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Eco-Friendly Methods of Livestock Waste Recycling

Mohd. Rashid, Amandeep Singh, Gurpreet Kour

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Abstract In India being the agrarian country growing of crop in combination of livestock farming and the use of manure as fertilizer, are traditional practices. Such type of integration is the bases of the farming systems, because of small land holding. This paper describes ways in which these systems can be made more efficient, more productive and more environmentally friendly, by applying simple, low cost eco-friendly methods for recycling the manure through biodigesters, duckweed ponds and earthworms.

Keywords Livestock waste, Recycling, Eco-friendly, Compost.

Mohd. Rashid
Associate Professor, Division of Veterinary Public Health & Epidemiology, Faculty of Veterinary Sciences & Animal Husbandry, Sher-E-Kashmir University of Agricultural Sciences & Technology of Jammu, R.S. Pura, Jammu, Jammu & Kashmir, India 181102
e-mail: rashidvph03@gmail.com

Amandeep Singh*
MVSc Scholar, Division of Extension Education, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar-Pradesh, India 243122
e-mail: amandeepsinghvet@gmail.com

Gurpreet Kour
MVSc Scholar, Department of Animal Genetics & Breeding, Guru Angad Dev Veterinary & Animal Sciences University, Ludhiana 141012, Punjab, India
e-mail: gurpreetkour1469@gmail.com
*Corresponding author

Introduction

Loss of soil fertility and species biodiversity and environmental pollution, are negative consequences of modern agricultural practices in the industrialized countries where, on most farms, intensive systems of production have resulted in the physical separation of livestock and crop production.

The role of animals in the progress of developing nations is imperative as animal wealth for livelihood and nutrition is an important segment. Veterinarians are focusing more on the sustainable increase in the livestock production systems whether it is production of meat, milk, eggs or fiber but are least concerned about the wastes emerging out from the livestock industry and livestock itself. The unconditional use of chemicals in the agriculture and livestock industry has not only raised an environmental concern but also a health concern for the humans. The excretions from the animals have the residues of certain chemicals which are noxious for humans as well as for environment. Further, the excretions of diseased animals may have certain zoonotic pathogens which are very harmful for humans and can remain in soil for several days to weeks. The active compounds in the animal excretions and the effluents erupting from the livestock products and processing industries pose a greater threat to all the components of environment. Hence, livestock wastes are to be managed properly to mitigate production of these pollutants in order to protect environment. Proper utilization of livestock waste into biogas, compost and vermicompost making can be very useful to increase crop yield and sustainability.

Composting

Composting is the actively managed process of decomposition of organic matter in the municipal solid waste stream. The end product, compost, is organic material that can be used as a soil medium to grow plants. Mature compost contains a stable, carbon rich material called humus that is dark brown or black in color with a soil like, earthy smell.

Composting is a natural aerobic process that stabilizes a variety of organic matter and livestock manure (Rodriguez 1997). Well composted manure has the odor of humus. Because of the heat produced during composting, well-controlled composting results in the destruction of both pathogens and weed seeds. The dead animals also can be effectively recycled via composting; however, feathers, teeth, and bone fragments may resist composting, which can be removed by mechanical screening if necessary. The poultry industry in the United States found a solution to its dead bird disposal problem by composting them by special procedure (Morrow and Ferket 1993). The composting of sheep, goats or pig carcasses may be carried out in bins built from treated wood, concrete or bales of hay, over a concrete floor (McCaskey et al. 1996). A layer of carcasses is placed over 1 feet layer of sawdust and then covered on all sides with 1 feet of sawdust. Add other layers until bin is full. Carcasses may be composted, whole or dismembered in case of large sows (Morrow et al. 1995). After 3 months, the compost may be turned manually or mechanically. and then allowed to stand another 3 months for the process to be completed (Fulhage 1993). If static-pile composting is being used, the compost is not turned for the whole period.

Animal dead bodies can be buried into compost pile within 24 h of death and covered with thich layer of solid manure or soil. Composting is done in such a way that it will control odors, flies rodents and other vermin. Dead animals with history of neurological disease, anthrax or other diseases and conditions kept under quarantine should not be composted (Belay et al. 2002).

Types of composting

Backyard or onsite composting

This technique is feasible when wastes are in small amounts particularly in rural setting where people have 5-10 animals. Yard trimmings and small quantities of food scraps can be composted onsite. Animal products and large quantities of food scraps are not appropriate for onsite composting. Backyard or onsite composting offers the highest environmental benefit among organics management strategies because of the decrease or climination of transportation impacts. Normally composting takes two years, but manual turning can speed up the process and reduces time from three to six months (Rodriguez 1997).

