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Estimation of Greenhouse Gases from Disposal Sites of Selected Abattoirs of Eastern Ethiopia; 2019

Sina Temesgen Tolera, Fekade Ketema Alemu

College of Health and Medical Sciences; Haramaya University; P.O.Box: 235, Harar, Ethiopia

*Corresponding Author: Sina Temesgen Tolera

***Abstract*— Introduction**: *abattoir waste poses a threat to the wellbeing of individuals and the environment. Abattoir waste disposal sites also contributes to climate change through emission of Green House Gases. In urban areas of developing countries the problem is more severe, however little is known about the exact amount of abattoir waste generated as well as the Green House Gases emitted. Therefore, the purpose of this study was to quantify abattoir waste generation and estimate Green House Gases/GHGs/ from selected disposal sites from December 1st, 2018 to January 2019.* **Methods**: *A cross-sectional study was conducted in four selected abattoirs of Eastern Ethiopia. The magnitude of waste composition were computed based on Aneibo mathematical computational from the actual number of slaughtered livestock. While greenhouse gases was computed based IPCC model.* **Result**: *The study reported that about 2,026.80kg/day and 804,470.40kg/year (30.6%) of blood waste; 2,015.90kg/day and 920,884.20 kg/year (31.4%) of bone waste; 1,354.25kg/day and 606,607.50 kg/year (21%) of intestinal contents waste; and 1,066.40 kg/day and 461,112.00 kg/year (17%) of tissue; waste and as combined about 6,463.35kg/day and 2,793,074.10kg/year was estimated from four selected abattoirs. From these amount of abattoir wastes disposed on sites of four selected Eastern Ethiopia abattoirs, about 3,790.96 kgCO2-e/day and 1,638,225.38 kgCO2-e/year of greenhouse gases emission was estimated.* **Conclusion**: *The study concluded that large amount of abattoir waste is generated and Green House Gases are also formed. Therefore, proper waste disposal and installation of anaerobic digestion plants are recommended as short term and long term measures respectively to ensure environmental safety and public health.*

***Keyword*— Abattoir, Eastern Ethiopia, Greenhouse Gases, Livestock, Waste generation.**

I. INTRODUCTION

Abattoir operations are where animals (such as cattle or goat or sheep, camel, pig and poultry are butchered and, where animals are killed for consumption as food and it is also known as slaughterhouse (Addass et al., 2010). The waste produced by these operations known as abattoir waste that can be defined as pollutants which consist animal faeces, tissue waste, blood, fat, bone, tissue, animal trimmings, intestinal content and urine (FOA, 2010). From these, blood wasteis liquid part of abattoir waste which is the major dissolved pollutants in abattoir wastewater, has the highest COD of any effluent abattoir; bone waste is a mixture of finely and coarsely ground animal bones and abattoir waste products used as a nutritional supplement for animals and as an organic fertilizer for plants; it does not consists the bone attached to meet for meal (Adrian et al., 2011). The third one is intestinal content waste is liquid of abattoir waste in which waste from washing and other generated were not considered in this waste ; and the fourth is tissue waste that is the semi- liquids of abattoir waste in which edible

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tissue may attach to meet are not considered tissue waste (FOA, 2010).

Rapidly growing livestock production in response to increasing meat demand, particularly in developing countries, is associated with environmental pressures and problems. Some of these can be mitigated through appropriate measures, but many of them are unavoidable and difficult to address. Similar to livestock production, the conversion of livestock into meat at the abattoir stage can be linked to various health and environmental hazards. Fortunately, these hazards can be contained if abattoirs function properly and produce meat according to stringent hygiene and environmental rules and regulations (FAO, 2010).

Abattoir waste have highly organic waste with relatively high levels of suspended solid, liquid and fat (Aneibo et al. 2009). Especially, low-income countries show rapid urban growth that is putting extraordinary pressure on gigantic amount of abattoir waste in the urban (Ezeoha.et.at. 2000). The nature and quantity of the waste varies at each stage, but includes the carcasses of dead animals, parts of animals which are treated as inedible, bones, hides and blood. Moreover, of abattoir waste, the volume of waste water from abattoirs is 70 – 75% of the abattoir water that contributes to a high organic load as well as a considerable amount of suspended material in the waste (Roberts et al, 2011).This is however, it becomes a major pollutants and the possibility to increase of greenhouse gases, when the abattoir wastes are not properly managed; In addition, when it discharges into waterways, it can introduces pathogens and excess nutrients into surface water (Alonge,2005).

In addition, the properties of abattoir wastes are similar to that of municipal sewage, however the former is highly concentrated wastewater with 45% soluble and 55% suspended organic composition. Blood has a very high COD of around 375,000 mg/L and is one of the major dissolved pollutants in abattoir wastewater (Masse, 2000a). The major problems of poor abattoir management practice particularity developing countries are due to low commitments of industries, lack of abattoir waste disposal restriction of industries, lack of abattoir waste control system and low awareness of both individual and government towards severe impacts of waste on ecosystem (UN, 2013). The seriousness of environmental and health problems have been reported by so many scholars have been reported to contaminate and increase the level of nitrates in ground water and cause methaemoglobinaemia (Abiade et al., 2006).

