

Technology Assessment of Slaughterhouse Solid Waste Management

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ABSTRACT: Due to the demand local and export of meat production in India, slaughterhouse are increased year over year. During per tonne of slaughtering of animal 25% of solid wastes are generated. The quantity of solid waste generation from slaughterhouses is varies depending on the scale of slaughtering process. Several treatment and disposal facility are practised such as open landfill, composting, incineration, anaerobic digestion etc. The present paper is focused on the assessment of treatment technology on the basis of socio, economic, environment and viable aspects. which consist following criteria i) facility requirement ii) treatment efficiency iii) technology implementation iv) cost v) socio vi) Environment and vii) health. The overall assessment score in the order of Open landfill (135) > Incineration (95) > composting (70) > anaerobic digestion (69) > anaerobic co-digestion (65). Based on the assessment anaerobic co-digestion is feasible and viable treatment technology for SHSW management in all the above criteria

KEYWORDS: Slaughterhouse, Solid waste management, Technology, Assessment.

I. INTRODUCTION

According to the livestock census 2014, India has the world's largest livestock population country, which is 56% of buffaloes, 13% of cattle, 13% of goat and 5% of sheep of world population respectively. According to FAOSTAT production data, India ranks top position among countries in the world in terms of number of cattle, buffaloes and goat. Based on the availability livestock population, India is contributing first largest exporter of buffalo meat production, second largest production in goat meat and third largest in sheep meat production. In FAOSTAT [1], India is trading of meat through the exporting 1511 million US\$ which is about 14, 49,100 tons of meat all over the world. There are nearly 2300 slaughterhouse in all over India [2]. Out of which 65 modern abattoirs [3] majorly contributing Indian meat export business. Due to demand of meat production, slaughterhouse are increased year over year. In India, over 2 million cattles and buffaloes, 50 million sheep and goat are slaughtered annually for domestic meat consumption and export purpose reported by CPCB [4].

The typical process of slaughterhouse process (figure 1) consisting of lairage, killing, abattoir, evisceration, chilling and processing. It is modified depends up on the slaughtering type i.e manual, semi-mechanized and mechanized. During per tonne of slaughtering of animal 25% of solid wastes are generated [5]. The quantity of solid waste generation from slaughterhouses is varies depending on the scale of slaughtering process [6]. The major solid wastes from slaughterhouses consist of dung, rumen contents, horns, intestine, paunch, urinary bladder, gall bladder, uterus, ear, meat trimmings, hide and skin trimmings and condemned meat. Typical slaughtering process and solid waste generation and management is depicted in Figure 1.

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At present no specific treatment is practising in slaughterhouse for solid waste management [7]. Several treatment and disposal facility are practised such as opendumping, composting, incineration/pyrolysis, anaerobic digestion etc., [8]. Small and medium slaughterhouses are not practising any treatment facility. They practising only disposal in the open dumping along with municipal solid waste, which has been more affect the air, land, water bodies and also the health issue [9]. Generally the solid waste are generated from lirage i.e maure is treated by composting and anaerobic digestion process in moderinzed salughterhouse. Whereas in small and medium slaughterhouses, entire solid wastes are dumped in to the open landill along with municipal solid waste. In the case of other solid waste like bone, meat trimming etc., has been treated by rendering plant and incineration for by-product recovery. Slaughterhouse solid wastes (SHSW) are highly organic in nature, due to disposal in the open dumping, emits methane in the atomosphere, which contributing global warming poteintial [10]. Presence of high organic material in the waste, which is more suitable for biological treatment [11]. The present paper is focused on the assessment of treatment technology on the basis of socio, econmic, environment and vaiability aspects.