Vermicomposting

Manure, kitchen and kitchen garden wastes, Food scraps, Paper, Yard trimmings such as grass and plants can be used for vermicompositing. Red worms (earth worms, the 2 species used are *Eudrilus eugeniae, Perionyx excavatus*) in bins feed on food scraps, yard trimmings and other organic matter to create compost. The worms break down this material into high quality compost called castings. Worm bins are casy to construct and are also available for purchase. One pound of mature worms (approximately 800-1,000 worms) can eat up to half a pound of organic material per day. The bins can be sized to match the volume of food scraps that will be turned into castings. It typically takes three to four months to produce usable vermicompost. The castings can be used as potting soil. The other by product of vermicomposting known as “worm tea” is used as a high quality liquid fertilizer for house-plants or gardens. It is a good technique for recycling farm wastes. Worms are sensitive to changes in climate. Extreme temperatures and direct sunlight are not healthy for the worms. The best temperatures for vermicomposting range from 55^0 F to77^0 F. In hot, arid areas. the bin should be placed under the shade.

Pile/Bed method

This method is useful where farmer cannot afford cemented structure as it can be taken up under shade of tree and without any structure, the material required is 3-4 quintals of dry grass, leaves, farm yard manure (FYM), 7-8 quintals of wastes of crop and 8500-10000 worms per sq. meters. First spread 15 cm layer of dry wastes and then 15 cm FYM should be placed over it. Sprinkle the water to retain proper humidity for 24 h. Then place 300-350 worms in one sq. meter area and hide it with 20 cm layer of wastes of crop residue. Maintain 60% humidity for about 60-65 days and save it from birds. In this way 3-4 quintals or compost and 20000-25000 red worms can be obtained within 2 months.

Pit method

This method is comparatively better than the pile method. In this method a cemented twin pit of 4 × 1.25 × 0.75 meters each and after 30 cm there must be a whole in the wall of the pit. Filling is to be done as discussed above in pile method.However, the ratio of the crop residue and FYM in 2:1. While filling out of the two, one pit should be left vacant to allow earth worms to move there after preparation. After 15 days of filling place 8000-10000 worms there and keep the temperature at 20-30^{0}C and relative humidity of 60%. After 60-65 days compost is ready.

Aerated (Turned) windrow composting

Aerated or turned windrow composting is suited for large volumes of wastes generated by entire communities and collected by local governments and high volume food processing businesses (e.g., restaurants, cafeterias, packing plants). It will yield significant amounts of compost, which might require assistance to market the end product. Local governments may want to make the compost available to residents for a low or no cost.

This type of composting involves forming organic waste into rows of long piles called "windrows" and aerating them periodically by either manually or mechanically turning the piles. The ideal pile height is four and eight feet with a width of 14 to 16 feet. This size pile is large enough to generate enough heat and maintain temperatures. It is small enough to allow oxygen flow to the windrow's core.

Large volumes of diverse wastes such as yard trimmings, grease, liquids and animal by-products (such as fish and poultry wastes) can be composted through this method.

Aerated static pile composting

Acrated static pile composting produces compost relatively quickly (within three to six months). It is suitable for a relatively homogenus mix of organic waste and work well for larger quantity municipal solid waste (e.g., food scraps, paper products). This method, however, does not work well for composting animal by-products or grease from food processing industries.

In aerated static pile composting organic waste mixed in a large pile. To aerate the pile, layers of loosely piled bulking agents (e.g., wood chips, shredded newspaper) are added so that air can pass from the bottom to the top of the pile. The piles can also be placed over a network of pipes that deliver air into or draw air out of the pile. Air blowers might be activated by a timer or temperature sensors.

In-Vessel composting

In-vessel composting can process large amounts of waste without taking up as much space as the windrow method and it can accommodate virtually any type of organic waste (e.g., meat, animal manure, biosolids, food scraps). This method involves feeding organic materials into a drum, silo, concrete-lined trench, or similar equipment. This allows good control of the environmental conditions such as temperature, moisture, and airflow. The material is mechanically turned or mixed to make sure the material is aerated. The size of the vessel can vary in size and capacity.

This method produces compost in just a few weeks. It takes a few more weeks or months until it is ready to use because the microbial activity needs to balance and the pile needs to cool.

Biogas production technology

Gas production from anaerobic biomass digestion is a famous technology. Billions of biogas units have been already established throughout the world. Biogas is a clean, efficient and renewable source of energy, which can be used as a substitute for other non-renewable fuels in order to save energy in rural areas particularly in developing countries of Asia and Africa. In European countries the biogas generation was 62 billion kWh in 2006 and among them Germany was the largest biogas producer with 4,300 plants generating 1,600 MW of electricity (Fachagenturfu"rNachwachsendeRohstoffee. V. (FNR) 2009). India and China are the two leading Asian countries using biogas technology. The biogas produced is mainly used for household application in majority of developing countries of Asia and Africa.

