PARIVESH

Solid Waste Management in Slaughter House

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EDITORIAL

The importance of waste management in industries hardly needs any emphasis. Effective waste management not only reduces environmental problems but also increases productivity of industrial activity. Slaughter house generates substantial quantity of solid wastes. Waste management in regard to this category of units has special significance because their wastes tend to form an ideal breeding ground for pathogenic micro-organisms. Such wastes attract flies, dogs, birds and other vermin, thus causing public nuisance and also accompanied by the danger of spreading disease if disposed of without proper care. Burning or burying of wastes leads to the total loss of potential by-products. Waste processing and disposal has to be economical and environmentally acceptable. It needs to be noted that almost all the wastes generated by a slaughter house can be processed to obtain various products which have commercial value.

The issue of Parivesh outlines different methods for processing, utilisation and disposal of slaughter house wastes. I am thankful to my colleagues Shri D.S. Kharat, Environmental Engineer, Shri Lokesh Kumar, Sr. Scientific Assistant, Shri P. Kumar, Sr. Environmental Engineer and Shri P.M. Ansari, Additional Director for their contribution in this publication

It is hoped that this publication would be useful to municipal agencies, agencies responsible for day-to-day operation of slaughter houses, regulatory agencies and others involved in this field.

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1. INTRODUCTION

There are 2702 registered slaughter houses in the country, which are mostly service oriented performing only slaughtering and dressing. Slaughter houses, besides catering to the needs of consumers, serve as source of raw materials for a wide range of industries such as tanneries, bone mills, gelatine, glues, live stock animal feed processing units and pharmaceuticals. A large number of the slaughter houses are very old and operate with inadequate basic amenities such as lairage, proper flooring and water supply.

Live stock available for slaughtering comprises of animals namely, buffaloes, cattle, sheep, goats, pigs and poultry. As per the recent data published by the Ministry of Agriculture, live stock population is 84.2 million buffaloes, 204.5 million cattle, 50.8 million sheep, 115.3 million goats, 12.8 million pigs and 307.1 million poultry. In the year 1992-93, meat production was 1.5 million tonnes which increased to 2 million tonnes in 1997-98. State-wise meat production is given in Table 1. West Bengal, Bihar, Delhi and Maharashtra are the states which contribute over 60 per cent of meat production in the country.

Table 1: State-wise production of meat

State	1992-93	1997-98
1 Andhra Pradesh	96	106
2 Arunachal Pradesh	14	17
3 Assam	22	16
4 Bihar	260	400
5 Goa		
6 Gujarat		18
7 Haryana	7	8
8 Himachal Pradesh	4	4
9 Jammu & Kashmir	10	23
10 Karnataka	58	73
11 Kerala	99	111
12 Madhya Pradesh	17	22
13 Maharashtra	147	199
14 Manipur	10	18
15 Meghalaya	22	29
16 Mizoram	2	7
17 Nagaland	13	18
18 Orissa	29	37
19 Punjab	5	6
20 Rajasthan	25	39
21 Sikkim		3
22 Tamil Nadu	60	41
23 Tripura	3	6
24 Uttar Pradesh	106	157
25 West Bengal	410	427
26 A&N Islands	0	1
27 Chandigarh	1	1
28 D.& N. Haveli		0
29 Daman Diu		0
30 Delhi	166	200
31 Lakshadweep		0
32 Pondicherry	3	3
Total	**1591**	**1988**

Quantity expressed as thousand tonnes
Source: Department of Animal Husbandry and Dairying, Ministry of Agriculture, Govt. of India

2. CLASSIFICATION OF SLAUGHTER HOUSES

Based on scale of operation, slaughter house have been classified into three categories namely, large, medium and small as given in Table 2.

Table 2: Classification of slaughter houses

Category	Slaughtering capacity (tonnes of live weight killed per day)
Large	Above 70
Medium	15 - 70
Small	Below 15

3. PROCESS AND OPERATIONS

Slaughtering: Large animals are slaughtered as per the Islamic rites by halal method. In majority of units stunning facility is not available, and the animal is pushed on the floor for slaughtering and bleeding.

Goats and sheep are slaughtered either by halal or jhatka methods as per the needs of consumers. The animal is stunned with the help of electric stunner in mechanized slaughter houses, whereas in manual slaughter houses stunning is not practiced before slaughtering.

Dressing: The dressing operation consist of removal of horns, legs, head trimming, demasking, flaying of abdomen and chest and removal of hide or skin.

Evisceration: In this process, edible and non edible offal are segregated. While the edible offal are cleaned with water and sold, the non edible portions are disposed of as solid waste In mechanised slaughter houses, dressing and evisceration is carried out in hung position with the help of equipments.

In case of pig slaughtering also the basic unit operations viz. slaughtering and bleeding, dressing, and evisceration are identical to large animals (bovines) and goat and sheep slaughtering. Only the additional operations are stunning, scalding and dehairing.

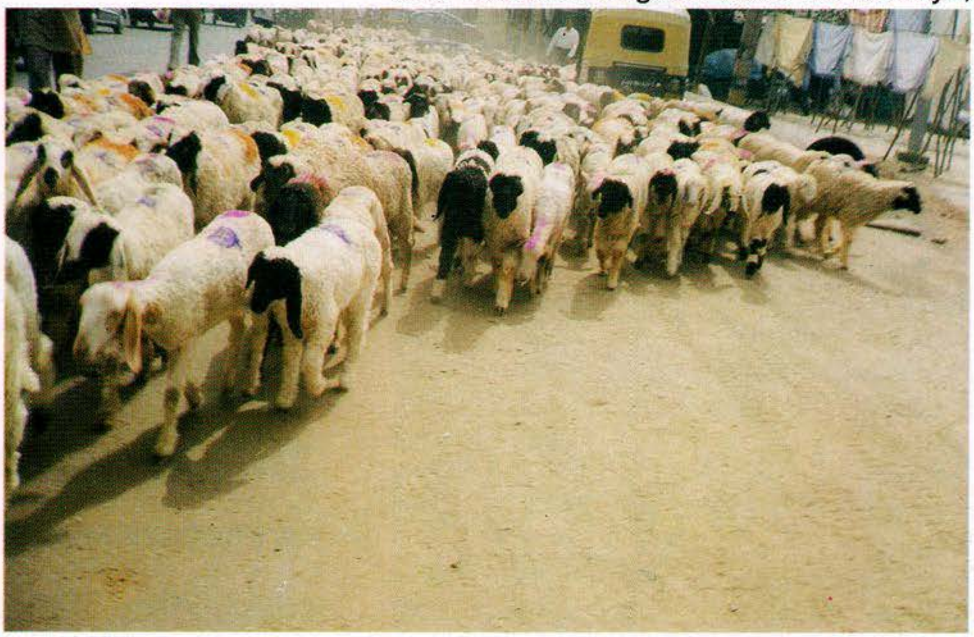
Stunning: The animal is stunned with an electronic instrument. Subsequently, sticking is done and body is hoisted on rail to ensure complete bleeding.