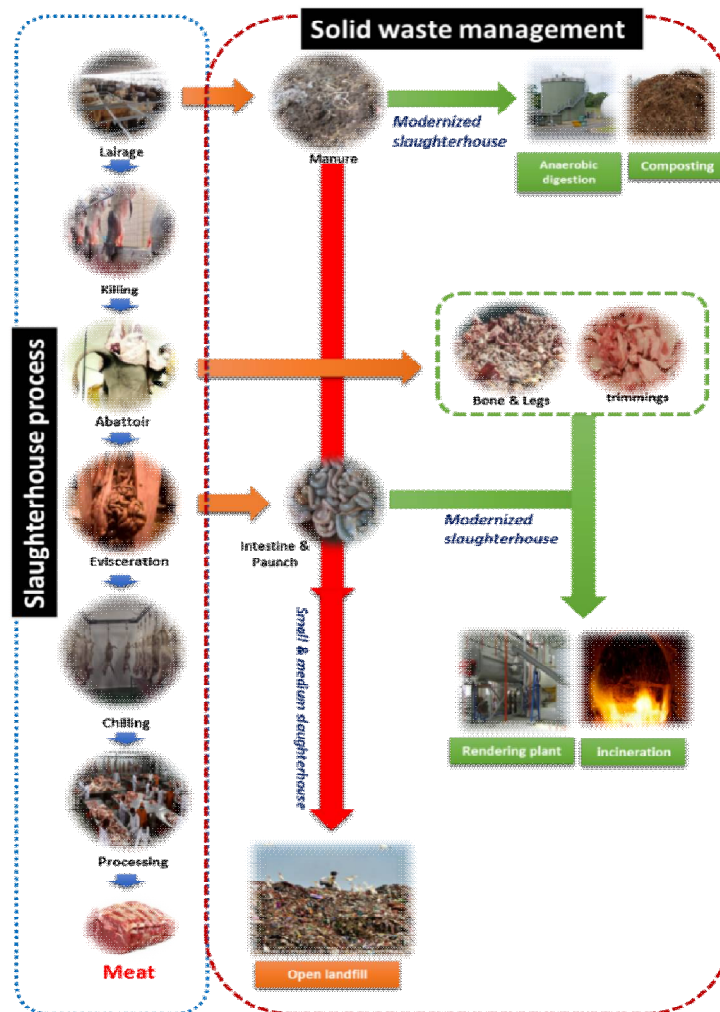


Fig. 1. Typical slaughtering process and solid waste generation and management

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II. METHODOLOGY

Assessment of different treatment technology for sustainable and feasible manner, which consist following criteria (Figure 2) of i) facility requirement ii) treatment efficiency iii) technology implementation iv) cost v) socio vi) environment and vii) health. The parameter consists of the assessment criteria is depicted in Figure 3. In the facility requirement criteria consist of land, energy and time requirement for treatment of SHSW. Treatment efficiency is considering the loading of solid waste, degradation efficiency, energy and by-product recovery. Technology implementation is reflects the installation viability and operation and maintenance (O&M) issue of the treatment facility. Cost consisting of both investment and O&M, in the case of open dumping transporation charge has been considering under this criteria. Socio is condering the job opportunity such as number of manpower required and quality of manpower (Skilled manpower). In the environment criteria focusing by pollution load from the treatment facility affects the air, water and land envionments. In the case of health parameters is focused by the pollution from treatment option, which impacts to human, plant, animal and microbial communities. Based on the parameters the score has been cacluated both impact of the treatment and efficiency of the treatment is tabulated in Table 1.

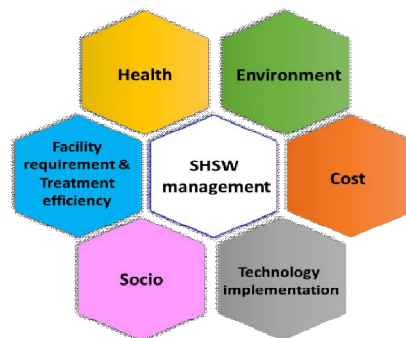


Fig. 2 Criteria for technology assessment of slaughter house solid waste management

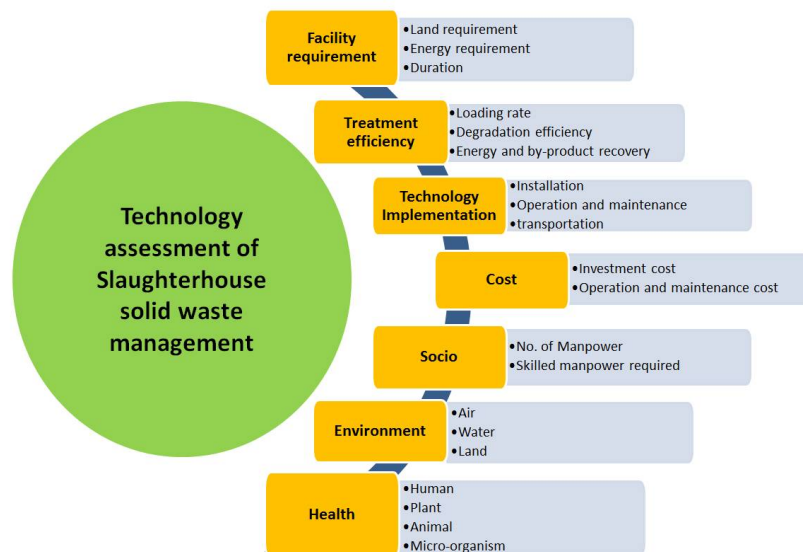


Fig. 3. Parameters used the technology assessment of slaughterhouse solid waste management

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Table 1 Score for assessment of impact and efficiency of treatment technology

Impact	Score	Efficiency
No	0	High
Low	1	Medium
medium	5	Low
High	10	No

The following technologies are commonly adopted in small, medium and large scale slaughter houses such as a) open landfill b) composting c) incineration d) anaerobic digestion and e) anaerobic co-digestion. The small and medium scale slaughterhouse are disposed the solid waste in open land fill along with municipal solid waste. Some of the municipal slaughter houses are practising composting the manure waste. The modernized large scale slaughter house are installed rendering plant for by product recovery and incineration/pyrolysis plant. It is very cost effective and energy intensive technology. Some of the slaughterhouses are applying anaerobic digestion system only for animal manure.

