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Livestock waste management: A review

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Abstract
Livestock Waste" means livestock excreta, bedding material, rain or other water, soil, hair, feathers or other debris normally included in animal waste handling operations. Improperly managed livestock wastes can lead to fecal contamination of waters receiving agricultural runoff. The danger to humans lies in the possibility of these fecal organisms entering water and food supplies. Groundwater and surface waters may harbour pathogens originating from animal fecal deposits. Animal waste contains many beneficial constituents that if recycled effectively, can be used as fertilizer for crops, fodder for animals and to produce energy. Composting is an accelerated bio-oxidation of organic matter passing through a thermophilic stage (45 to 65 ºC) where microorganisms (mainly bacteria, fungi and actinomycetes) liberate heat, carbon dioxide and water.

There are a number of methods of livestock waste management which are biogas production, rotatory drum composting, vermicomposting, biodynamic fertilizer etc. Biogas is clean environment friendly fuel that can be obtained by anaerobic digestion of animal residues and domestic and farm wastes, abundantly available in the countryside. Biogas is bacterial conversion of organic matter in to gases under anaerobic conditions. Average calorific value of biogas is 20MJ/m3 (4713kcal/m3).

The earthworm eats the organic matter and excrete little pelleted material called “Vermicompost”. During vermicomposting, the important plant nutrients, such as N, P, K, and Ca present in the organic waste are released and converted into forms that are more soluble and available to the plants. Among all advance methods biogas production and vermicomposting are most common in India.

Keywords: Livestock waste, biogas, vermicompost

Introduction
Livestock Waste" means livestock excreta, bedding material, rain or other water, soil, hair, feathers or other debris normally included in animal waste handling operations. According to 19th Livestock Census livestock population in India is 512.05 million which produces 1095 million MT dung per year [18]. Waste from livestock and poultry industry includes a mixture of excreta (manure), bedding material or litter (e.g.wood shavings or straw), waste feed, dead animals/birds, broken eggs, feathers and farm sweep outs.

Animal husbandry specialists used to worry about how the effect of environment on animals can be mitigated. But, of late, there is talk of livestock and livestock industries themselves polluting the environment in general. In fact, like any other production activity, livestock and climate have mutual positive as well as negative interactions of different intensities. Indian livestock estimated using dry matter intake approach was 10.08 Tg (trillion grams = 1 ton) methane due to enteric fermentation in the year 2010, in which crossbred cattle, indigenous cattle, buffaloes, goats and sheep and other livestock (mule, yak, camel, donkey, pig, mithun, horse and pony) emitted about 4.6, 48.5, 39, 4.7, 1.8 and 1.4%, respectively. Amongst states, methane emission was highest in Uttar Pradesh followed by Madhya Pradesh and Bihar due to their larger livestock population.

The early method of handling livestock wastes was very simple. The manure droppings from livestock on pasture were not even recovered but left to become integrated in the soil. However, with the advent of modern livestock production, considerable attention is being given to alternative uses and treatments of livestock wastes to recover fertilizer, feed, and fuel and at the same time achieve pollution control. All these properties of animal waste will be available only if they are carefully managed. If not they might cause detrimental effects on climate and human.

Importance of livestock waste management
The most common concern with animal waste is that it affects release of large quantities of

CO_2, and ammonia which might contribute to acid rain and the greenhouse effect. It could also pollute water sources and be instrumental in spreading infectious diseases. If the disposal of water is not properly planned it might create social tension owing to the release of odors and contamination of water sources. Pollution and spreading of disease/ pathogens, is required for efficient utilization of waste on large farms. Proper management of livestock waste is required due to following reasons:

1. Livestock manure helps to maintain soil fertility in soils lacking organic content. Adding manure to the soil increases the nutrient retention capacity, improves the soil's physical condition by increasing its water holding capacity, and improves soil structure.
2. Animal manure also helps to create a better climate for micro flora and fauna in soils.
3. Dung is also used as fuel.
4. Waste manure and other organic materials from livestock farms could be an important source of energy production.
5. Livestock waste can be used in resource management, in crop and livestock production and in the reduction of post-harvest losses [6].
6. Livestock waste management plays an important role in the livelihoods of many rural dwellers in India.
7. Bio-energy sources are increasingly gaining attention as a sustainable energy resource that may help to cope with challenges like, increasing demand for energy, rising fuel prices by providing substitutions for expensive fossil fuels.
8. Biogas from livestock waste and residues provides renewable and environmentally friendly sources that supports sustainable agriculture. Additionally, the by-products of the 'digesters' provide organic waste of superior quality [1].
9. Reduce source of infection for animal and human population.
10. Reduce source of methane emission (0.28-1.95g/day).
11. Reduce Cause of bad odor in surroundings.
12. Reducing fly nuisance.
13. Helps in proper nutrient management practices (reduce loss of organic matters).
14. Helps in controlling vectors and fomits.
15. Reduce environment pollution.
16. Reduces illegal discharge of waste which can pose a direct threat to the quality of soil and water system.
17. Nitrogen in manure is tied up in its organic state until, through decomposition it is converted to a soluble form (ammonium nitrate). When ammonium nitrate is mixed with soil it improves soils fertility.