Scalding: For dehairing, the carcass is dipped into hot water at 60 °C for 5 minutes to relax the muscles and make the dehairing operation easier.

Dehairing: Animal is transferred to a mechanical dehairing machine. The final dehairing is done manually or by using gas burner. Thereafter, the dehaired carcasses are washed. In manual slaughtering, stunning is not practised and dehairing is done manually.

4. SOLID WASTE GENERATION

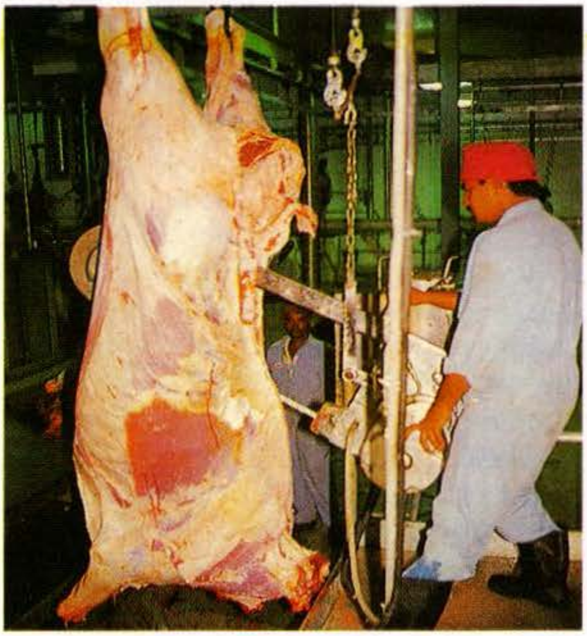
Carcasses are the products of slaughter house. Other offals are by-products or wastes. Generally, the terms by-products and offal are used to denote every part which is not included in a dressed carcass. By-products can be divided into two groups namely, edible and inedible. Organs such as kidneys,



Animals arriving at slaughter house

brain, liver, heart, gullet are examples of edible by-products. Hooves, horns, hair, bristles, gall blader, ears, skin etc. are among the inedible by-products. By-products can form a part of edible meat or can be converted to produce items for various commercial usages. The components left unrecovered simply form solid wastes. It has been observed that waste generation is largely influenced by the facility for recovery of by-products. It also depends on customs of consumer community. As such, quantity of wastes varies from place to place.

Ruminal, stomach and intestinal contents essentially form solid waste. Besides this, stomach and large intestine are also disposed of as waste in most of the slaughter houses. Soft meat pats such as lungs and pancreas are collected in large slaughter houses for sale to poultry feed processing units, whereas these offals are disposed as waste in medium and small slaughter houses. Horns and hooves are generally collected for sale.



Dressing of carcass in progress

Based on the data collected during the survey, the solid waste quantity generated in the bovine, goat and sheep and pig slughter houses is shown Table 3. Average solid waste generation from bovine slaughter houses is 275 kg/tonne of live weight killed (TLWK) which is equivalent to 27.5 per cent of the animal weight. In case of goat and sheep slaughter house, average waste generation amounts to be 170 kg per TLWK which is 17 per cent of animal weight. Solid waste generation from pig slaughtering is 2.3 kg/head equivalent to 4 per cent of animal weight.

It is observed that there is no organised system for disposal of solid wastes in most of the slaughter houses. The entire solid waste is collected and disposed of as land fill. In few slaughter house, dung and rumen digesta are collected separately for composting.

Table 3: Solid waste generation

Animal	Quantity of Solid Waste		
	Kg/ Head	Kg/ TLWK	% of Animal weight
Bovine	83	275	27.5
Goat/ sheep	2.5	170	17
Pig	2.3	40	4

Slaughter house waste contains mostly biodegradable matter. Characteristics of solid wastes form goat and sheep slaughtering are given in Table 4.

Table 4: Characteristics of slaughter house waste

Parameters	Value
Moisture, %	69.45
Total solids, %	30.55
Volatile solids, %	87.95
Fixed solids, %	12.05
Org. carbon, %	23.32
Total nitrogen, %	2.71
Phosphorous, mg/g	4.19
Potassium, mg/g	6.9

5. CLASSIFICATION OF SOLID WASTE

The solid waste of slaughter houses can be broadly classified into two categories i.e. vegetable matter and animal matter as given in Table 5. These waste streams should be segregated so that wastes can be properly treated.

Table 5: Classification of solid wastes

Category	Constituents of waste
Type-I waste	Vegetable matter such as rumen, stomach and intestine contents, dung, agriculture residues etc.
Type II waste	Animal matter such as inedible offals, tissues, meat trimmings, waste and condemned meat, bones etc.

6. SOLID WASTE MANAGEMENT

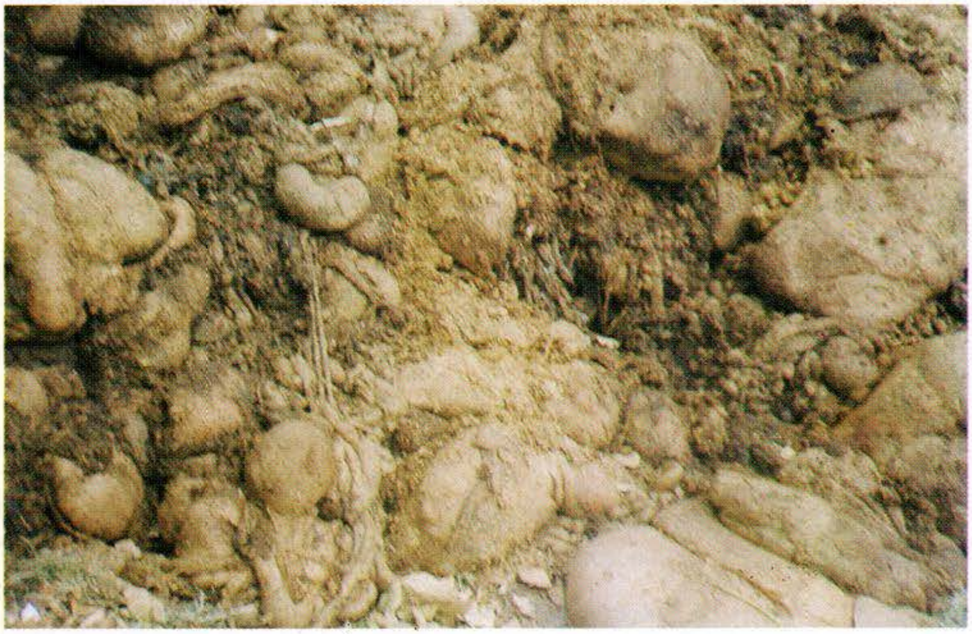
All most every by-product of slaughter house can be utilized. However, various circumstances do not always permit by-product recovery. The reasons may be inadequate quantity of materials, lack of markets, cost of processing etc. In such instances, they simply form part of waste lot for which different methods of processing and disposal have to be considered. For the slaughter house wastes composting, biomethanation and rendering systems are suggested. Selection of appropriate method, however, depends mainly on type of wastes and its quantity. Incineration is also an option for treatment of slaughter house waste.