The other report indicated that abattoir waste piled up within the environment not only caused pollution but also produced methane gas that intensifies greenhouse effect (Adeyemo, 2002). Moreover, these problems are happening due to lack of well design of abattoir and maintenance lack of abattoir, lack of regulations on restriction and prohibition of abattoir wastes discharge, the insufficient skill of human power, poor quality of equipment of abattoir, lack of political awareness (Chukwu, 2008). Of developing countries Ethiopia is one of the African developing countries which facing abattoir waste management where abattoirs exist (Abrha, 2009).

Likewise, abattoir wastes generating from selected abattoirs are simply dumping on open surrounding environment which is could result in greenhouse gases that are contributing on climate change. In these area, there wasn't data available on estimation of abattoir waste generation rate and greenhouse gases emission from dumping sites even if on other wastes. Therefore, the purpose of the study was to quantify abattoir waste generation and estimate greenhouse gases sustain; in case of Eastern Ethiopia selected abattoirs.

II. METHODS AND MATERIALS

2.1 Study Setting

The study areas are found in Eastern Ethiopia; the first three study areas are Harar Abattoir; Haramaya University Abattoir Enterprise and Haramaya abattoirs, which are found in Harar; Haramaya University and Haramaya towns; about 503 km, 508km and 527km far from the national capital Addis Ababa, respectively. They are characterized by subtropical highland climate, throughout the year, afternoon temperatures are warm to very warm, cool at mornings and rain falls between March and October (https://en.wikipedia.org/wiki/Harar)

The second study is Dire Dawa abattoir, which is found in Dire Dawa Admiration and far 453kmfrom Addis Ababa. It has 9°36′N41°52′Elatitude and longitude with Coordinates of 9°36′N41°52′EThe city is characterized by hot semi-arid climate. The region has two rain seasons; that is, a small rain season from March to April, and pronounced rain season that extends from July to August

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(https://en.wikipedia.org/wiki/Dire_Dawa)

2.2 Study Design

A cross sectional study was conducted in selected abattoirs of Eastern Ethiopia, namely, Haramaya, Haramaya University enterprise, Harar and Dire dawa abattoirs

2.3 Abattoir Waste Estimation Methods

All number of slaughtered livestock such as cattle, goats and sheep were collected from December 1st, 2018 to January 30th, 2019 from each registry municipalities. Then Aniebo et al (2009) mathematical model abattoir waste generation was applied.

2.3.1 Slaughtered cattle

From "One cattle could produce 12.6kg of blood waste, 8.0 kg of intestinal content waste, 6.4kgof waste tissue waste and 11.8kg of bone waste (total 38.8). Thus,

Equation: $\sum(bLw + Bnw + Icw + Tw) * N$ ..... *(1)*

Where: BLw=blood waste, Bnw=bone waste, Icw=intestinal content waste and Tw=tissue waste; "N" is number of slaughtered livestock.

3.3.2 Slaughtered goat or sheep

From "One slaughter Goat/sheep/ could generate 0.72kg (blood waste), 1.25 kg (intestinal content waste), 0.8kg (tissue waste) and 2.06kg (bone waste (total 4.83kg).Thus,

Equation: $\sum(bLw + Bnw + Icw + Tw) * N$ ..... *(2)*

Where: BLw=blood waste, Bnw=bone waste, Icw=intestinal content waste and Tw=tissue waste; "N" is number of slaughtered oat or sheep

2.4 Greenhouse gases/GHGs/ emissions from disposal site

GHG emission was estimated from disposal site of abattoir waste using Intergovernmental Panel Climate Change /IPCC/ (2000) factors and Joint Global Change Research Institute /JGCRI/ (2018)_Global Change Assessment Model (GCAM), in which "Global Warming Potentials (GWPs)" are used to convert masses of different greenhouse gases into a single CO_2-equivalent metric (IPCC, 2000 and JGCRI, 2018)

Equation 3*: GHG Emissions (t CO2-e) from dump sites*

Equation *= [((Q x DOC x DOCF x F1 x 1.336) – R) x (1 – OX)] x 25 ..... (3) Where:*

- ✓ Q = Quantity of abattoir waste expressed in tones/kg/ from waste records
- ✓ DOC= Degradable Organic Carbon expressed as a proportion of abattoir waste with the default value of 0.12
  - ✓ DOCF= Fraction of degradable organic carbon dissimilated for the abattoir waste with default value of 0.7.
  - ✓ F1= Methane fraction generate from dumping gas with the default value of 0.50
  - ✓ 1.336= Conversion rate of carbon to methane
  - ✓ R= Recovered methane during the year, measured/expressed in tones (here no recovered methane)
  - ✓ OX=Oxidation factor which has a default value of 0.1 for well-managed and a value of 0 for un manged)
  - ✓ 25=CH4 global warming potential used to convert the quantity of methane emitted to CO_2-e from the quantity of abattoir waste produced

2.5 Data Quality and Analysis

For estimation of abattoir wastes the slaughtered livestock was counted from each abattoir in each day, week and months of a year (December 2018 to January, 2019). Proper training will give for all data collector and data entry. Whereas, Data was simply entered into excel and SPSS for range, mean, sum and percentage for numerical to summarize and describe the data to make them more graspable.