III. DISCUSSION

Technology assessment of SHSW has been carried out the above mentioned parameters is given in Table 2. Based on the study, all the categories are assessed and scored individually.

Facility requirement

In this categories the parameters are evaluated by the treatment system requires to implementation. The land requirement criteria, open landfill requires more land when compared with other treatment technologies. Further the composting treatment also need to have little high land requirement than the incineration, anaerobic digestion and anaerobic co-digestion process. In the case of energy requirement of the treatment facility top of the list is incineration. Incineration treatment needs to high energy consumption for burn the organic materials. the Anaerobic digestion and co-digestion process needs to very little energy requirement for pumping of digestate and sludge dewatering system. But in the case of composting and open landfill does not required energy. The duration for treatment SHSW was in the order of open landfill > composting > anaerobic digestion > anaerobic co-digestion > incineration. Based on the over all score of facility requirement open landfill and composting has high impact than other treatment technologies. In terms of energy consumption parameter, incineration not under the feasible and viable manner.

Treatment efficiency

This parameter consist of loading rate, degradation efficiency, energy and by-product recovery. Open landfill has a serious impact during the degraion of solid waste like which cause air, water and land pollution. In the other case of treatment facilities loading rate is evenly good. Whereas in degradation efficiency of anaerobic digestion limited due to presence of high protein and lipids, which is also affect biogas production due to ammonia and VFA toxicity [12-14]. But in the case co-digestion the toxicity has been minimized by addition of co-substrate due to dilution of toxic compounds, improve the balance of nutrients, which will be reflects in the enhanced energy recovery [15,16]. In the case of composting the average loading rate should be maintained for degradation and by-product recovery. Incineration is highly controlled facility and thermal destruction of organic is highly effective. Similarly anaerobic co-digestion is enhanced the biogas production when compared to the anaerobic digestion due to the balance of nutrient inside the reactor, which reflects methane composition in the biogas also high. Based on the overall treatment efficiency criteria incineration and anaerobic co-digestion fesiable and viable.

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Table 2 Technology assessment of slaughterhouse solid waste treatment

	Open landfill	composting	Incineration	Anaerobic digestion	Anaerobic co-digestion
FACILITY REQUIREMENT					
<input type="checkbox"/> Land requirement	10	10	5	5	5
<input type="checkbox"/> Energy requirement	0	0	10	1	1
<input type="checkbox"/> Duration	10	10	1	5	5
Sub-total A	20	20	16	11	11
TREATMENT EFFICIENCY					
<input type="checkbox"/> Loading rate	10	5	5	5	5
<input type="checkbox"/> Degradation efficiency	10	1	1	5	1
<input type="checkbox"/> Energy and by-product recovery	10	10	1	5	1
Sub-total b	30	16	7	15	7
TECHNOLOGY IMPLEMENTATION					
<input type="checkbox"/> Installation	0	5	10	10	10
<input type="checkbox"/> Operation and maintenance	0	5	10	5	5
<input type="checkbox"/> Transportation	10	1	1	1	5
Sub-total C	10	11	21	16	20
COST					
<input type="checkbox"/> Investment cost	0	1	10	5	5
<input type="checkbox"/> O&M cost	0	1	10	5	5
Sub-total D	0	2	20	10	10
SOCIO					
<input type="checkbox"/> Manpower required	5	5	5	5	5
<input type="checkbox"/> Skill based manpower	0	5	10	5	5
Sub-total E	5	10	15	10	10
ENVIRONMENT					
<input type="checkbox"/> Air pollution	10	5	10	1	1
<input type="checkbox"/> Water pollution	10	1	1	1	1
<input type="checkbox"/> Land pollution	10	1	1	1	1
Sub-total F	30	7	12	3	3
HEALTH					
<input type="checkbox"/> Human	10	1	1	1	1
<input type="checkbox"/> Animal	10	1	1	1	1
<input type="checkbox"/> Plant	10	1	1	1	1
<input type="checkbox"/> Micro-organism	10	1	1	1	1
Sub-total G	40	4	4	4	4
OVERALL TOTAL	135	70	95	69	65

Treatment implementation

This criteria has been covered by installation, operation and maintenance of treatment facility and transportation of waste. Apart from the open dumping and composting treatments, impact of installation, operation and maintenance is high. Compared with the anaerobic digestion and co-digestion technology, operation and maintenance little difficult in incineration process. Whereas in composting very less impact in installation and operation and maintenance. In the case of transportation impact is in the order of open landfill > anaerobic co-digestion > composting = incineration = anaerobic digestion. Open landfill is a high impact of transport the waste to open landfill site. Similarly in the anaerobic co-digestion process, co-substrates has been transported from source. While in the case of composting, incineration and anaerobic digestion normally implemented adjacent to the slaughterhouse.