6.1 Composting

Practically, all slaughter house waste i.e. type I and type II waste, can be used for compost making. The agriculture residue and dung from the lairage, ruminal and intestinal contents, blood, meat cuttings, floor sweepings, hair, feathers, hide trimmings can be stabilized by composting.

For preparation of compost stack, it is suggested that alternate layers of type I waste and type II waste should be built up to a height of 4 to 5 feet as shown in Fig 1. The heap should preferably be laid direct on the ground. It is advisable to put a layer of about 6-inch of course material, such as maize or millet stalks, banana stumps, straw, grass, small twigs etc. underneath in order to achieve proper ventilation. In case type II waste contains large organs such as kidneys and lungs or other similar wastes, then they are not put in whole but need to be minced or chopped into 2 to 3 inch pieces. For better results it is advised to mix these pieces with earth and evenly spread out in the centre of the heap where the temperature is high. Higher temperature in compost keeps rats, dogs or other vermin away. The ruminal and intestinal contents provide sufficient moisture for a start of bacterial activities. As such no water is required initially.

To achieve optimum conditions for the bacteria, moisture and proper aeration must be maintained from start to finish. A gradual reduction in height will follow, because of the shrinkage of decomposed matter. At least two turnings are required to obtain a uniform compost material. The first turning is normally advised after 2 to 3 weeks and the second turning after 3 to 4 weeks. The compost can be removed after 4 to 5 weeks. The total time required is about 90 days. This is reasonably enough time for composting, although it depends on many factors, such as type of material, size of heap, ambient temperature etc.



Solid Waste of Slaughter House

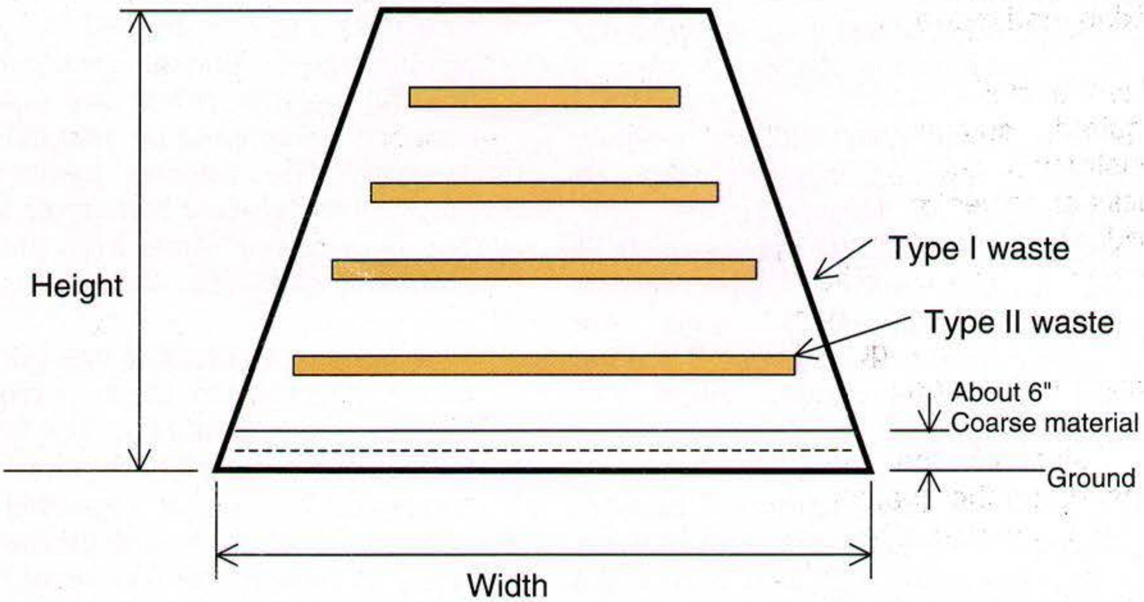


Fig. 1: Schematic of compost stack making

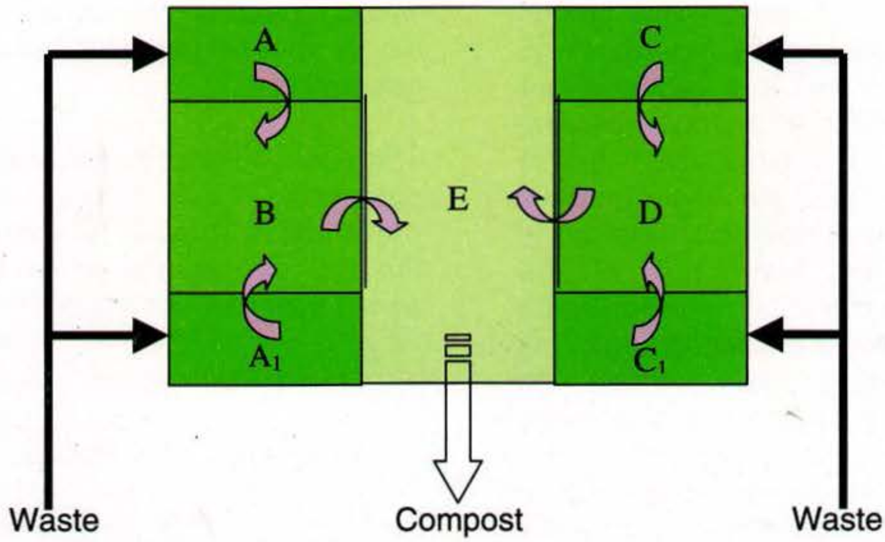
Manure Generated in Composting System

The quality of compost can be improved gradually with experience by proper combination of different wastes, providing appropriate time intervals for mixing, and moisture control.

