.

Conclusion

Cows and buffalos are main milk producing animals and contribute more than 70% of total excreta production in India. 50% of the cattle dung is used to make dung cake and remaining 50% is required to be suitably utilized or disposed. It has number of pathogenic organism which is responsible for zoonotic diseases and unfortunately India has topped in zoonotic diseases with widespread illnesses. Microorganisms in livestock manure causes zoonotic diseases in humans include bacteria, protozoa, helminthic and virus. The bacterial pathogens are E. coli, Yersina enterocolittica, Salmonella, Campylobacter, etc. Faecal coliforms and faecal streptococci ratio indicate the presence of animal and human pollution. The ratio of 4 indicates the pollution is of human origin and <0.7 indicates pollution of animal waste origin. From the above collected literature, it may be concluded that livestock waste management and its handling & storage method play a crucial role in reducing adverse health impacts on humans.

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