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**Invited Review Article**

# Animal and fish wastes; environment: A critical review

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## Abstract

**Animal waste management includes proper conversion of animal wastes to harmless substances or products of economic importance. According to the 19th Animals Census, India has 512.05 million livestock, producing 1095 million MT of manure annually. A large portion of the estimated 35% of global greenhouse gas emissions attributable to agriculture and land use, comes from the raising of livestock. The acidity of land and water surfaces due to a high atmospheric ammonia concentration can harm plants and reduce plant biodiversity in a natural environment. The different physical processes include sedimentation, mechanical separation, incineration, solar drying, pit disposal, rendering, membrane processes etc. The animal wastes can be subjected to vermicomposting, biogas production and burial in pits. Galvanizing Organic Bio-Agro Resources-Dhan scheme was implemented by the Government of India in April 2018 in order to manage animal wastes. Both developed and developing nations should adopt and abide by the laws and standards necessary to clean up the environment by properly disposing of and handling animal excrement. Once these rules are considered, and various methods for disposing of animal faeces are used, the threat of global warming and climate change can be reduced.**

**Key words:** Animal waste, Climate change, Environment, Fish wastes, Global warming

## Highlights

- Scientific animal waste management practices can help farmers in improving their socio-economic status.
- Alternative animal feeds can be prepared from animal wastes leading to decrease in cost of production.
- Suitable knowledge tests may be developed to assess the knowledge level of farmers on waste management.

## INTRODUCTION

Animal excrement, such as urine, faeces, or other excretions, digestive emissions, urea, or comparable substances, are all considered as animal waste. Animal faeces are frequently combined with dirt, compost, bedding materials, feed, and other materials that are normally associated with this kind of wastes. Excreta from cattle, bedding materials, water from rain or other sources, soil, hair, feathers, and other detritus are all considered to constitute livestock wastes. According to the 19th Livestock Census, India has 512.05 million livestock, producing 1095 million metric tonnes (MMT) of manure annually (Prasad *et al.*, 2014). Excreta (manure), bedding material or litter (such as wood shavings or straw), waste feed, dead animals or birds, cracked eggs, feathers, and farm sweep outs are all included in the waste from the livestock and poultry industries.

The amount of trash likewise grows as the number of animals increase. To put things in perspective, roughly 2.5 billion pigs and cattle on the earth annually excrete more than 80

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million metric tonnes (MMT) of waste nitrogen. The oxygen concentration in the air is lowered and respiratory illnesses are being developed by the constant incorporation of nitrogen from urine and faces. Instead, garbage disposal in water leads to water pollution, waterborne illnesses, and shortage of clean drinking water. When handling and caring for animals, especially animal wastes like urine, faeces/ dung, and dead bodies, which are the carriers of infections, there is a continued risk to human life. These excretes can occasionally transfer to people very complex diseases including Listeriosis, Leptospirosis, Salmonellosis, Brucellosis and Vibriosis (Korner *et al*., 2003). Actions are needed in response to the steadily rising production of slaughterhouse waste in order to solve the environmental concern and provide value to the biorefinery idea. When it comes to this, some of these animal by-products contain a sizable amount of fatty acids that might be effectively converted into bioplastics like polyhydroxyalkanoates (PHAs) by carrying out suitable substrate screening with generating bacterial strains and using reasonable pretreatments (Acedos *et al*., 2022). Methane gas is produced during the organic matter's breakdown. Unmanaged livestock wastes can release pollutants that harm the environment, and manure's methane emissions may have an impact on climate change. Waste-to-energy (WTE) technologies offer ways to utilise waste materials profitably in the production of electricity, fuel for vehicles, and chemicals (Badgett *et al*., 2019). Two different types of compost, sheep-waste-sawdust (SPW-SD) and goat-waste-sawdust (GTW-SD) were put to a soil at a rate in a study conducted in Oyo state, Nigeria (0 g, 750 g, 450 g). The outcome showed that the applied bioremediation agents increased natural bioremediation in the contaminated soil, and that SPW-SD treatment of the contaminated soil produced the greatest results (Adekunle *et al*., 2021). The findings of a study carried out in the Iranian province of Golestan by Azadbakht *et al*. (2021) revealed that 339.63 million $m^3$ of agricultural crop residues, 103.13-353.16 million $m^3$ of animal and poultry manure, and 362.61 million $m^3$ of abattoir waste could all be produced annually. A total of 2085.35 million kWh of power can be produced annually. In the Al-Mafraq governorate (north of Jordan), the amount of livestock and chicken manures created in 2017 was predicted to be over $250 \times 10^3$ tonnes, with an expected rise in the following years (Alnhoud *et al*., 2021). Poultry feathers being rich sources of keratin proteins and amino acids can be converted into valuable products such as feather meal, bio diesel, biodegradable plastic and fertilizer. Poultry manure is also useful as fertilizer, methane and to produce electricity (Muduli *et al*., 2018). Composting with black soldier fly larvae (BSFL) is a process that turns biodegradable food waste into organic fertiliser and protein for animal feed. Mixed food waste offers the greatest potential for BSFL composting; however, only plant-based waste is approved as larval feeding in accordance with European Union standards (Lindberg *et al*., 2022). Fish processing activities alone in India produce more than 4 million metric tonnes of fish waste per year. Shrimp processing produced the most waste, followed by fin fish processing and cephalopod processing. Beheading, skinning, gutting, descaling, filleting, and other preparation procedures are included. Up to 40% of entire shrimp and krill, 50% of crab, and 24% of squid are processed discards. Besides, there is enormous amount of wastes from fish processing units very much important for their organic content and high BOD values.