Types of livestock waste

Solid Waste: It includes

A. Dung: also known as cow pats or cow manure is the waste product of bovine animal species. Cow dung is the undigested residue of plant matter which has passed through the animal gut. The resultant fecal matter is rich in minerals.

Cow dung contain

Moisture	77 per cent
Organic matter	20 per cent
Nitrogen	0.32 per cent
Phosphorus	0.14 per cent
Potassium	0.30 per cent
Calcium	0.40 per cent

B. Wasted feeding material: Food waste or food loss is food that is discarded or lost or uneaten.

C. Soiled bedding material: Straw, saw dust and wood shavings, Paper-based bedding materials etc.

Liquid Waste

A. Urine

B. Washed water

Table 1: Dung and Urine production by different species

Animals	Quantity of dung[1] (kg/day/animal)		Urine[2] (ml/kg bwt/day)
	Range	Average	Range
Horse	9-18	13.50	3-18
Cattle	18-30	24.00	17-45
Buffalo	25-40	32.50	3-18
Sheep and goat	1-25	1.25	10-40
Pigs	3-5	4.00	5-30
Poultry (100 birds)	2.5-3.5	3.00	-

Table 2: Water requirement for washing

Species	Water requirement for washing (liters)/Animal/Day
Cattle and Buffalo	45-70
Horse	36
Pigs	25-28

Collection of livestock waste

Because of the management system which allows grazing during the day and kraaling at night, a substantial amount of the faces is deposited on the crop fields and grazing land. These components of wastes are not usually collected but rather go directly to fertilize the soil. For those deposited within enclosed structures such as the animal house and poultry buildings, they must be removed to avoid health hazards.

Waste collection methods

1. Separate Collection

Solid and liquid manure are separated, a special pit has to be constructed to allow the solid waste to get decomposed. The pit should be far away from water sources, animal and human habitations to avoid fly menace and spread of diseases. While planning for construction a pit due attention should be given to the labor required in transporting and the mode by which the manure will be shifted to the pit.

Collection of solid waste

By means of wheel barrow and shovel, disposed into a pit for decomposition. Such manure will return 75 percent of its fertilizing value to soil. Manure pits should be about 200 meters away in a place where no fuel smell would pass through buildings. The production of manure from each dairy cow is about 24 kg per day. The volumetric capacity of fresh manure is 700 to 900 kg/cubic m. Frequency of collection should be twice in a day.

Collection of liquid waste

Flushing of liquid waste can be done by the drain channel up to the storage tank, or it can be drain directly in main drain channel of the area.

2. Flushing of both waste

Manure along with other waste is flushed together and can be

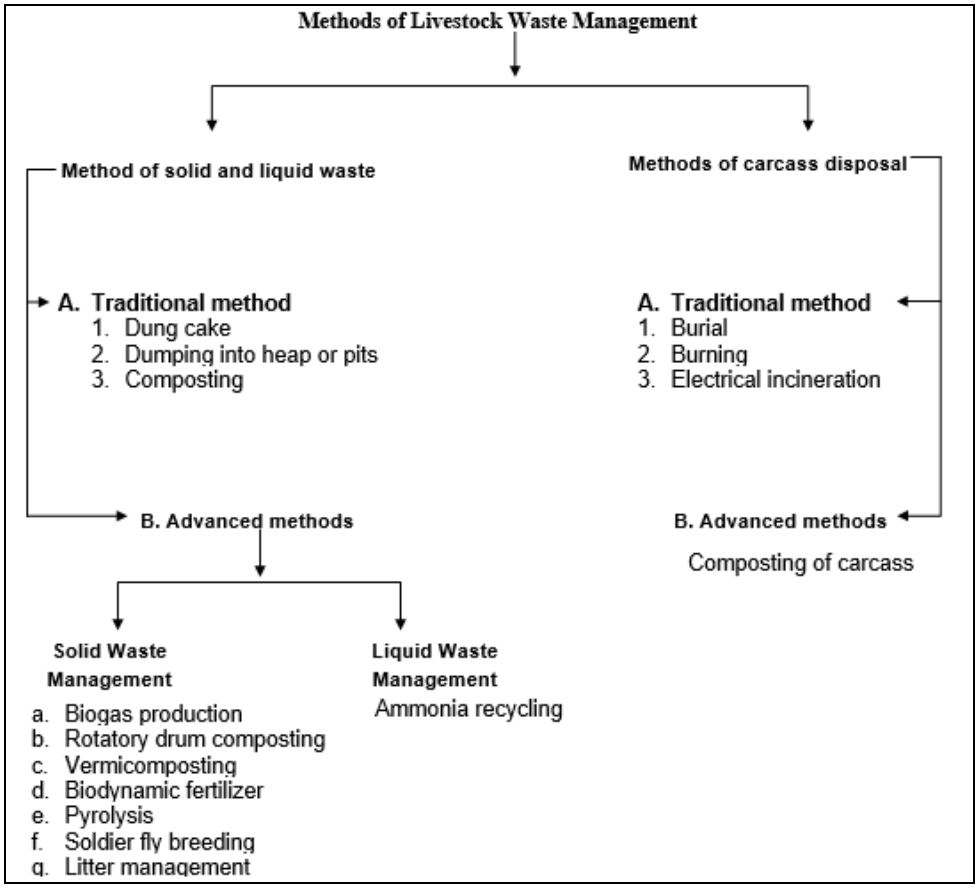
adopted in places where there is plenty of water available to forced and also in buffalo farms where the dung voided is watery in consistency. In these types of animal sheds a U-shaped gutter or drain should be located longitudinally to the long axis of the shed. Outside the shed the liquid manure from each shed can be connected to a main drain of shed preferably a closed one. The main drain leads the liquid water to a liquid storage tank from where it can be pumped to agricultural lands for manuring [20].