2.6 Ethical Consideration

Permission to conduct this "Grant research coded "HUKT-2018-01-03-63" was provided by Haramaya University Research Partnership and Group Directorate. The reviewer of proposal and Ethics Committee of Haramaya University were approved this research project. Then, Haramaya University Health and Medical Sciences waswritten the formal letter to Haramaya town, Haramaya University Enterprise abattoir, Harar town Municipality and Dire Dawa Municipality Authority abattoir service for realization of legal research.

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III. RESULT

3.1 Slaughtered Livestock

About 37 /day and 13,505/year, 128/day and 46,720/year, 46/day and 16,790/year, and 30/day and 10,950/year of livestock were slaughtered in Harar abattoir, Dire Dawa abattoir, Haramaya town and Haramaya University enterprise (HU-E) abattoirs, respectively. Thus, a total 241/day and 87,965/year of livestock slaughtered. More than 12,050kg/day and 4,398,250kg/year of meat could produce and distribute to surrounding community of Eastern Ethiopia (Table 1).

Table 1 Slaughtered livestock in selected Abattoirs from December 1st, 2018 to January 30th, 2019

Selected Abattoir	Rate of slaughtered livestock(No)							
	Daily		Weekly		Monthly		Annually	
Harar	C*=33 GS**=4	**37**	C=232 GS=27	**259**	C=993 GS=117	**1,110**	C=12083 GS=1422	**13,505**
Dire Dawa	C=77 GS=51	**128**	C=538 GS=358	**896**	C=2304 GS=1536	**3,840**	C=28032 GS=18688	**46,720**
Haramaya	C=16 GS=30	**46**	C=115 GS=207	**322**	C=493 GS=887	**1,380**	C=5996 GS=10794	**16,790**
HU- Enter.	C=30 GS=0	**30**	C=210 GS=0	**210**	C=900 GS=0	**900**	C=10,950 GS=0	**10,950**
Total		**241**		**1,687**		**7,230**		**87,965**

C* and GS** stands for number of slaughtered Cattle and Goats/sheep, respectively.

3.2 Abattoir Waste Generation and Composition

During meet production, numerous amount of wastes are generating. Huge amount of abattoir waste was generated.Table 2 shows about 1,300kg per a day and 494,819kg per a year; 3,234kg per a day and 1,440,755kg per a year; 765.70kg per a day and 432,640kg per a year; and 1,164kg per a day and 424,860kg per a year of abattoir wastes were estimated from Harar town, Dire Dawa city, Haramaya town and Haramaya University-Enterprise abattoirs, respectively.

The study shows that about 6,463.35kg, 45,243.45kg 229,618.35kg and 2,793,074.10kg of abattoir waste was estimated per a day, a week, a month and a year, respectively from four selected Eastern Ethiopia abattoirs , which was simply disposed on surrounding environment (Table 2).

Table 2 Waste compositions and Abattoir Waste Generation Rate from Selected Abattoirs, 2109

Selected Abattoirs	Amount of abattoir waste composition rate			
	Daily	Weekly	Monthly	Annually
Harar Municipality				
Blood waste (*kg)	418.68	2,930.76	12,810.96	155,862.36
Bone waste(kg)	397.64	2,783.48	12,646.08	153,848.28
Intestine content waste(kg)	269.00	1,883.00	8,505.00	103,470.00

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Tissue waste(kg)	214.40	1,500.80	6,710.40	81,638.40
Total waste generation(kg)	***1,299.72***	***9,098.04***	***40,672.44***	***494,819.04***
Dire Dawa Municipality				
Blood waste (kg)	1,006.92	7,048.44	33,402.24	406,338.84
Bone waste(kg)	1,013.66	7,095.62	39,550.02	481,034.32
Intestine content waste(kg)	679.75	4,758.25	25,938.75	315,492.50
Tissue waste(kg)	533.60	3,735.20	19,557.60	237,889.60
Total waste generation(kg)	***3,233.93***	***22,637.51***	***118,448.61***	***1,440,755.26***
Haramaya town Municipality				
Blood waste (kg)	223.20	1,562.40	8,575.20	104,299.20
Bone waste(kg)	250.60	1,754.20	12,894.60	156,791.60
Intestine content waste(kg)	165.50	1,158.50	8,227.50	100,045.00
Tissue waste(kg)	126.40	884.80	5,880.00	71,504.00
Total waste generation(kg)	***765.70***	***5,359.90***	***35,577.30***	***432,639.80***
Haramaya University enterprise				
Blood waste (kg)	378.00	2,646.00	11,340.00	137,970.00
Bone waste(kg)	354.00	2,478.00	10,620.00	129,210.00
Intestine content waste(kg)	240.00	1,680.00	7,200.00	87,600.00
Tissue waste(kg)	192.00	1,344.00	5,760.00	70,080.00
Total waste generation(kg)	***1,164.00***	***8,148.00***	***34,920.00***	***424,860.00***
Grand total waste generation(kg)	**6,463.35**	**45,243.45**	**229,618.35**	**2,793,074.10**