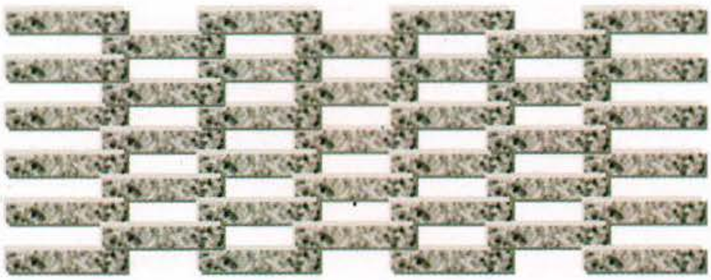
When a clean, neat and tidy heap is required, compost bunkers can be constructed. As shown in Fig. 2(b), bricks or cement blocks may be used to build a wall, leaving open spaces between bricks. Brick walls are preferred over wood, because the wood tends to rot very quickly unless it is properly preserved.

The size of the compost bunkers depends on the quantity of raw material to be converted. Fig. 2(a) shows the recommended layout, which facilitates easy turning of material and removal of finished product (compost). This consists of four raw material bunkers namely A, A_1 and C, C_1. Each of these bunkers has four walls. Bunkers B and D share two walls with A and C and have one outer wall each. The fourth side of B and D is formed by inserting wooden planks. Bunker E is used for the finished material. It has one outer wall, and one side closed by wooden planks or door. The wooden partitions are provided to facilitate turning or loading. The floor of the whole area should be preferably earth.

Raw material is stacked into bunkers A and A_1 first. When these bunkers are full, start using C and C_1. The first layer forming the base of A, A_1 and C, C_1 is suggested be coarse vegetable matter of about 6 inch thick. The bunker is now ready to receive the first lot of material from the slaughter house. The method for preparing heap and time of turnings remains the same as in case of compost stack.



(a)



(b)

Fig. 2: Compost bunker (a) Lay our plan; and (b) Break structure of bunker wall

6.2 Biomethanation

A biomethanation plant can be constructed in two ways. The gas is produced in one or more digesters and then it can be stored in a separate gas holder from where it is drawn as and when required. The other alternative is that the digester and gas holder are built so as to form one single unit. The gas is produced in the lower part of the structure, while the upper tank serves as a gas holder. While the second option is extremely simple and cheap in construction, but it has the disadvantage that gas production is affected during recharge. On the other hand, with a separate gas holder, continuous supply of gas can be assured even when one or more digesters are being charged. It is, therefore, more practicable for larger units to have separate gas holders.

Conventional Biogas Plant: Fig. 3 shows a conventional floating drum type biomethanation (biogas) plant. An inverted drum with a diameter slightly less than that of cylindrical digester serves as gas holder. The plant delivers gas at uniform pressure and provide good seal against gas leakage. It is reliable and has proven performance for cattle dung processing. However, the plant feed on slaughter house wastes such as rumen and paunch contents, dung etc. will also exhibit same performance when loading rate is maintained about 0.5 - 0.6 kg volatile solids / m^3/day. The waste should be suitably diluted before feed. The plant can handle feed with solid content up to 8 percent.

The anaerobically digested sludge has higher nitrogen content than compost manure. The sludge should be dewatered by sand filtration or filter press. The dried sludge can be utilized as manure in field. The filtrate is recycled for preparation of feed slurry, which contains microorganism. The biogas can be used for boiler or power generation.

The economics of a typical biogas plant processing 1250 kg/day of waste is presented in Table 6. It can be seen that the plant can save up to Rs. 83,800/- on account biogas and manure.

Table 6: Economics of a biogas plant

	Particulars	Value
a	Waste processing	1250 kg/d
b	Capital cost	Rs. 1.5 lakh
c	Operation & maintenance cost	Rs. 0.98 lakh /year
d	Interest and depreciation @ 15% interest, plant life 10 year	Rs. 0.30 lakh /year
e	Potential returns	
	Biogas generation	42.5 m3/day
	Equivalent power @ 2kwh/m3	85 kwh/day
	Cost of power @ Rs. 3/kwh	Rs. 0.918 lakh/year
	Quantity of manure	164 kg/day
	Cost of manure @ Rs. 2/kg	Rs. 1.18 lakh /year
f	Savings (e-c-d)	Rs. 0.838 lakh/ year

The success of a biomethanation plant depends on several factors, such as the quality of the raw materials, temperature, ratio of water to solids, and also on the type of bacteria present.