3. Semi-automatic cow dung cleaning machine

It is a semiautomatic machine which runs through electricity it equipped with small trolley with four wheels, fork and brush. Brush is made to rotate with help of gear motor with belt drive and pulley arrangement.

Advantages

- Low power consumption.
- Frequent cleaning gives better hygiene and better cow health.
- Easy installation.
- Smart equipments features.



Traditional method of livestock waste management

1. **Dung cake**: The only use for manure other than fertilizer is in underdeveloped countries, where cow manure is gathered by hand and placed on suitable racks to sun-dry for use as fuel for cooking and heating. In north Indian States-Cow-Dung Cake is major fuels for cooking [19].

2. **Dumping into heaps or pits:** It is most common and old method of waste management, in this method all waste material dumped in to a pit at farm or field.

3. **Composting:** Composting is an accelerated bio-oxidation of organic matter passing through a thermophilic stage (45 to 65ºC) where microorganisms (mainly bacteria, fungi and actinomycetes) liberate heat, carbon dioxide and water. The heterogeneous organic material is transformed into a homogeneous and stabilized humus like product through turning or aeration. Composting is the aerobic degradation of biodegradable organic waste. It is a relatively fast biodegradation process, taking typically 4–6 weeks to reach a stabilized material. The composted material is odorless and fine textured with low moisture content and can be used as an organic fertilizer. Composting biological waste with poultry manure can be an effective means of conserving the nitrogen in the manure, which not only improves the fertilizer value, but also reduces the potential for NH_3 to contribute the environmental pollution [15].

Disadvantages

Loss of nitrogen and other nutrients during composting, equipment cost, labor, odor and requirement of land. Moisture (60%) and C/N ratio (20:1) have a major influence on a successful composting process. For poultry waste, a low C/N ratio contributes to large ammonia losses. High moisture content of more than 75% inhibits a quick start to the composting process.

Methods of composting

Farm compost is made by placing farm wastes in trenches of suitable size (4.5 m to 5.0 m long, 1.5 m to 2.0 m wide and 1.0 m to 2.0 m deep). Farm waste is placed in the trenches layer by layer. Trenches are filled up to a height of 0.5 m above the ground. The compost is ready for application within five to six months. There are various methods of composting:

1. Coimbatore method

Composting is done in pits of different sizes depending on the waste material available. A layer of waste materials is first laid in the pit. It is moistened with a suspension of 5-10 kg cow dung in 2.5 to 5.0 I of water and 0.5 to 1.0 kg fine bone meal sprinkled over it uniformly. Similar layers are laid one over the other till the material rises 0.75 m above the ground level. It is finally plastered with wet mud and left undisturbed for 8 to 10 weeks.

2. Indore method

Organic wastes are spread in the cattle shed to serve as bedding. Urine soaked material along with dung is removed every day and formed into a layer of about 15 cm thick at suitable sites. Urine soaked earth, scraped from cattle sheds is mixed with water and sprinkled over the layer of wastes twice or thrice a day.

3. Bangalore method

Dry waste material of 25 cm thick is spread in a pit and a thick suspension of cow dung in water is sprinkled over for moistening. A thin layer of dry waste is laid over the moistened layer. It is given a turning, plastered with wet mud and left undisturbed for about 5 months or till required.

Table 3: Factors affecting composting

Factors	Range	References
Temperature	52°C -60°C	Miller, 1992
Moisture content	50-60%	Gajalakshmi and Abbasi, 2008
pH	5.5-6.8	Miller, 1992
C:N	25:1 to 35:1	Bishop and Godfrey, 1983
Aeration (Oxygen)	15%-20%	Miller, 1992

The benefits of compost

- Compost adds organic matter, improves soil structure, reduces fertilizer requirements and reduces the potential for soil erosion.
- Composting reduces the weight and moisture content and increases stability of manure. Compost is easier to handle than manure and stores well without odors or fly problems, thus lowering the risk of pollution and nuisance complaints.
- Composted manure is less susceptible to leaching and further ammonia losses.
- Composting high-carbon manure/bedding mixtures lowers the carbon/nitrogen ratio to acceptable levels for land application.
- Proper temperatures within the compost pile will reduce pathogens.