*kg= Shows 1kg=1 liter=0.001 ton

Abattoir waste compositions

From daily total abattoir waste generated, the percentage of abattoir waste compositions weight is generated from each abattoirs is varied separately. For instance, from daily generation of abattoir waste from selected abattoirs 397.64 (31%), 1,013.66 (31%), 250.6 (29%) and 354 (32%) of bone composition was estimated from Harar abattoir (HA), Dire Dawa abattoir (DDA), Haramaya abattoirs (HRA) and HU-Enterprise abattoir (HU-A), respectively. As combined, from daily waste generated (6,463.35kg/day=100%) from four selected abattoirs, about 1420(31%), 1355(31%), (21%) and 716 (17%) were bone waste, blood waste, intestinal content waste and tissue waste compositions were estimated, respectively (Figure 2).

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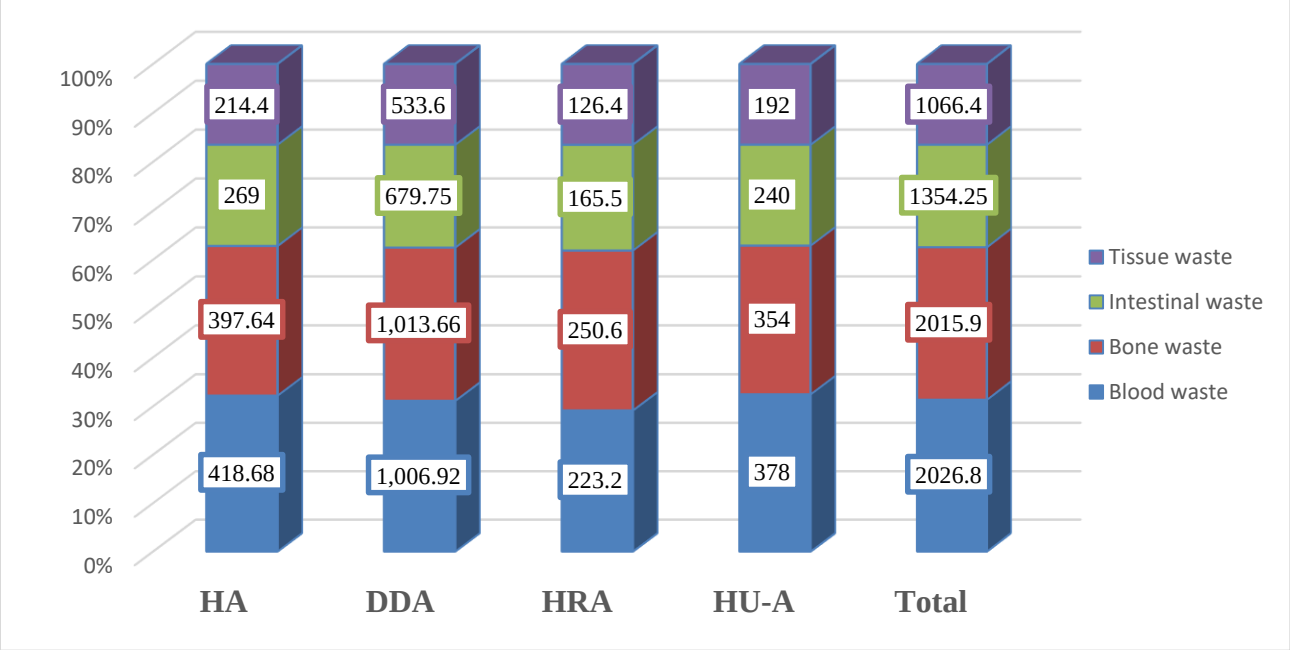

Fig.1: Percentage of waste compositions of abattoirs from Dec. 1st, 2018 to Jan. 30th, 2019

Proportion of abattoir waste

The following figure shows that from the current abattoir waste generated(either per day or per a year i.e. 6,463.35kg/day or 2,793,074.10kg/year), half percent (50%) of the abattoir waste was generated from Dire Dawa municipality abattoir. The rest 20%, 18% and 12% of percentage abattoir waste generated was accounted by Haramaya town municipality, Harar municipality and Haramaya university abattoir, respectively (Figure 4)

