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***Original Research Article***

# Study on Existing Livestock Manure Management Practices in Bangladesh


## ABSTRACT

Livestock manure, up to 55% of feeds fed to ruminant animals that pass through digestive tract undigested, pollutes the environment through conventional managements. . It is being considered a waste may turn into wealth through improved management. Considering this point of view a research was taken to identify the existing livestock manure management practices followed by the Bangladeshi farmers, figure-out the problems and constraints, and find out possible technology and policy intervention to increase farm income and safeguard environment. To attain the objectives a survey was conducted through a constructed questionnaire and the finding reflects that broadly two types of managemental system are available at farmers field-one is conventional and another is improved. Under conventional system solid store and burned fuel and under improved system anaerobic digester and liquid slurry system was observed. Only a few (25%) farmers were using digester where 33.64% farmers were store manure as solid and 34.71% were used manure as burned fuel for cooking. About 58.62% and 24.14 % farmers store manure as solid and burned fuel respectively inspite of having bio-digester. But the ration is much higher in non-digester group and it is 78.02% farmers are storing and 36.16% famers are drying manure. Bio-slurry is a valuable product come from bio-digester and about 48.3% farmer use it as fertilizer in crop land, certain portion in aquaculture about 31% become wasted. To determine the impact of existing managemental system on climate methane emission factor was calculated and it was seen that highest amount of methane is emitted from liquid slurry (5.81kg/head/year) and burned fuel (5.46kg/head/year) and it is much controlled in anaerobic digestion system (1.24kg/head/year). Lack of manure treatment capacity, information and awareness, credit problem, illiteracy, lack of bank loan facilities etc were identified as major constrains of improved manure management.


***Key Words: Livestock manure, Solid store, Burned fuel, anaerobic digester, Liquid slurry, Methane and Environment***

## I. INTRODUCTION

Livestock manure, feed biomass fed to animals that pass through digestive tract undigested and urine excreted from subsequent tissue metabolism, is conventionally termed as wastes. It pollutes environment through emitting greenhouse gases (GHGs) estimated to be 9.50% of the total of livestock origins [1]. Improved livestock manure management reinforcing the planet pillar of sustainable livestock production [2] may reduce food-feed-fuel competitions. It may support the vision of climate smart agriculture (CSA, FAO) and green growth dynamics also ($7^{th}$ Five Year Plan, Bangladesh). About 26 million large ruminants, 18 million small ruminants and 137 million poultry [3] of Bangladesh, 70% to 82% of which are being raised by landless and small farmers, produce manure largely piled as solids and liquid slurries at a variable concentration per unit land area. The manure of large ruminants is also dried as sticks & cakes for using as cooking biomass depending on their distribution and rearing systems. However, the database

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of conventional uses of livestock manure and the extent of GHGs emissions are not studied thoroughly considering variations in livestock production systems in different regions of Bangladesh.

The livestock rearing systems have both positive and negative effects on natural resource base, public health, social equity and economic growth [4]. Livestock manure, in addition to production of energy for rural areas via biogas/electricity from anaerobic digestion, improving livelihood, saving fuelwood and reducing methane emissions may build up soil organic matter [5][6][7] of arable land depleted through gradual increase of crop intensities, if livestock manure based fertilizer is used as a source of soil nutrients [8] ). However, the plethoric open solid storages of manure and spread of slurry in the environment reduce air, water and soil quality posing threats to public health and causing social and economic impacts. It may contain bacterial, viral, protozoal or parasitic pathogens that are significant health hazards to both humans and livestock.

Global concerns of climate pollution changed the perception of livestock manure management very recently. The vision of CSA along with the gradual transformation of subsistence animal agriculture to input supported systems has been emphasizing the development of market oriented good practices of manure management. This requires research, development and extension works focusing on strategies, systems and techniques that allow maximization of the benefits of manure uses while minimizing its impacts on natural resource and ecosystems. Organizing community based biogas production systems based on livestock manure available to small farmers may be gateways for trapping the socioeconomic benefits of livestock rearing [9]. All the above factors substantiate development of database of livestock manure under different animal rearing system in different regions of Bangladesh, and its present uses by farmers.