B. Advance methods of livestock waste management

1. Solid waste management

a. Biogas production

Biogas is clean environment friendly fuel that can be obtained by anaerobic digestion of animal residues and domestic and farm wastes, abundantly available in the countryside. Biogas is bacterial conversion of organic matter in to gases under anaerobic conditions. Biogas generally comprise of 55-65% methane, 35-45% carbondioxide,0.5-1.0% hydrogen sulfide and traces of water vapor. Average calorific value of biogas is 20MJ/m3 (4713kcal/m3). An estimate indicates that India has a potential of generating 6.38X1010m3 of biogas from 980 million tons of cattle dung produced annually. The heat value of this gas amounts to 1.3X1012MJ [9]. In addition, 350 million tons of manure would also produce along with biogas.

Various advantages of bio gas production

1. Biogas provides an environmentally friendly process that supports sustainable agriculture.
2. It is one of the simplest sources of renewable energy and can be derived from sewage; liquid manure from hens, cattle and pigs; and organic waste from agriculture or food processing.
3. The by-products of the 'digesters' provide organic waste of superior quality
4. Biogas is particularly well suited to household energy needs as it, improves both soil conditions and household sanitation.
5. Manure-based biogas digester systems are considered ecological since the technology captures and utilizes methane directly, thereby limiting total greenhouse gas emissions from livestock.
6. By using bio-energy resources and non-polluting technology, biogas generation serves a triple function: waste removal, environmental management and energy production.
7. Biogas is now widely integrated with animal husbandry and can become a major means of manure treatment in the agricultural sector and environmental protection.

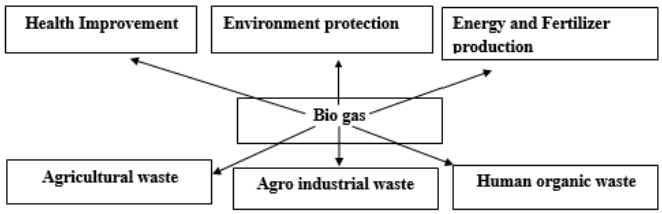


Fig 1: Multiple benefits from integrating waste flows for energy production

Table 4: Potential of gas production from different wastes

Type of waste	Gas yield/ kg (m3)	Normal manure availability per animal per day (kg)	Gas yield per day (m3)
Cattle dung	0.036	10.00	0.360
Buffalo dung	0.036	15.00	0.540
Pig manure (approx. 50 kg wt.)	0.078	2.25	0.180
Chicken manure (approx. 2 kg wt.)	0.062	0.18	0.011
Human excreta (Adult)	0.070	0.40	0.028

Table 5: Quantities of biogas consumed for various applications [12]

Use	Specifications	Quantities of gas consumed
Cooking	Per person per day	0.24 m3/day
Lighting of lamp	100 candle power lamp	0.13 m3/h
Duel fuel engine	75-80 % replacement of diesel oil per B.H.P.	0.50 m3/h
Electricity	1 Kwh	0.21 m3/h

Types of biogas digester

Biogas digesters are generally sized on the basis of local energy requirements and the cattle dung production of the farm.

Two main types of designs exist the fixed dome type of biogas plant and the floating drum type biogas plant.

1. The fixed dome biogas plant placed underground. The plant is constructed with local materials: bricks sand and cement and has an estimated lifetime of 25 years. The family size biogas plant ranges from 1 to 10 cubic meters, depends on the resources available and gas utilization. The average cost of a 2 m3 /day fixed dome biogas plant is approximately Rs. 21,500.