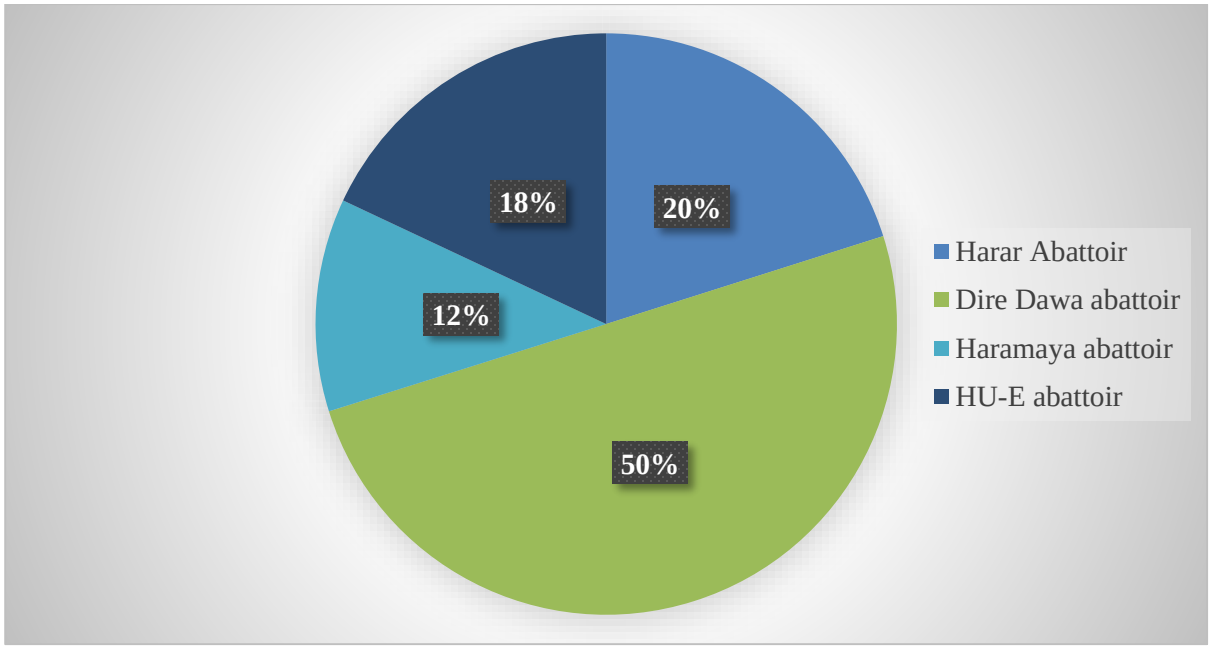

Fig.2: Amount of abattoir waste generation from selected eastern Ethiopia abattoirs, 2019

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Disposal sites Observation

Field observation showed that huge amount of abattoir wastes were disposed on surrounding environmental. From four abattoirs, improper waste disposal system were observed as shows in the following figure.