Thus, the present research work was undertaken with the following objectives.

i. to determine existing livestock manure management systems and their shares according to the type of animals
ii. to quantify methane emission factors and the extent of pollution through livestock manure management
iii. to identify major limitations to on farm management of livestock manure

## II. Material and Methods

The study was conducted by the Bangladesh Livestock Research Institute (BLRI), Dhaka, in cooperation with the Wageningen University, the Netharlands and the Stockholm Environment Institute, Asia-Centre, Bangkok in the selected district of different livestock production area of Bangladesh characterized as follows.

The mixed farming of Bangladesh consists of irrigated area embraces a broad range of food and cash crops and more than 10 percent of the total value of production comes from non-livestock farming activities; and rainfed area, steep and highlands and sources of more than 90 percent of the value of non-livestock farm production [10].

Depending on the length of growing period (LGP, [11] the irrigated farming area was again divided into humid area, LGP is greater than 270 days, and sub-humid area, LGP is 271-280 days. The LGP does not vary in the rainfed area, as crop growing period is not shortened by flood water. Considering the extent of pollution by the number of animals in a farm two categories of farms were randomly selected viz, i) Commercial (having average per household 15 animals) and ii) subsistence (having average per household 2.0 animals, [12]. A summary illustration of different geographical and livestock farming characteristics is presented in Fig1. The data were generated through visiting individual farmer`s house and sharing questions of a pre-set questionnaire developed by the University of Wageningen,

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Netherlands and SEI (Stockholm Environment Institute) -Asia Centre and pre-tested locally before the use at farm levels.

Considering agroecological area (humid, sub-humid & rainfed) total 47, 63 and 10 farmers, respectively, were randomly selected for visiting and sharing their responses on the preset questions. In each area there were subsistence and commercial farmers, and their number, respectively, was 40 & 7 in humid, 45 & 18 in sub-humid and 5 & 5 in rain fed area. The researchers developed an itinerary and visited each farm in different times with the local support of the district livestock office of each district, an administrative area. Out of 23, 32 and 6 total district in three areas 4, 5 and 2 districts, respectively, were randomly selected under the field study. The total farm animals was classified into i) dairy cattle, ii) other cattle, iii) buffalo, iv) goat and sheep and chicken & ducks. The number of farmers of different categories, their land area and number of different types of animals are presented in Table 1.

The data of manure management system of different livestock, the fate of dung and urine, farmer's opinion on major technical, socio-economic and institutional constraints and any source of information regarding LMM available to them were recorded. All the data were inserted in Microsoft excel sheet for calculation of secondary data and any significant differences in methane emission between the two livestock production system was analyzed using SPSS 17.0. The extent of pollution by methane production from different LMM system was calculated using **Equation 10.23:** $EF_T = (VS_T.365).[B_{o(T)}.\frac{0.67Kg}{m^3}.\sum_{S,k}\frac{MCF_{S,k}}{100}.MS_{(T,S,k)}]$ of the IPCC, where methane emission factor (EF) of LMM was calculated using default values of volatile solid (VS), and maximum methane producing capacity of manure (Bo) specified for different farm animal categories of the Indian sub-continent & methane conversion factor (MCF) for different manure management system at an ambient temperature >26$^{o}$C. The emission factor (EF) was determined using the data of manure management system (MS) of different animals.

## III. RESULTS AND DISCUSSIONS

### 3.1 General Information of the Respondent farmers

Table1 shows land holding area and the number of different types of farm animals of the selected farmers in different region. Commercial farm area was higher (2.17 ha) in sub-humid region than other two but the subsistence farmers possessed almost similar land area irrespective of region and the area is was so low. Number of dairy and other cattle was higher in case of commercial farmer and low in case of subsistence farmer (Table-1). No difference was observed in cattle population in humid, sub-humid and rain-fed region. Buffalo rearing was dominant in sub-humid region than other two region. Commercial buffalo farming was not observed among the selected farmers and the average buffalo number of subsistence farmer was only 8. Small ruminant (Goat and sheep) farming was existing in three region but commercial rearing was observed only in humid region (table-1) and farmers of remaining two region rears sheep and gat sporadically. No commercial poultry farm was surveyed in rain-fed region but bird number of humid commercial farm was higher than sub-humid one.