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Cost

In terms of cost spending towards the implementation (investment cost), operation and maintenance impact is in the order of incineration > anaerobic co-digestion = anaerobic digestion = composting > open dumping. Incineration facility required high investment cost, O&M cost when compared to the other treatment facility. Whereas in anaerobic digestion and co-digestion process need medium investment, O&M cost. Composting need very less amount of investment cost.

Socio

This criteria focused on the number of manpower required and skilled based manpower required. All the treatments have been moderate employment opportunities. Whereas incineration, anaerobic digestion and co-digestion technology must need skilled manpower requirement for operation and maintenance of the treatment technology. But in open landfills and composting technologies not required skilled manpower.

Environment

This criteria focused on the pollution impact from treatment technology especially air, water and land environment. Open landfill is major impact causing facility, which emits methane and carbon di-oxide in to the atmosphere. These are greenhouse gas and it majorly contributes the global warming. Similarly leachate from the open landfill is through the ground water, which majorly pollutes the water bodies. Open landfills generated more odours nuisance and also attract the flies and parasites, which causes the health impacts in the environmental organisms. Whereas, other treatment technologies are little controlled by treatment facility. Anaerobic digestion and co-digestion process capture the methane and generate the energy and limits the global warming potential. In the case of incineration process also pollutes the atmosphere. Composting treatment emits little amount of temperature and odour.

Health

Based on the pollution parameters, the impact and health risk of living organism such as human, animal, plant and micro-organism has been assessed in this criteria. Open landfill is highly affect the human, plant and soil micro-organism when compared with other treatment facilities. All other treatment facility impact living organism has been low. End product of composting process is "Compost" which is more benefit to fix the soil nutrient in to the land.

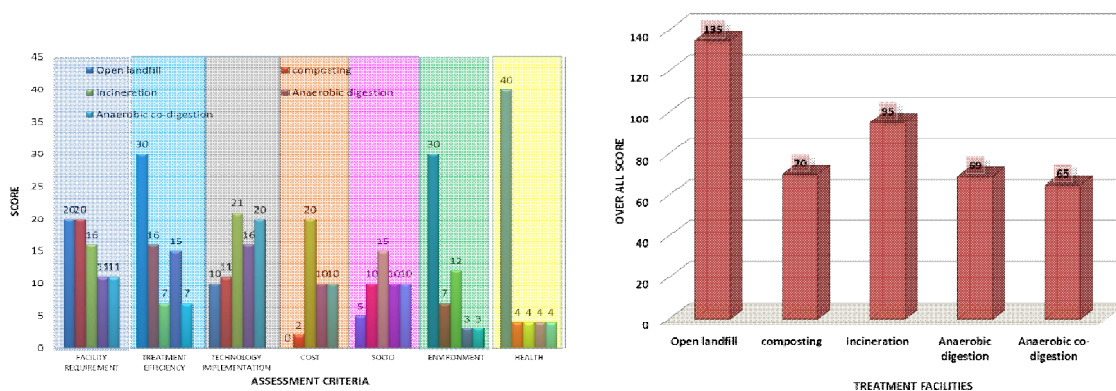


Fig. 4 a) Technology assessment criteria score b) overall score of treatment facility for SHSW management

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IV. CONCLUSION

Based on the assessment using above seven criteria and twenty parameter, the least score are eligible for best treatment facility to adopt the SHSW management (Figure 4A &B). The overall assessment score has in the order of Open landfill (135) > Incineration (95) > composting (70) > anaerobic digestion (69) > anaerobic co-digestion (65). Open landfill is highly impact in all the criteria, which is not suitable to practice for slaughterhouse solid waste management. It make more nuisance in environmental and health risk. Second highest impact is the incineration process, which is more energy intensive and economically not feasible technology for SHSW. Composting, anaerobic digestion and co-digestion processes are more suitable technology for SHSW. The comparison of above three treatment facility composting need longer duration to treat the SHSW. Similarly, anaerobic digestion also need to have high retention time. In the case of anaerobic co-digestion process is more suitable to practice for SHSW in all aspect especially facility requirement, treatment efficiency, cost, social environment and health. Based on the assessment anaerobic co-digestion is feasible and viable treatment technology for SHSW management in all the above criteria.

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