The distribution of biogas through pipeline to end users is very costly. A novel system of biogas purification and bottling was recently developed at IIT, New Delhi (Vijay 2011). Pure biogas stored in cylinders is a marketable product and hence, can be easily used any time anywhere as LPG cylinders. The compressed natural gas (CNG) technology has become easily available and therefore, biomethane (or enriched biogas) which is similar to CNG can be used for all applications for which CNG is being used. The initial biogas bottling projects at villages of Maharashtra and Punjab states of India have successfully produced pure biogas with 98% methane content which was compressed to 150 bar pressure for filling in cylinders. The Biogas-based Power Generation Program (BPGP) is the main policy in India to promote biogas power in which 73 projects were installed with a total capacity of 461 kW (Ministry of Newand Renewable Energy (MNRE) 2010). The efforts of Government of India has started to give fruits as about 17538 MW power was generated from biomass which was shared 20% from all sources of renewable energy (CSO 2012). Germany has 7,320 power generating biogas plants with 2,997 MW capacities which was 13% of all renewable power sources (Anon 2013). The other Asian countries such as Indonesia have potential to generate 684.83 Mw power from biogas (Widodo and Hendriadi 2005). China has started to introduce biogas-based power plants but until 2012 there was only 3% plants used for power generation.

Integrating composting and vermicomposting

The major problems associated with traditional thermophilic composting are the long duration of the process, the frequency of turning of the material, loss of nutrients during the prolonged composting process, and the heterogenous nature of the product. The major drawback in the vermicomposting process is that it must be maintained at temperatures below 35^{0}C which does not remove all the pathogens. Thus, an integrated system approach that harvests advantages from both processes would be necessary to provide a product free of pathogens, and a product with desirable characteristics at a faster rate than either of the individual processes. If vermicomposting is used in combination with the traditional composting, the required temperature for ensuring adequate pathogen kill would be achieved. Above said approach was tried at Spain using vermicomposting process for 30 and composting for 28 days in sequences (Ndegwa and Thompson 2001) and found successful.

Integration of waste treatment with algal cultivation

The carbon dioxide is a major component in the product gases from anaerobic digestion (Vijay 2011) and thermochemical conversion processes from livestock waste which can be used for production of algal biomass. Algae can utilize carbon dioxide ten times more efficiently than terrestrial plants and can generate algal biomass and intracellular oil (Miao and Wu 2006). The algae cultivation has several benefits, i.e., rapid generation rates with biomass harvesting up to 50 metric tons acre-1 year-1 (Demirbas 2001); the accumulation of large amounts of fatty acids and hydrocarbons; as well as the ability to play a role in waste treatment. These algal products can be processed into many value-added products including bio-oil. So it is a most promising non-crop-based raw material for biofuel production.

Integration of fish with livestock farming

Integration of fish with livestock farming is the best method for recycling of organic wastes. Cattle manure has been used extensively in India as a source of manure in carp polyculture (Sinha et al. 2005). The various poultry waste-fed aquaculture were tried at Japan with good fish yield (Little and Satapornvanit 1996). They got highest dry matter yield with highest feed conversion efficiency in egg laying duck based aquaculture. A wide range of plant species can be grown in water fertilized with livestock excreta, such as duckweed *(Lemna cacea)*, water hyacinth *(Eichhornia crassipes)* and water spinach *(Ipomoea acuatica)*. (Rodriguez and Preston 1996a,b). Duckweed has high nutritive value about 40% of protein and can be fed to livestock as a source of protein.

Conclusion

Although the processes and methods given in the paper is a small reference for managing the livestock. Singh and Rashid (2017) in they work has provided a comprehensive outlook for managing the livestock waste by touching all the possible means of livestock waste management. They have discussed strategies based on managing the animal waste and also strategies to achieve the nutrient balance in soil. At this point of time it is imperative to say that although livestock plays an important role in economies of all the developed and developing countries of the world but emerging waste from livestock sector needs to be managed in such a way that waste coming from the livestock can be transformed to wealth. Composting seems to be an excellent way for doing the same and not only it has the capability to address the waste menace but also the sale of compost will provide some earning to the farmer thereby augmenting the farm income. There is a strong need to work and evolve more such novel methods of livestock waste management which will not only solve the current problem but also have the potential to sustain its usage for longer periods of time and with positive effect on the environment.

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