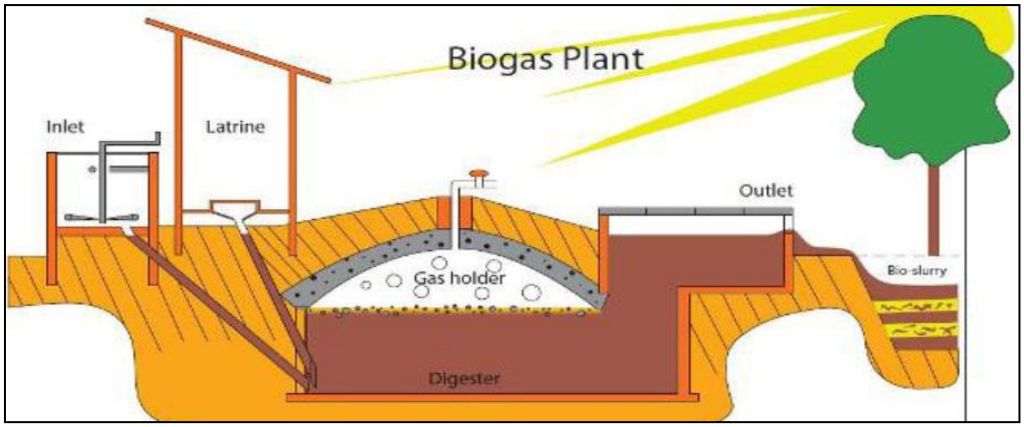


Fig 2: Fixed dome type biogas plant

2. The floating drum biogas plant is relatively simple in construction but costly as compared to fixed dome type for same size plant. The average cost of a floating drum type biogas plant of 2 m3/day capacity is around Rs. 35,000. It ranges from 1 to 200 cubic meter/day capacity plants. The gas drum is installed above the digester in the ground. The inlet tank is installed higher than the outlet tank and connected by the digester with asbestos cement pipe. The biogas produced in the digester is stored in the floating drum which is connected to the gas burner with GI / PVC tubing. The cattle dung is mixed with water in 1:1 ratio in the input tank and feed into digester after proper mixing daily for biogas production. After complete digestion, the digested slurry comes out from the digester and stored in outlet tank which further used as organic fertilizer in the field for crop production.

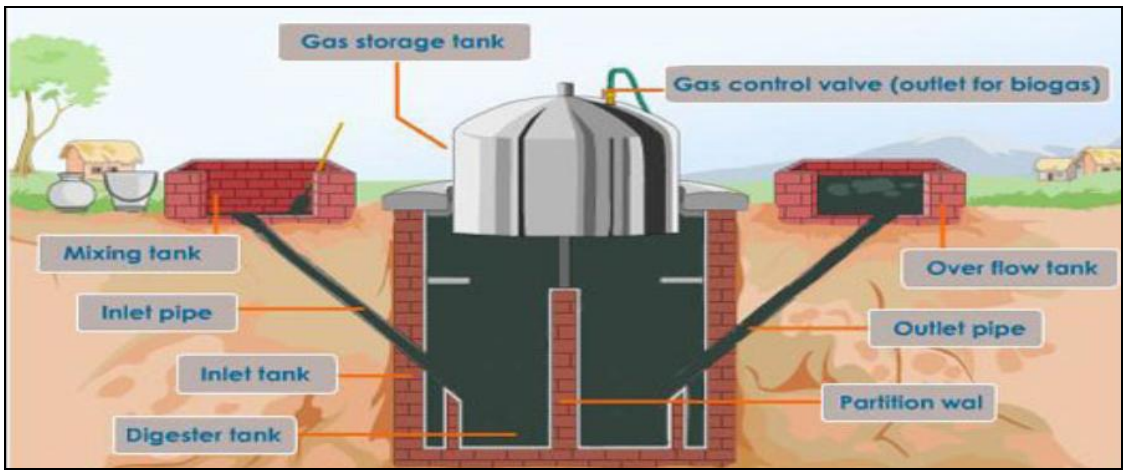


Fig 3: Floating drum type biogas plant

Biogas production process

Biogas production process (Anaerobic digestion) is a multiple-stage process in which some main stages are:

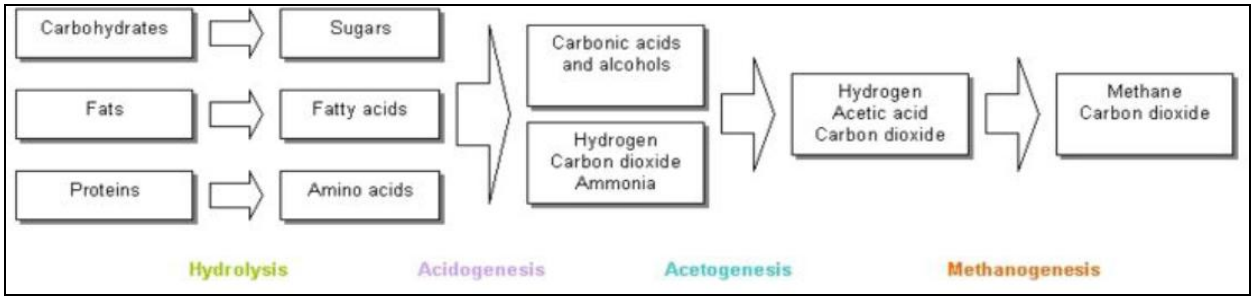


Fig 4: Bio gas production process

In the first stage, complex components, including fats, proteins and polysaccharides, are hydrolysed and broken down to their component subunits. This is facilitated by facultative and anaerobic bacteria, which then subject the products of hydrolyses to fermentation and other metabolic processes leading to the production of simple organic compounds. This first stage is commonly referred to as acid fermentation and in this stage organic material is simply converted to organic acids, alcohols and new bacterial cells.

The second stage involves the conversion of the hydrolysis products to gases (mainly methane and CO_2) by several different species of strictly anaerobic bacteria and is referred to as methane fermentation. Anaerobic digestion results in the production of biogas and also stabilizes raw slurry and reduces a substantial proportion of its polluting power in terms of biochemical oxygen demand and chemical oxygen demand. The readily degraded organic components are removed and the resulting materials are more uniform, more liquid and much easier to mix. Some of the fibers are partially degraded and the solid fraction can be separated from the liquid portion, sorted in a heap, and utilized by land application. The odor is reduced and much of the original nitrogen is retained in the liquid fraction.