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**Table1: Farmers of different areas and the number of different animals**

| Attributes | Humid | | Sub-humid | | Rain fed | |
|---|---|---|---|---|---|---|
| | Subsistence | Commercial | Subsistence | Commercial | Subsistence | Commercial |
| Av. area of land, ha | 0.13 | 1.30 | 0.004 | 2.17 | 0.004 | 1.57 |
| Dairy cattle | 2 | 22 | 3 | 20 | 4 | 28 |
| Other cattle | 1 | 9 | 1 | 15 | 2 | 15 |
| Buffalo | 0 | 0 | 8 | 0 | 0 | 0 |
| Goat & sheep | 4 | 20 | 3 | 3 | 1 | 0 |
| Chicken & ducks | 271 | 7000 | 200 | 2236 | 9 | 0 |

## 3.2 Existing Livestock Manure Management systems

The manure management system of Bangladesh, as defined by the Inter-governmental Panel on Climate Change [13],may be categorized into i) Solid storage, ii) Liquid slurry, iii) Burned fuel, iv) Anaerobic digester, and v) Without litter, a system practiced only for commercial poultry. The manure produced by dairy or other cattle is mostly kept as solid storage (56.2%) and burned as fuel (37.3%). The rest of the manure of cattle is used for anaerobic digestion (4.80%). A few number of farmer stated that they store bioslurry (1.65%), and, as stated by farmers, in most cases all form of liquid slurry including bioslurry, instead of keeping in confined systems, are practically lost out of ignorance, and in some cases it was kept as open spreads (Table 2). Similarly, about 57.0% buffalo manure was stored as solid storage and the rest 43% was burned as fuel, while the total amount of manure of goat and sheep (100%) was kept as solid storage (Table2).A major fraction (74.5%) of poultry manure, on the other hand, was without litter and 25.5% was used for anaerobic digestion. The latter fraction of poultry manure was quiet high. Representation of a lesser number of poultry farms without anaerobic digestion system, under the present study, may be one of the causes of showing a higher percentage of anaerobic digestion.

**Table 2: Manure management system (MS %) of different farm animals and annual methane emission (Kg$CH_4$/head/Yr)**

| Farm animals | Solid storage | | Liquid slurry | | Burned fuel | | Anaerobic digester | | Without litter | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MS | $CH_4$ | MS | $CH_4$ | MS | $CH_4$ | MS | $CH_4$ | MS | $CH_4$ | MS | $CH_4$ |
| Dairy cattle | 56.2 | 2.322 | 1.65 | 0.968 | 37.3 | 3.08 | 4.80 | 0.40 | - | - | 100 | 6.77 |
| Other cattle | 56.2 | 0.96 | 1.65 | 4.01 | 37.3 | 1.28 | 4.82 | 0.16 | - | - | 100 | 6.41 |
| Buffalo | 57.0 | 2.16 | - | - | 43.0 | 3.26 | - | - | - | - | 100 | 5.42 |
| Small ruminant | 100 | 0.203 | | - | - | - | - | - | - | - | 100 | 0.203 |
| Poultry | - | - | - | - | - | - | 25.5 | 0.006 | 74.5 | 0.018 | 100 | 0.024 |