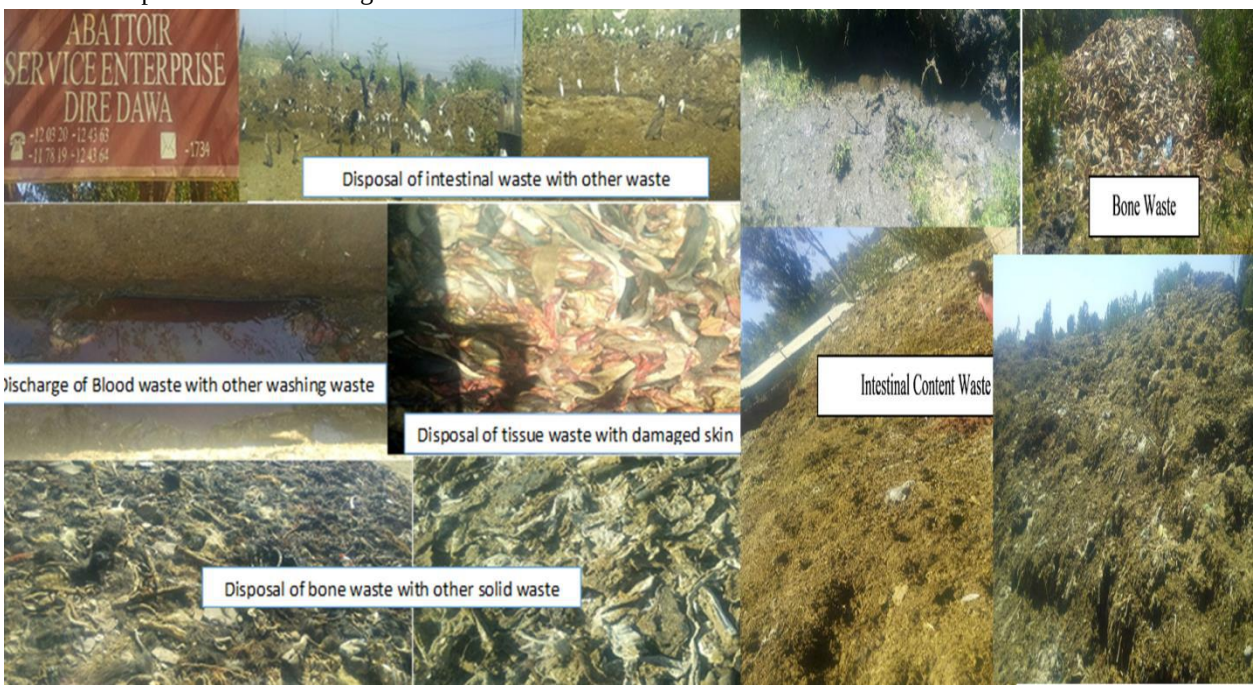

Fig.3: Waste disposal site of abattoir waste from selected municipality abattoirs, March, 2019

3.3 GHGs emission from Dump Sites

About 762.33 $kgCO_2$equivalence per a day and 290226.85$kgCO_2$ equivalence per a year; 1,896.80$kgCO_2$equivalence per a day and845,048.06$kgCO_2$ equivalence per a year; 449.11 $kgCO_2$equivalence per a day and 253,756.78 $kgCO_2$equivalence per a year; and 682.72$kgCO_2$equivalence per a day and 249,193.69 $kgCO_2$equivalence per a year of greenhouse gases emission was estimated from disposal sites of Harar abattoir; Dire Dawa; Haramaya abattoir; and HU-E abattoir, respectively (Table 3). From Eastern Ethiopia abattoirs dumping sites , about 3,791 $kgCO_2$ 26,537kgCO2, 134,678$kgCO_2$ and 1,638,225$kgCO_2$ equivalence of greenhouse gases emission was estimated per a day, a week, a month and a year, respectively(Table 3).

Table 3 Greenhouse gases emission from disposal sites of abattoirs; Dec. 1st, 2018 to Jan. 30th, 2019

Selected Municipalities	Amount of abattoir waste generation rate			
Abattoirs	and Green House Gases (GHGs) emission			
Harar town Municipality	Daily	Weekly	Monthly	Annually
Abatttoir waste generation(kg)	1,299.72	9,098.04	40,672.44	494,819.04
GHGs emission (*$kgCO_2$-e)	762.33	5336.2	23855.66	290226.85
Dire Dawa Municipality				
Abatttoir waste generation(kg	3,233.93	22,637.51	118,448.61	1,440,755.26

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GHGs emission ($kgCO_2$-e)	1,896.80	13,277.61	69,473.82	845,048.06
Haramaya town Municipality				
Abatttoir waste generation(kg)	765.70	5,359.90	35,577.30	432,639.80
GHGs emission ($kgCO_2$-e)	449.11	3,143.75	20,867.20	253,756.78
Haramaya University enterprise				
Abatttoir waste generation(kg)	1,164.00	8,148.00	34,920.00	424,860.00
GHGs emission ($kgCO_2$-e)	682.72	4,779.06	20,481.67	249,193.69
Grand waste generation(kg))	6,463.35	45,243.45	229,618.35	2,793,074.10
Grand GHGs emission ($kgCO_2$-e)	**3,790.96**	**26,536.7**	**134,678.35**	**1,638,225.38**

*$kgCO_2$-e= A kilogram of carbon dioxide equivalent or sometimes used as tCO_2 equivalent(t=ton) based on amount of waste generated , sometimes, also abbreviated as kgCO2-eq (tCO2-eq) is a metric measure used to compare the emissions from various greenhouse gases on the basis of their global-warming potential (GWP).

IV. DISCUSSION

Abattoir waste generation rate

The study was sought to focus on abattoir waste generation from selected Eastern Ethiopia abattoirs namely: Harar Abattoir, Dire Dawa Abattoir, Haramaya Abattoir and Haramaya University Enterprise Abattoirs. These abattoir serving as slaughterhouse for slaughtering livestock such as cattle, goats and sheep. Therefore, the researchers were considered these livestock in this study. The study revealed that the average number of livestock slaughtered in these two hundred forty one per a day and eighty seven thousands nine hundreds, sixty five per a year of livestock were slaughtered. From these slaughtered livestock, more than twelve thousand kilogram per a day and more than four million per a year of meat could produce from selected Eastern Ethiopia abattoir and distribute to surrounding community of Eastern Ethiopia from December 1st , 2018 to January 30th , 2019 to which was distributed to the surrounding community(Table 1).

However, during meat production, huge amount of abattoir wastes are generation from these selected abattoirs. In fact, due to its complexity and difficulty, Aneibo (2009) mathematical computation approach was used to estimate abattoir waste composition generated from the abattoirs. The main principal abattoir waste compositions such as blood waste, bone waste, intestinal content waste and tissue were considered in this assumption. However, the percentage of these abattoir waste compositions obtained was varied generated among selected abattoirs (Table 2). That means the proportion of abattoir waste compositions generated from selected abattoirs were not be same. This is because of slaughtered livestock type (such as cattle, goats and sheep).