## Environmental hazards

Animal excrement is turning into a severe environmental issue as livestock production rising across the globe. The damage has occasionally been stunning and even tragic. It is commonly acknowledged that there is a connection between livestock production and greenhouse gas (GHG) emissions. Steeg and Tibbo (2012) estimate that agriculture is responsible for between 59% and 63% of the

world's non-carbon dioxide (non-$CO_2$) GHG emissions, including 84% of nitrous oxide ($N_2O$) emissions and 54% of methane ($CH_4$) emissions. A large portion of the estimated 35% of global greenhouse gas emissions attributable to agriculture and land use, according to McMichael *et al*. (2007), comes from the raising of livestock.

## Air pollution and climate change

Organic and inorganic dust, diseases, and other microbes, as well as gases including ammonia, nitrous oxide, carbon dioxide, hydrogen sulphide, and methane, are among the aerial pollutants caused by the cattle business (Okoli *et al*., 2006). The ammonium ion is changed into ammonia gas, which easily volatilizes to air and raises the atmospheric N level, as the pH of cattle manure rises (Moore, 1998). Odours that are bothersome are reported to coexist with ammonia emissions from moist animal droppings in areas with heavy livestock production (Chavez *et al*., 2004). The acidity of land and water surfaces due to a high atmospheric ammonia concentration can harm plants and reduce plant biodiversity in a natural environment. Livestock, both directly and indirectly, contributes to air pollution and global warming. Over the past 250 years, the production of cattle has considerably contributed to the rise in $CO_2$ and other greenhouse gas levels (Darwin, 2001). Agriculture, primarily from ruminant animals, generates around 40% of the methane that is released (Rosenzweig and Hillel, 1998). Due to their effectiveness in absorbing infrared radiation, methane and nitrous oxide are regarded as important greenhouse gases. Methane and nitrous oxide, which both contribute to climate change and global warming, absorb 26 to 200 times more infrared radiation than carbon dioxide (Sommer and Moller, 2000).

## Water pollution

Animal manure is applied as slurry to pastures and crops to fertilise the soil and enhance it with different types of nitrogen. After harvest, if too much animal manure is given to crops that cannot absorb the nitrogen effectively, the remaining high nitrate content may seep through the soil to the groundwater and cause issues. Field nitrogen loss occurs mostly through runoff and leaching into ground and surface waters (Rotz, 2004). The resultant leachate and discharge contaminate groundwater with high concentrations of nitrates, contaminating both human and livestock drinking water sources.

## Land degradation

Long-term heavy grazing contributes to the extinction of edible plant species and the consequent dominance of shrubs or inedible herbaceous plants in many regions. According to Whitemore (2001), the impact of livestock on the soil may be divided into two major categories: first, the physical impact of the animal as it moves through the soil, and second, the chemical and biological influence of the faeces and urine that the animal deposits on the soil. Grazing cows excrete an amount of urine in the order of 2 lit per 0.4 $m^2$, which equates to an instantaneous application of 400 to 1,200 kg N per hectare. Such large quantity burns vegetation and is frequently poisonous to plant roots, which take up to a year to fully recover. The issue is exacerbated in regions where animals congregate (Early *et al*., 1998). In addition to nitrogen, too much phosphorus is a particular problem since it has low solubility in soil, contaminates surface water, and causes erosion.

## Heavy metals

The majority (usually >90%) of the heavy metals consumed by animals are expelled in the manure. In the Netherlands, a study on the balances of the heavy metals Cd, Cr, Cu, Hg, Ni, Pb, and Zn in agricultural soils revealed that all the elements were in excess (Delahaye *et al*., 2003). These heavy metals were present in excess, which caused them to accumulate in plants and leach into surface and groundwater.