Factors affecting optimum biogas production

- Temperature (35-37°C Mesophilic condition).
- C/N ratio (optimum between 25:1 to 30:1).
- pH (optimally pH between 6.8-7.2).
- Solid content (feed material should have approx.10:1) should not have toxic material/ harmful material to bacteria in digester.
- Hydraulic Retention Time –30, 40, 55 days.
- Loading rate.

Utilization of biogas

Cooking

Biogas can be used in a specially designed burner for cooking purpose. A biogas plant of 2 cubic meters capacity is sufficient for providing cooking fuel needs of a family of about five person [14].

Lighting

Biogas is used in silk mantle lamps for lighting purpose. The requirement of gas for powering a100 candle lamp (60W) is 0.13 cubic meter per hour.

Power generation

Biogas can be used to operate a dual fuel engine to replace up to 80% of diesel-oil. Diesel engines have been modified to run 100 percent on biogas. Petrol and CNG engines can also be modified easily to use biogas.

Fuel

After removal of carbon-dioxide, hydrogen sulphide, and water vapor, biogas can be converted to natural gas quality for use in vehicles.

Compressed bio-gas (CBG) from bio-gas

CBG produced by compressing 40 % by volume of carbon dioxide and fraction of hydrogen sulphide. Scrubbing system enriched with methane about 95 %, it makes gas moisture free by passing it through filters. Gas compressed up to 200 bar pressure using a three-stage gas compressor. Stored in high pressure steel cylinders [24].

- CBG can be used to power motor vehicles.
- Can be used as fuel for cooking.
- Can be used as lighting of houses.

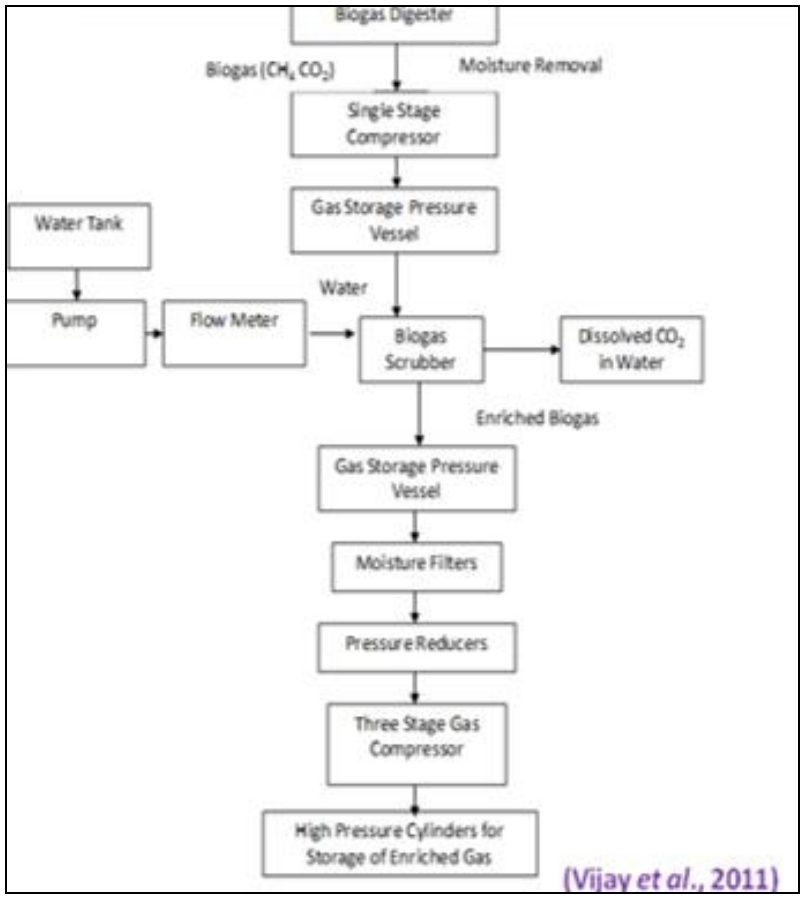


Fig 5: Process flow chart of bio gas enrichment and compression

Table 6: Estimate for 1000m³ Biogas to CBG Bottling Plant

Particular	Amount
Waste Required	20 Tons Cattle Dung
Biogas Production	1000 M³ /Day
Cost	Rs. 60 Lakhs
Purified Gas Quantity	375 Kg
Purified Gas Composition	CH4: 95 %, H2S: < 25 ppm, Moisture: < 20 ppm
Cost	Rs.55 Lakhs
Annual Profit	Rs 34.125 Lakhs

Electricity from biogas

Methane produces 600-800 Btu/ft^3 heat, this Mechanical energy activates generator to produce electrical power. Gas turbines and internal combustion diesel engine use to convert gas into power. It can produces maximum 15 kw power and fuel consumption is 1m³ of biogas per kwh output. Cost - Rs.20,000 to 25,000/- per installation [8].