For instance, when high number of goat and sheep slaughtered in abattoir it was resulted high amount of bone was estimated and followed by blood, intestinal content and tissue waste, respectively. Such type of waste composition estimation was observed in Haramaya and Dire Dawa Abattoirs. But, blood waste composition was highest among abattoir waste compositions in Harar and Haramaya University Enterprise where purely cattle were slaughtered; and then followed by bone, intestinal content and tissues waste composition, respectively (Figure 2). Therefore, overall composition was varied among the selected abattoirs due to type of slaughtered livestock. Therefore, this study indicated abattoir waste generation produced the throughout the year was varied among months due to livestock slaughtered were varied as the result of different fasting and meat-eating holidays. This leads high amount of abattoir waste generation could be obtained from abattoirs was resulted from high number of slaughtered livestock. When combined the current abattoir waste into together, half percent of abattoir waste generated during study period was from Dire Dawa municipality abattoir. While Harar town municipality, Hawassa University enterprise municipality and Haramaya town municipality was accounted the remaining percentage of abattoir waste compositions in decreasing order (Figure 4).

As combined the for principal abattoir waste compositions, more than one ton of abattoir waste was

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estimated from Harar , three ton from Dire Dawa , more than six hundred kilogram from Haramaya town abattoir and more than one of abattoir waste was estimated Haramaya University enterprise per a day. Annually, more than 494.82 ton, 440.76 ton, 432. 64 ton and 424. 86 ton of abattoir waste were estimated from Harar abattoir, Dire Dawa abattoir, Haramaya abattoir and Haramaya University enterprise, respectively from December 1st, 2018 to January 30th, 2019. Therefore, more than sixth thousand kilogram (more than six ton) of abattoir waste was generated per a day, while more than two million kilogram (more than two thousand ton) of abattoir waste was estimated from four selected Eastern Ethiopia abattoirs (Table 2).

As contrast, the current abattoir waste estimated (3,233.93kg/day and 1,440,755.26kg/year) generated from Dire Dawa Municipality abattoir is higher than with finding obtained from Hawassa Town municipality (2,530kg/day and 923,995kg/year) reported by Tolera et al. (2019) and also Elfora Kombolcha, Adama and Mekele abattoirs in Ethiopia (Yesihak and Edward, 2015). This result also higher that the data recorded in Minna abattoir, Abuja Nigeria (i.e. 2,394 kg/day and 873,810 kg/year) reported by Ahaneku et al (2015); Tamale municipality abattoir, Ghana (i.e. 2,134 kg/day and 778,910 kg/year) reported Frederick et al (2010). However the finding obtained from Harar town municipality abattoir (1,299.72kg/day and 494,819.04kg/year); Haramaya town municipality abattoir (765.70kg/day and 432,639.80kg/year); Haramaya University enterprise abattoir (1,164.00kg/day and 424,860.00kg/year) was smaller than the finding reported by (Frederick et al., 2010;Yesihak and Edward, 2015; Ahaneku et al., 2015; Tolera et al., 2019).

Moreover, the current abattoir waste generate could contrasts with other organic municipality waste that are generating from the households of the same situation. Accordingly, the current estimated abattoir waste (6,463.35kg/day and 2,793,074.10kg/year) generated selected abattoirs, Eastern Ethiopia is higher than municipality waste (422.7kgkg/day and 154,285.5 kg/year) generated from 85 households of Aweday Eastern Ethiopia (Beneberu, 2011). That means the present abattoir waste generating from four abattoirs is fifteen time than that of organic waste generated from eighty five households. Therefore, this is indicating that huge amount of abattoir waste is generating from few number of abattoir operations as compared to other waste generating from many different institutions and households. But, there is no attention either from government and ownership/private or owner enterprise/ like other waste mentioned here and there.

GHGs Emission from Disposal Sites

As many scholars reported improper disposal of wastes like abattoir waste is one of the big problem for climate change over all the world due to greenhouse gases/GHGs/ emission from their disposal sites (Chukwu, 2008). Thus, to estimate greenhouse gases emission from disposal sites, the authors used IPCC (2000) and GWPs coefficient factors. The computation was done by considering different masses of greenhouse gases conversion into a single carbon dioxide-equivalent metric (CO2-e), by multiplying a mass of a particular gas(i.e. the emissions are multiplied by 25 to calculate the carbon dioxide equivalent (CO2-e) emissions) by its GWP, which gives the mass of carbon dioxide emissions that would produce the same warming effect. Despite of fact that methane (CH4) vented to the atmosphere is considered an emission as this action would be adding to atmospheric.