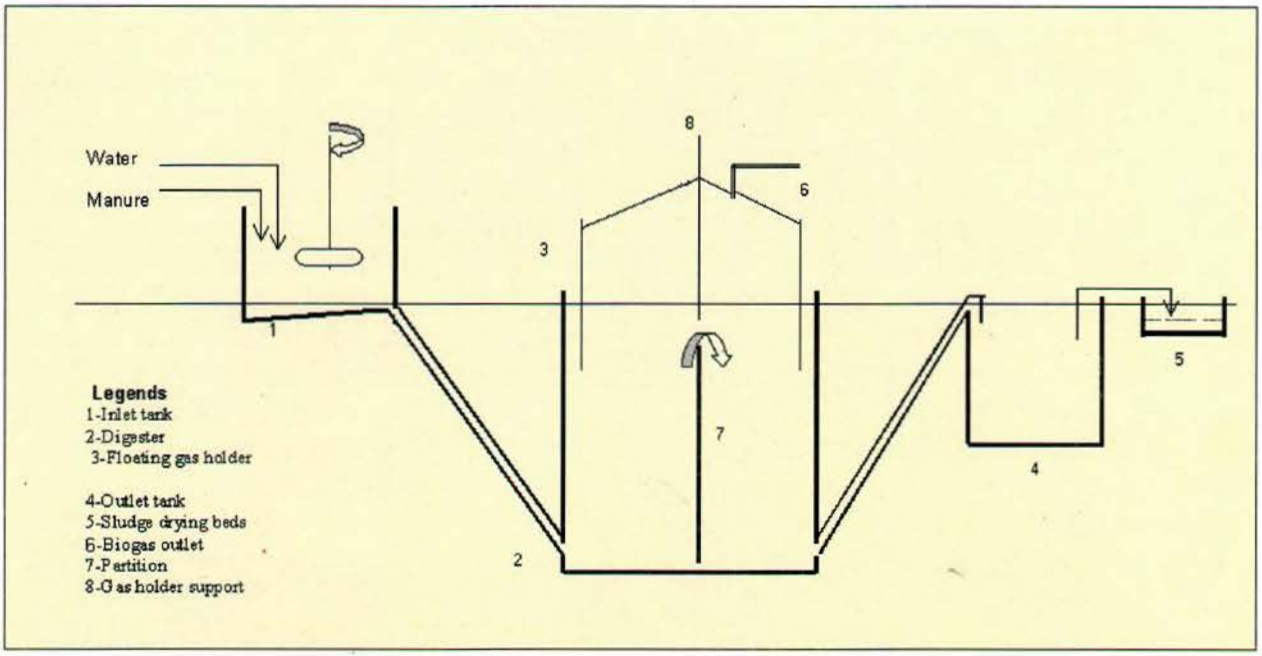
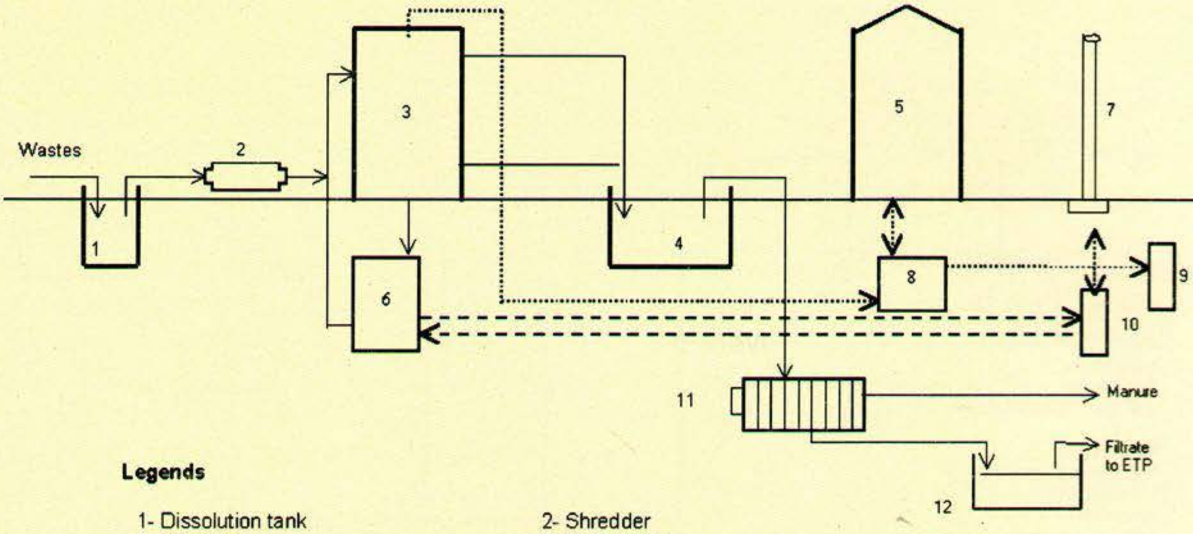


Fig. 3 Schematic Diagram of Conventional Biogas Plant

High Rate Biomethanation: The essential elements of a high rate biomethanation are complete mixing and uniform temperature with more or less uniform feeding of the substrate. Pre-thickening or dilution of the digester contents are optional features of high rate digestion system. The benefits of high rate biomethanation are reduced digester volume requirement and increased process stability. In high rate biomethanation system, there is proper arrangement for operation control and safety measures.

Complete mixing of substrate in the high rate digester creates a homogeneous environment throughout the digester. It also quickly brings the feed into contact with microorganisms and evenly distributes toxic substances, if any, present in the wastes. The entire digester is available for active decomposition, thereby, increasing the effective solids retention time. Temperature is one of the important environmental factor. In the cold climate areas, digester heating is beneficial because the rate of microbial growth and therefore, the rate of digestion increases with temperature.

A schematic diagram of a typical high rate biomethanation plant is given in Fig. 4. Wastes consisting of rumen and paunch contents, dung, agriculture residue, fat and blood is processed in the high rate plant. The solid wastes from different sections are collected in dissolution tank. The dissolution tank is used to adjust moisture and solid ratio and mixing the waste thoroughly. The waste containing up to 12 per cent solids is passed through shredder, which reduces solid waste size to required level. Waste is now pumped to digester. Hydraulic retention time of waste in the digester is about 25 days. At organic loading rate up to 2.5 kg/m^3/day, the digester can give up to 55 per cent efficiency in terms of volatile solid destruction. In digester optimum temperature of about 36 °C is maintained with the help of heat



Legends

1- Dissolution tank	2- Shredder
3- Digester	4- Buffer tank
5- Gas holder	6- Heat exchanger
7- Flare	8- Safety device
9- Steam boiler	10- Hot water boiler
11- Filter press	12- Holding tank
____ Substrate,	- - - Hot water
.... Biogas	

Fig. 4 Schematic Diagram of a High Rate Biomethanation Plant

exchanger. The digester has all accessories such as temperature and pressure indicators, overflow, safety valve etc. Specific biogas production in high rate plant is about 0.8 m^3/kg of volatile solids destroyed, having electrical equivalent of 2.11 kwh/m^3 of gas.