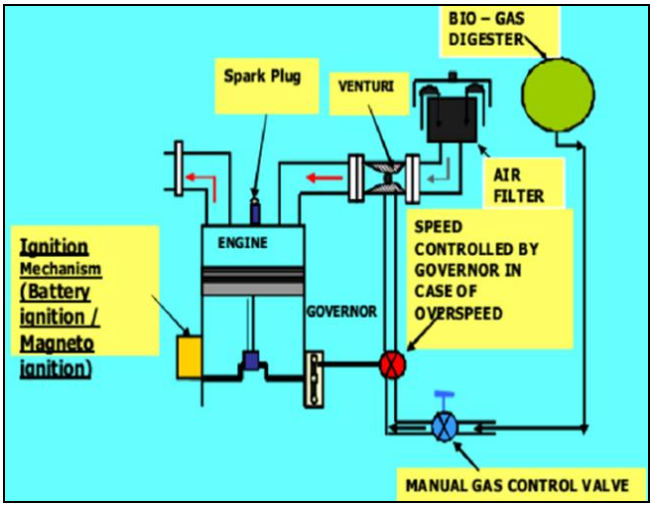


Fig 6: Schematic diagram for conversion to biogas engine from diesel engine

b. Rotary drum composter

Drum is mounted on four metal rollers attached to a metal stand, which is rotated by 7.5 MW motor 2 times in a day. Rotation adds oxygen and release the heat and gaseous products of decomposition. Maximum particle size in the mixed waste is 1cm [12].

Advantages

- Composting time is drastically reduced to 2-3 weeks.
- It can be placed at the site of organic waste generation.

C. Vermicomposting

The earthworm eats the organic matter and excrete little pelleted material called "Vermicompost". During vermicomposting, the important plant nutrients, such as N, P, K, and Ca present in the organic waste are released and converted into forms that are more soluble and available to the plants. Vermicompost also contain biologically active substances such as plant growth regulators. Moreover, the worms themselves provide a protein source for animal feed. It Increase N, P, K content 3 to 4 times and composting time is reduced to 60-75 days.

Types of earthworms

There are different species of earthworms Viz. *Eisenia foetida* (Red earthworms), *Eudrilus eugeniae* (night crawler), *Perionyx excavates* etc. Red earthworm is preferred because of its high multiplication rate and thereby converts the organic matter into vermicompost within 45-50 days. Since it is a surface feeder it converts organic materials into vermicompost from top. Its conversion rate is 2 quintal/ 1500worms/2months.

Methods of vermicomposting

Vermicomposting is done by various methods, among them bed and pit methods are more common.

Bed method

Composting is done on a pucca/kachcha floor by making bed (6x2x2 feet size) of organic mixture. This method is easy to maintain and to practice.

Fig 7: Bed method of composting

Pit method

Composting is done in the cemented pits of size 5x5x3 feet. The unit is covered with thatch grass or any other locally available materials. This method is not preferred due to poor aeration, water logging at bottom, and more cost of production.

Fig 8: Pit method of composting

Process of vermicomposting

Following steps are followed for vermicompost preparation

- Vermicomposting unit should be in a cool, moist and shady site.
- Cow dung and chopped dried leafy materials are mixed in the proportion of 3:1 and kept for 15-20 days.
- A layer of 15-20 cm of chopped dried leaves/ grasses should be kept as bedding material at the bottom of the bed.

- Beds of partially decomposed material of size 6x2x2 feet should be made.
- Each bed should contain 1.5- 0.2 quintal of raw material and the number of beds can be increased as pre raw material availability and requirement.
- Red earthworm (1500-2000) should be released on the upper layer of bed.
- Water should be sprinkled daily and cover with gunny bags.
- Bed should be turned once after 30 days for maintaining aeration for proper decomposition.
- Compost gets ready in 45-50 days.
- The finished product is 3/4th of raw materials used.

Harvesting

When raw material is completely decomposed it appear black. Watering should be stopped as compost gets ready. The compost should be kept over a heap of partially decompost cow dung from compost. After two days compost can be separated and sieved for use. Optimum moisture level 30-40 % should be maintained and 18-25 ºC temperature. C/N ratio of vermicompost should be 11.88, total nitrogen should be 1, 02%, Total Phosphorus should be 0.30%, Total potassium should be 0.24% and calcium and Magnesium should be 0.17% and 0.06% respectively.