Thus, based on IPCC and GWPs coefficient factors, it is possible to estimate the amount of GHGs emission from four disposal sites of the selected abattoirs. Table 3 shows that more seven hundreds of kilogram of carbon dioxide equivalence of greenhouse gases was emitted from 1. 3 ton of abattoir waste disposed per a day; while more than two hundred ninety ton of carbon dioxide equivalence of greenhouse gases was estimated from 494. 82 ton of abattoir waste disposed at sites of harar municipalities. In same manner, from the daily disposed of abattoir waste (3.23 ton), almost 2 tons of carbon dioxide equivalence of greenhouse gases was emitted and more than 845 ton of carbon dioxide equivalence of greenhouse gases emitted from 1,440.76 ton of abattoir waste disposed on the site of Dire Dawa municipality abattoir (Table 3).

As combined, about 3. 8 ton/day and 1,638. 23/year ton of carbon dioxide equivalence of greenhouse gases emitted from 6. 46 ton/day and 2,793. 07 ton/year of abattoir waste disposed, respectively in the sites of selected abattoirs found in Eastern Ethiopia from December 1st, 30th and January 30th, 2019 (Table 3)

Hence, this amount of gases contribute to climate change, could enhance greenhouse effect that is expected

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to have widespread consequences, causing: sea-level rise and possible flooding of low-living areas; melting of glaciers and sea ice; changes in rainfall patterns with implications for floods and droughts; and changes in the incidence of climatic as Anthony et al (2009) reported. Therefore, such climate change could have impacts on ecosystems, health, water resources, and key economic sectors such as agriculture, and water resources on surroundings. Hereby, these amount of greenhouse gasses emission from the disposal sites of selected municipal abattoirs are one of the significant sources of air pollution at surrounding cities fully and at national level particular.

General condition of selected abattoirs

The general sanitary condition of the four selected abattoirs namely Harar, Haramaya, Dire dawa and Haramaya University abattoir was observed by the researchers. The researchers were assessed based on national meat inspection, hygiene and sanitary manual check list evaluation developed by South Africa for any abattoirs' condition, sanitary and hygiene (2007). The observation supported by check list which was consisted sanitation of abattoir, hygiene and data record for segregation of abattoir waste.

Accordingly, field observation indicates that in average less than 50.0% of sanitation. These three are categorized under poor sanitary condition. Why because they are not easily cleanable of floor, walls and ceiling, not good repair, have no appropriate height; they haven't ample space for waste disposal, are not free from dust, has not good slope for drainage; the disposal of waste is improperly constructed, the window and door are narrow; the toilet are not clean, not well lighted, and not conveniently located as compared to the guideline. This finding is consistent to study conducted in Malaysia (Auwalu et al., 2016)

Only 60.0% had good personal hygiene and 40% of the abattoir have poor operational activities in such a way that most of their equipment were left unwashed with some blood clot on them in an open space after meat processing and the premises was not comfortable for both the workers and visitors. Based on finding obtained thought key informants, improper management of abattoir waste practice was due to lack of hygiene practice and compliance with the abattoir laws. This finding is consistent to study conducted in Malaysia (Auwalu et al., 2016).

Moreover, the general condition of less than half (43.0%) and the entire abattoirs visited, no records of their activities were presented (less than 55%). The abattoirs haven't personal hygiene monitoring,lack of environmental sanitation, and use of water guards at their entrances that couldn't prevent transmission of pathogens from the workers themselves to the abattoir premises. This finding is consistent to study conducted in Malaysia (Auwalu et al., 2016) conducted in Akure, Western Nigeria by showed that such type of unhygienic operation of a city abattoir has an implications on surrounding environment (Akinro and Ologunagba, 2011)

In common, this field observation conveyed that the current abattoir waste has been discharging and disposing into open environment without any treatment methods/ disposal system. Such type of abattoir waste management has adverse effect on both ecosystem (biotic and abiotic) including human being particularly who are living around these abattoirs. These sort of improper management has bad odor that leads to pollute air; waste water discharging has potential to cause ground water pollution and soil pollution. The similar study conducted in Akure, Western Nigeria by showed that such type of unhygienic operation of a city abattoir has an implications on surrounding environment (Akinro and Ologunagba, 2011)

Limitation of study

The research didn't deal with number of livestock slaughtered around homes or outside the selected abattoirs including slaughtered camels in these selected abattoirs. In addition, the magnitude of abattoir waste was estimated based on assumptions that was adopted from Nigeria, African, which might be resulted either lower or higher abattoir waste estimation record in these study areas.

V. CONCLUSION

The present study shows that large quantity of abattoir waste was generated as compared to other waste generated, which was directly disposed into the surrounding environment without any disposal system. Moreover, the study revealed that the amount of greenhouse gases emitted from the disposal sites of the selected abattoirs could contribute to climate change, which could be resulting in detrimental effects on environmental and public health in the surrounding community. Therefore, the municipality

should design abattoir waste treatment technology as sustainable management to safeguard the environment from greenhouse emission and ensure public health for the as long term plan, while proper abattoir waste disposal will forward as short term.

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CONFLICT OF INTEREST

None

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