Antibiotics, hormones, and leftover veterinary medication are additional harmful compounds that need to be dealt with when raising animals. These components might be harmful to human health by affecting the quality of food or aquatic environment health, and/or both.

## Processes employed for treatment of animal wastes

The processes employed for the treatment of animal wastes can be basically classified as physical and biological processes.

**Physical processes:** The different physical processes include sedimentation, mechanical separation, incineration, solar drying, pit disposal, rendering, membrane processes etc. They are explained below:

- Sedimentation: The most straightforward method for removing suspended solids from liquid manure is to use natural settling or sedimentation. The relatively straight-forward technique and affordable equipment make the sedimentation option seem like a promising way to remove fine particulates from slurry.
- Mechanical separation: Mechanical screening, a simple method that can be used on farms to separate the coarse materials from the slurry, can result in a quicker separation. In many full treatment methods, mechanical screening is also a preliminary step in the process.
- Incineration: For better management, animal excrement might be burned. However, it is impossible to burn the enormous volume of waste produced by animals. Wealthy nations have a set of emission criteria that must be adhered to in this procedure, and underdeveloped nations cannot afford the incinerators used for waste treatment. This is an economical and safe method (Parihar *et al.*, 2019)
- Solar drying: The manure is dried by the sun to extremely low moisture levels. At such low moisture levels, most bacteria and protozoa become inactive, and the disease-causing capacity of the manure declines. Because there are fewer worms in the manure, the environmental contamination is also appropriately decreased.
- Pit disposal: Dogged pits have long been the preferred way for disposing of animal faeces because of their low cost and simplicity. For the disposal of dead birds, a deep pit with an internal frame and a tight-fitting lid or an open trench created by a backhoe has been utilised.
- Rendering: By removing carcasses from the farm and converting trash into useful feed ingredients, the rendering option helps to prevent environmental contamination. Processing plant wastes are heated, hydrolyzed, and pressed into by-product meals during rendering. The rejected carcasses on post mortem examination are sent for rendering (Kumar *et al.*, 2018).
- Membrane processes: Reverse osmosis, a type of membrane technology, can be used to dewater sow slurry, but before the liquid enters any membrane treatment stage, the organic fraction must be broken down and the solids removed by efficient sedimentation, separation, or filtering procedures.

**Biological processes:** The biological procedures used to treat animal faeces are as follows:

- Aerobic treatments: Activated sludge, continuous aerobic treatment systems, aerobic trickling biofilter use, built wetlands, and overland flows are a few of them.
- Anaerobic treatments: One of the most crucial treatments for animal dung and other organic wastes is anaerobic digestion, which results in the creation of $CH_4$, a universal energy carrier. Pumpable slurries are the most convenient and frequent way to do anaerobic digestion; however, high solids content (20-40% DM) plug flow reactors have recently been developed. Biogas, a combination of 60-70% $CH_4$ and

30-40% $CO_2$, is one of the by-products of the process.

## Vermiculture

Via a low-cost vermiculture system, animal waste may be transformed into vermin-cast and vermin-meal (protein meal). According to Boda (1990), one tonne of cattle manure can create 80 kg of dungworms.

## Alternative animal feed

The cost of chicken meat and eggs will decrease as a result of using correctly treated and dried animal waste as animal feed, increasing the profit margin. A possible beneficial resource for feeding cattle is animal by-products (ABPs), which include processed animal proteins, animal fats, milk and egg products, and other food products. According to European authorities, the slaughterhouses, dairies, and industries that produce food for human consumption generate roughly 18 million tonnes of animal fat and meat industry by-products each year in the European Union (EU) (Jedrejek *et al*., 2016).

## Extension approaches

The extension specialists must go for accessing the knowledge level and attitude level of the farmers. The training need assessment must be done, and based on it, the needful training on animal waste management must be given. Generally, in field conditions, the farmers are not aware of selling the waste to gain profit. Proper awareness must be given to the farmers. In a study by Singh *et al*. (2020) in the Ludhiana district of Punjab, it was discovered that vermicomposting produced the highest net returns per metric tonne of manure, followed by composting and biogas production. Similar research can be conducted to analyse the economics, and the farmers need to be educated based on the research findings and based on localities and needs. According to a study done among Israeli students, attitudes mediate the relationship between environmental knowledge and behaviour with regard to environmental pollution brought on by the livestock industry. Students who had higher levels of environmental knowledge also showed more pro-environmental attitudes and behaviours. Additionally, those who raised/reared animals showed greater knowledge, pro-environmental attitudes and conduct, and women showed these traits more than men (Dopelt *et al*., 2019).