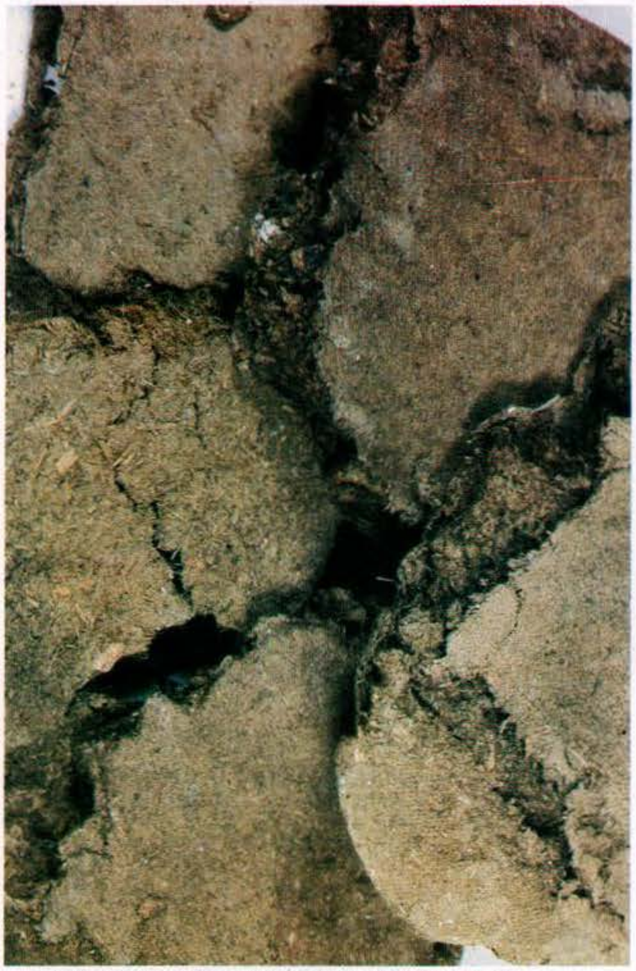
Economics of a typical high rate biomethanation plant catering to 60 tonnes/day of waste is worked out in Table 7. The plant generates about 2600 m3 biogas and 7 tonnes manure in a day which can give additional income of Rs. 40 lakhs per annum.

Table 7: Economics of a high rate biomethanation plant

	Particulars	Value
a	Waste processing	60 tonnes/day
b	Capital cost	Rs. 3.8 crores
c	Operation & maintenance cost	Rs. 31 lakhs /year
d	Interest and depreciation @ 16 % interest, plant life 15 years	Rs. 68 lakhs /year
e	Potential returns	
	Biogas generation	2600 m3/day
	Equivalent power @ 2.11 kwh/m3	5500 kwh/day
	Cost of power @ Rs. 4.5/kwh	Rs. 89 lakh /year
	Quantity of manure	7000 kg/day
	Cost of manure @ Rs. 2/kg	Rs. 50 lakhs /year
f	Savings (e-c-d)	Rs. 40 lakh/ year

6.3. Rendering

All the animal matter i.e. type II wastes such as inedible offal, tissues, meat trimmings, waste and condemned meat, bones etc. can be processed in rendering system. The main constituents of animal matter are fat, water and solids. The objective of rendering process is to physically separate the fat, the water and the solids. This is effected by heating and rupturing connective tissue of individual fat and muscle cells so that raw fat and other material bound within is freed. In rendering, fat recovered is used for industrial purposes, such as soap and greases. Fat recovered from flesh of healthy parts can also be used for edible purposes. Solid portion, which is known as meat meal or bone meal, is utilsed for the manufacture of stock feed and fertilizers.



Manure Produced in High Rate Biomethane System

Rendering is carried out in dry rendering or wet rendering plants. In both the processes, large pieces such as heads, bones etc are reduced in size by shredders or other machinery. Large soft offals are also cut to size before processing. Intestines, stomach and similar soft materials contain manure and, therefore, they are opened and cleaned before feeding to rendering plant.

Wet Rendering: The name wet-rendering is applied where the raw material is processed with added water or condensate derived from steam. The wet-rendering tank is usually a vertical, cylindrical boiler, having a cone-shaped bottom, with a gate valve outlet. Fig. 5 shows a typical batch type wet rendering plant.

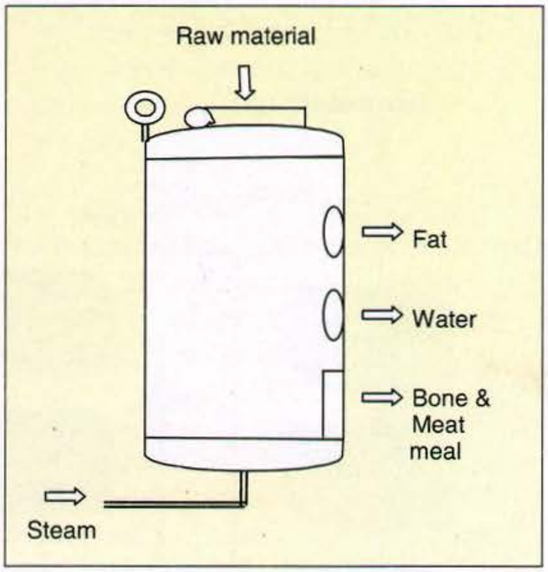


Fig. 5 Diagram of Batch Rendering Plant

At the top of the tank there is a manhole through which raw material is loaded, and also a valve through which obnoxious gases escape without reducing the pressure. Steam is injected from the bottom of the tank. Several draw-off cocks on the side of the tank, at different levels, enable the fat and water to be removed.

After the raw material is loaded, the manhole is tightly closed and steam is let into the mass. The steam pressure used will very with the material. The higher the pressure, the quicker the disintegration. For this reason, large plants often render the offal at a pressure of 4 kg/cm^2. However, high pressure may reduce the quality of the material, especially of the fat. For this reason, a pressure of 3 kg/cm^2 is usually maintained in the tank.

The time required to disintegrate the tissue and free all the fat varies from four to six hours, depending on the character of the offal. After cooking is completed, the contents of the tank are allowed to settle for about two hours. After settling, clean divisions is formed between the digested material, water and fat. The fat, having the lowest specific gravity, will be on the top, the sludge and solids having the high specific gravity will be at the bottom. The center will be occupied by water. Gradually the pressure is reduced to that of the atmosphere, and then the water and fat are ready to be drawn off through the side cocks. If the fat level is below a cock, the level can be raised as required by addition of water.