Doses: The doses for field crops should be 4.5-5 t. per hectare, for fruit crops 3-5Kg per plant.

d. Pyrolysis

A thermochemical process, in which waste is chemically decomposed in a closed system at 400 to 1472° F. Pyrolysis is the chemical decomposition of condensed organic materials by heating in a reactor, largely in the absence of oxygen. The pyrolysis mainly uses straw, branches, sawdust and other agricultural and forestry waste as raw material, through high temperature and pressure, forms the raw materials into a variety of products. Manure may be pyrolyzed by subjecting it to a temperature of 480-1830°F in an oxygen-deficient atmosphere. The products are gases, oil, and ash. The gases include H_2, H_2S, CH_3, CO, and ethylene. Various livestock manures and found that dairy feces produced the most gas per unit of dry solids, followed by chicken, beef, and swine feces [25].

f. Soldier fly breeding

Black soldier fly (BSF) larvae or "grubs" are uniquely suited to treat livestock waste. While the BSF adults only live for a few days their larvae can live for several weeks, and during that time they can consume huge quantities of food waste or manure. There are two useful byproducts of this process; the residue or castings which can be used as a soil enrichment, and the larvae themselves which represent an excellent source of food for many types of animals including fish, birds, reptiles, amphibians and more.

g. Litter management

Poultry litter includes excreta, bedding, wasted feed and feathers. Bedding may consist of wood shavings, sawdust, straw, peanut hulls or other fibrous materials. Most of the poultry litter is from broiler production. The litter may be from one crop of broilers or accumulated over several crops of birds. The litter usually contains 20 to 25% moisture.

Poultry litter is fed mainly to beef cows and stocker cattle. Broiler litter contains 25 to 50% crude protein and 55 to 60% TDN, dry matter basis, and is rich in essential minerals. Thus, the nutritional value is similar to or higher than good quality legume hay**.** Poultry litter instead of being a problem of waste can and should be a source of energy and nutrients.

The poultry farms in India exist as clusters and the quantity of litter available cannot be so high to encourage the investors to go for power generation using combustion route. Therefore, gasification (thermal degradation) appears to be the economically viable solution for the effective disposal of waste with revenue generation [13].

2. Liquid waste management

Ammonia Recycling

Recycle ammonia from livestock waste water by using gas permeable membrane is a common method [23]. This membrane is water proof and allow only the passage for gases. Passage of gaseous ammonia through a micro porous hydrophobic membrane helps to Capture and concentration of gases in a stripping solution. Stripping solution is organic acid, and mineral acid of 1 normality. Membrane used for filtering are Polypropylene, Polyurethane. Average removal rate are 45-153 mg of ammonia per lit. per day, manure pH – increases ammonia recovery 1.2% per hour when pH 8.3 and 13% per hour when pH 10.

3. Carcass Disposal

a. Traditional Method

1. Burial: The most common method of carcass disposal. For burial a pit of about 8-9 feet depth dug and the width and length depends upon the size of carcass. The carcass is laid on its back with feet upward in the pit. Bedding used for the dead animal, its excreta, feed left over and the top 5c.m. soil from the place where dead animal was lying, should also be buried along with the carcass. The carcass is covered with a thick layer of quick lime and the pit is then filled with dirt or soil. The pit can be fenced if required. The area surrounding the burial pit can also be sprayed with suitable disinfectant Select burial sites with care to avoid ground water contamination.

Buried carcass must be

- Five feet above the seasonal high-water table.
- Stay away from lakes, rivers, streams, ditches, etc.
- Covered immediately with enough soil to keep scavengers out (3 feet is sufficient).
- Avoid sandy or gravelly soil types.
- Maintain at least ten feet vertical separation from bedrock.
- After burial the site must be covered by at least three feet of soil, with at least top foot capable of sustaining vegetative growth.

2. Burning: It is the method of burning the carcass at high temperature of fire. In this method 7 feet long trenches crossing each other are dug. The trenches are made 15" wide and 18" deep in the centre and made shallow towards ends. The trench is first filled with wood, branches of tree, straws, etc. before placing the carcass. Sufficient quantity of kerosene is sprinkled over the entire material and then the straw is ignited by firing the wood the carcass and all the infectious materials will be completely burnt.

3. Electric incinerators: In this method carcass is burnt in electric incinerator. This is economical and safe method for cremating large number of carcass from a single trained

operator in lesser time without risk of infection.

b. Advance Method

Composting of carcass

Thumburmuzhy model is used to compost animal carcass, in this method a wooden bin of - 6 ft x 6 ft x 6 ft should be made Wooden container model with 2ft x 2ft x2ft made to contain the bin. A Ferro cement tank 4ft x 4ft x 4ft constructed with concrete bricks with air holed side. Six inch layers each of fresh cow dung, dry leaves /straw, and organic waste were layered over the base of bin first layer acted as the bacterial consortium, second layer act as the carbon source [5], third layer is comprised of carcass. Curing time-90 days ferro cement model is best.

Fig 9: Ferrocement thumburmuzhy model

Fig 10: Concrete brick masonry M

Conclusion

Livestock production systems produce a large quantity of animal manure. The management of manure as a resource can offer benefits to livestock producers. Livestock waste management helps to maintain soil fertility in soils lacking organic content. Efficient management of livestock waste helps to increase socio- economic status of developing country, and also reduce chances of spreading disease from waste.

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