Training needs assessment helps in identifying the gap between what a worker must be able to perform and what he or she can or is now doing is the definition of a training needs assessment. Therefore, a training needs assessment identifies the discrepancy between what the work requires of an employee and what the employee really does. Knowledge test refers to development of a knowledge test, which will act as a tool for evaluating the knowledge level of the respondents under study. Attitude scale is a tool that helps in assessing the degree of optimism or pessimism towards an object, event, person, things etc.

## GOBAR-Dhan Scheme by the Government of India

Galvanizing Organic Bio-Agro Resources-Dhan is known as GOBAR-Dhan (Ministry of Jal Shakti, GoI, 2021). It debuted in April of 2018. This programme was a part of the Swachh Bharat Mission's Biodegradable Waste Management Component (Grameen). The objectives of the plan included boosting rural households' incomes and using the excrement from the cattle to produce organic manure and energy. The GOBAR-Dhan principles include collecting cattle waste and turning it into biogas for domestic and industrial use, using bio-slurry as a by-product of the biogas process to make bio-fertilizer, actively involving the community, Self help groups, and milk cooperatives in operation and management, concentrating on making the process financially viable for everyone along the value chain, and fostering entrepreneurship for the large-scale production of compressed biogas and bio-fertilizer.

The different models of GOBAR-Dhan are

explained below:

- Individual Household Model: In accordance with this concept, Gram Panchayats will select potential households for the installation of GOBAR-Dhan units and make arrangements to offer technical and financial help for the development of biogas plants. Additionally, GPs would urge households to build biogas plants using their own resources or resources obtained from CSR through IEC initiatives. According to the NNBOMP funding guidelines, the New National Biogas and Organic Manure Programme (NNBOMP) of MNRE, the 15th Finance Commission, MPLAD, MLALAD, and other State schemes, among others, can be utilised to fund the construction of housing units.
- Cluster Model: According to this methodology, the GPs can pinpoint a group of residences for the installation of residential biogas plants. While the slurry will be gathered and processed at a central location that has been decided upon, the houses will use the biogas that is produced. The GPs will make sure the targeted homes utilise the generated biogas and sell the slurry to the agency for additional processing and conversion to bio-fertilizers/organic manure. Cluster units can be established using a variety of funding sources, including the New National Biogas and Organic Manure Programme (NNBOMP) of MNRE, SBM(G), 15th Finance Commission, MPLAD, MLALAD, and other State schemes, etc. The NNBOMP funding guidelines shall be followed. Cluster model's participating households will receive assistance from SBM-G.
- Community Model: Construction of community-level biogas plants is possible for a group of at least 5-10 families. Household garbage will be gathered and delivered to the biogas plants. While the slurry can be utilised in agriculture, sold to farmers, transformed to bio-fertilizers, or used as organic manure, the biogas produced will be distributed to homes, restaurants, institutions, etc. It is possible to utilise the various financing sources, including NNBOMP, SBM-G), the 15th Finance Commission, MPLAD, MLALAD, and other State programmes.
- Commercial Model: Huge Bio-Gas/ Compressed Bio-Gas (CBG) facilities can be built under this paradigm by businesses, cooperatives, gaushalas, dairies, etc., with the aim of producing a lot of raw biogas on a large scale. After being transformed into CBG, the biogas can either be sold directly through fuel dispensing devices or to businesses like Oil Marketing Companies (OMCs).

## Types of waste disposal

The best disposal methods will be those that fully utilise all currently available and appropriate disposal options, regardless of what those options may be. Table 1. explains the different types of carcass disposal in brief.

**Table 1. Methods of waste disposals**

| Sl. No. | Types of disposals | Remarks |
|---|---|---|
| 1 | Burial | Most common and safest method. It prevents worms from carrying bacterial spores to the surface as well as to prevent carnivorous. |
| 2 | Incineration | The carcass is incinerated in a destructor/incinerator at 1300ºC. Most sanitary and environment-friendly method. |
| 3 | Rendering | Rendering is the process of transforming carcasses to a pathogen-free, useful by-products like protein rich feed supplements. |
| 4 | Composting | Composting is a natural process of developing manure where the carcasses are fragmented into basic elements (organic matter) by microorganisms, bacteria and fungi. |
| 5 | Fisheries waste disposal | Can be disposed of by landfilling and composting. |

## Conclusion

Both developed and developing nations should adopt and abide by the laws and standards necessary to clean up the environment by properly disposing of and handling animal excrement. Once these rules are considered, and various methods for disposing of animal faeces are used, the threat of global warming and climate change can be reduced. Technologies already exist, and more research is being done to develop new ones that will protect the environment. The national governments should take the lead in coordination with civil society organisations, and farmers and the general public should get incentives to embrace these technologies, protecting the environment and improving the quality of life on earth.

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