After the fat and tank water have been removed, the gate valve is opened and the digested mass of meat and bones is taken out. At this stage the mass may contain up to 55 percent moisture and

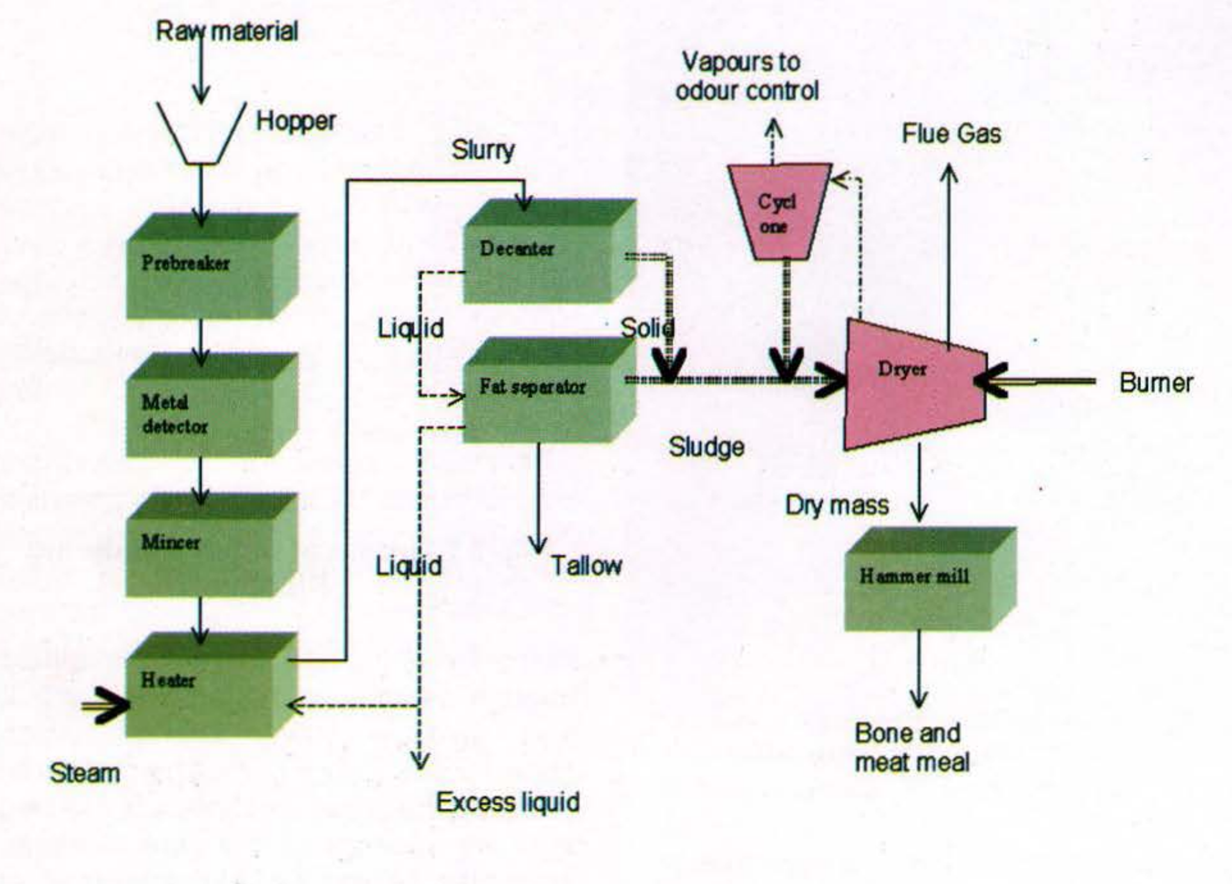


Fig. 6 Schematic Diagram of Integrated wet rendering plant

about 15 percent fat which can be dried in the dryer to obtain meat meal or bone and meat meal.

For large operation, integrated continuous rendering plants are used. An integrated rendering plant consists of pre-breaker, metal detector, fat separator, dryer and hammer mill. Total yield of bone and meat meal by wet rendering system is about 30 per cent of raw material weight and tallow about 10 per cent.

For large operation, integrated continuos rendering plants are used. An integrated rendering plant consists of pre-breaker, metal detector, fat separator, dryer and hammer mill. A schematic diagram of the integrated wet rendering plant is given in Fig. 6.

Dry Rendering: In this process, all the unwanted moisture is eliminated from type II wastes without the loss of any nutrient by using specially designed cooker. The dry rendering cooker, is a horizontal steam jacket equipped with a set of agitators, which keep the material in continuous motion. The steam is applied to the jacket only and not to the material to be processed, as in wet-rendering.

The material remains in the cookers for about 4 to 5 hours in most plants. Steam pressure in the cooker jackets usually ranges from 3 to 4 kg/cm^2. The dry heat transmitted from the steam jacket to the raw material converts the moisture present in material into steam, which gradually builds up the internal pressure of cooker. This pressure, combined with agitation, disintegrates the material and breaks down the fat cell. Dry rendering therefore works on steam pressure develop from the moisture contained in the raw material itself, and not as in wet-rendering, from the pressure created by injected steam.

In the wet-rendering process, the fat floats on top of the liquid and is separated out. In dry-rendering, the fat is released from the fat cells but is still dispersed throughout the material. The fat in the solids may be removed by either a hydraulic press or by using a centrifugal turbine fat extractor.

As seen from the above, the whole process, i.e., sterilization, digestion, and drying, take place in cooker only. Therefore, there is no loss of nutrient. The dry rendering process allows approximately 20 percent higher yield than the wet-rendering, as the water containing water-soluble extractives and proteinous suspended matter is not discarded.

The dry rendering plants have units such as metal detector, pre-breaker, cooker, fat extractor and hammer mill. A schematic diagram of a typical dry rendering plant is shown in Fig. 7.

Economics of dry rendering plant installed in a mechanised slaughter house has been worked out and presented in Table 8. On an average the plant renders 65 tonne/day of animal matters to produce 20.25 tonnes bone and meat meal and 8 tonnes tallow in a day.

6.4 Incineration

Incineration can be used for treatment of many wastes. Unlike previous methods, incineration provides no by-products but recovery of heat is possible. Incineration is a controlled combustion process for destruction of combustible wastes.

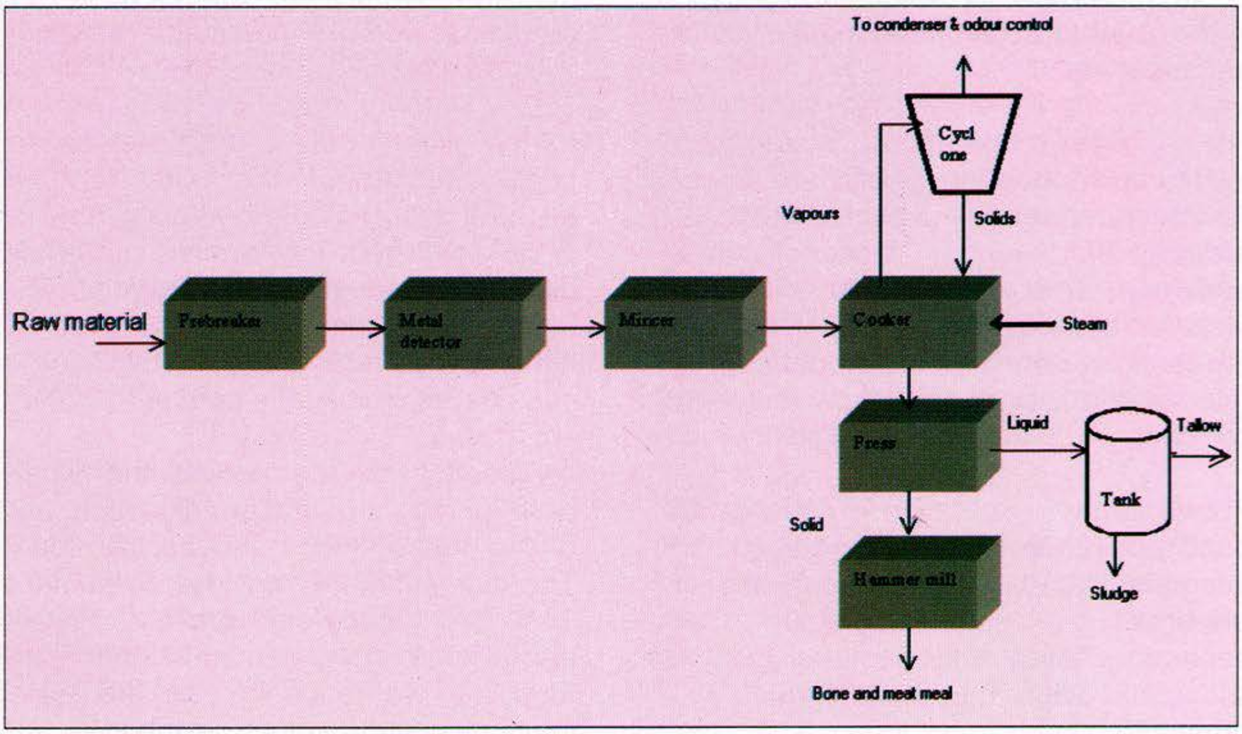


Fig. 7 Schematic Diagram of Dry Rendering Plant

Table 8: Economics of a dry rendering plant

	Particulars	Value
a	Waste processing	65 tonnes/day
b	Capital cost	Rs. 4 crores
c	Operation & maintenance cost	Rs. 12 lakhs /month
d	Interest and depreciation @ 16 % interest, plant life 15 years	Rs. 6 lakhs /month
e	Returns	
	Bone and meat meal production	20.25 tonnes/day
	Cost of bone & meat meal @ Rs. 9/kg	Rs. 47 lakhs /month
	Tallow production	8000 kg/day
	Cost of tallow @ Rs. 18/kg	Rs. 37 lakhs /month
f	Savings (e-c-d)	Rs. 66 lakh/ month

The wastes after combustion are converted to gaseous constituents and a non-combustible residue. The gases are released to atmosphere and the residue is usually disposed to landfill.

In incineration, waste is burnt at temperatures between 850 ^{0}C and 1100 ^{0}C in specially designed combustion chambers. An auxiliary fuel is required to start ignition and sustenance of combustion of wastes. Incineration is immediate, it does not require long residence as in case of other methods. Proper temperature control, mixing and turbulence are necessary for effective combustion. It requires skilled manpower for operations. Capital cost and recurring expenses of incinerator are high. By using heat recovery system, the cost of operation can be reduced through use or sale of energy. Incineration technique is yet to be practiced for treatment of slaughter house wastes in the country.

7. CONSTRAINTS AND RECOMMENDATIONS

Most of the slaughter houses in the country are very old and still in primitive condition. These units operate with inadequate basic amenities such as lairage, proper flooring, water supply etc. Many slaughter houses are much smaller and widely scattered. To equip such units for effective processing of waste is really a challenge. On reviewing various methods and the constraints, the best practicable method for different categories of slaughter house are suggested in following paras.

Large slaughter house are mostly in cities and located in congested areas. They generate substantial quality of solid wastes, which have to be processed in environmentally acceptable manner. For the large slaughter houses, biomethanation of type-I waste and rendering for type-II waste are suggested. Biomethanation requires less space, which is advantageous for the slaughter houses with land constraints.

Biomehanation for type I waste and rendering for type II waste should also be considered for medium size slaughter houses with an alternative of composting.

In case of small slaughter houses, sophisticated and capital intensive technologies is unviable due to low volume of wastes and non-availability of other infrastructure facilities. For small slaughter houses, a more pragmatic approach would be to make use of natural process such as composting. This would be financially and technically viable and should be acceptable by the small slaughter houses.

The best practicable methods currently available for processing and disposal of different wastes for the slaughter houses are summerised in Table 9.

Table 9: Recommended Methods for processing, utilization and disposal of solid wastes from slaughter house

Type of Waste	Constituents of wastes	Category of Slaughter House	Method(s)
Type I	Vegetable matter such as rumen, stomach and intestinal contents, dung, agriculture residues etc.	Large	Biomethanation
		Medium	Biomethanation Or Composting
		Small	Biomethanation Or Composting
Type II	Animal matter such as inedible offals, tissues, meat trimmings, waste and condemned meat, bones etc.	Large	Rendering
		Medium	Rendering Or Composting with type-I waste
		Small	Composting with type-I waste Or Burial*

*Should be considered as provisional measure.

Incineration can also be used, which is one of the effective means to treat volatile waste. These methods will reduce solid waste disposal problems in slaughter houses. However, there is need to upgrade old slaughter houses on modern lines for overall improvement in sanitation and hygiene and wholesome meat production. For modernisation of existing slaughter houses, the Ministry of Agriculture, Government of India provides assistance to the States. Financial incentives are also provided by the Ministry of Non-conventional Energy Sources for setting up of biogas plants and high rate biomethanation plants under its programmes on energy recovery from urban and industrial wastes and biogas management programmes.

8. CONCLUSION

All the methods, except incineration, facilitate recovery of secondary by-products such as manure, biogas, fat, bone and meat meal etc. while disposing the wastes in an environmentally sound manner.

Composting facility requires no initial investment. Once the compost system comes into operation, it produces manure, which is good soil conditioner. Biomethanation is admirably suited for the slaughter house waste to generate methane gas, which can be utilised for water heating, boiler or power generation and the manure of much greater fertilising value than ordinary compost. Fat and bone and meat meal obtained from rendering of animal matter also has varieties of commercial usage.

Adoption of above methods for solid waste management will improve sanitation in and around slaughter houses and it is beneficial to the slaughter houses in long run due to returns on account of recovery and use or sale of the secondary by-products.

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