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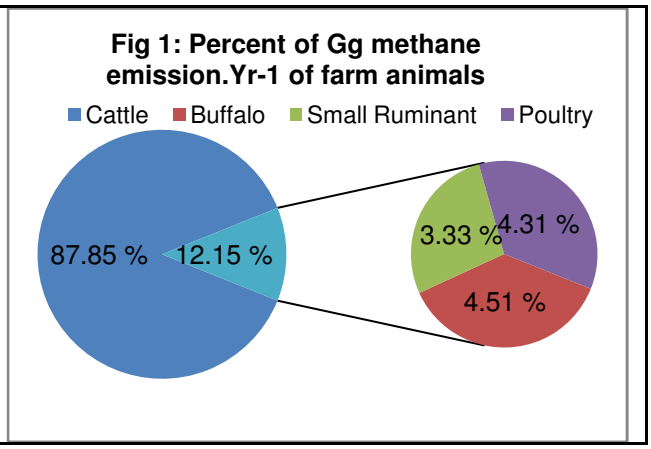
Among three greenhouse gases methane is mojor one whose warming potentiality is 25 fold higher than $N0_2$ and $CO_2$ [14]. Estimation of [15] shows that livestock are one of the leading causes of world wide green house effect. The annual methane emission ($KgCH_4$/head/Yr) of the manure produced by different farm animals under different management systems was estimated to be 6.77, 6.41, 5.42, 0.203 and 0.024, respectively, of a dairy or other cattle, buffalo, small ruminant or poultry, respectively(Table-2) Considering average distribution of livestock manure, the average emission factor of manure of different animals, respectively, was shown to be 6.0, 2.0, 5.0, 0.20 and 0.02 $KgCH_4$/head/Yr in the warm condition (26$^o$C to 28$^o$C) of Indian sub-continent region [16].

**Table 3: Annual livestock manure $CH_4$ emission (Gg) from different management system**

| Farm Animals | Number of farm animals (Millions, BER 2016) | Gg methane emission.Yr$^{-1}$ |
|---|---|---|
| Dairy cattle | 9.3 | 62.96 |
| Other cattle | 14.4 | 92.30 |
| Buffalo | 1.47 | 7.97 |
| Small Ruminant | 29.02 | 5.89 |
| Poultry | 317.7 | 7.62 |
| Total | | 176.75 |




The cattle, buffalo, small ruminants (goat and sheep) and poultry population of Bangladesh was reported to be 23.7, 1.47, 29.02 and 317.7 million in 2015 (Table 3, BER, 2016). The dairy cattle and other cattle number may be calculated to be 9.30 and 14.4 million, respectively, following the ratio reported by [17]. Considering the methane emission of different types of animals (Table2) the annual methane emission calculated to 62.96, 92.3, 7.97, 5.89 and 7.62 Gg, respectively, of different farm animals described above, and a total annual methane emission of livestock and poultry manure managed in different systems is amounted to be 176.75 Gg of Bangladesh. The findings was supported by [18] who reported that in 1980-83 the total calculated emitted methane from livestock manure management was 80.7 Gg, in 1996 it was 86.64 Gg and 2008-09 it was 99.15 Gg and the trend of methane emission was increasing gradually.The manure of cattle share the highest emission (87.85%) and the rest (12.15%) is shared by other farm animals. [19] also stated that methane emission from dairy cattle was much higher than non-dairy animals amd it may due to emission factor variation. The manure of buffalo, small ruminants and poultry emits 4.51%, 3.33% and 4.31%, respectively (Fig 1).

### 3.3 Regional and farming system variation in cattle manure management

**Table 4: Different management system of cattle manure in different areas of Bangladesh**

| Manure management system | Humid | | Significance | | Sub-Humid | | Significance | | Rain fed | | Significance | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Comm. | Subsist | SE | Level | Comm. | Subsist | SE | Level | Comm. | Subsist | SE | Level |
| Solid storage | 82.8 | 53.3 | 19.4 | p<0.01 | 33.5 | 26.9 | 12.1 | p<0.01 | 66.1 | 41.9 | 64.6 | p<0.01 |
| Liquid slurry | 0 | 9.48 | 0.85 | NS | 1.99 | 6.17 | 1.3 | p<0.05 | 0 | 0 | - | - |

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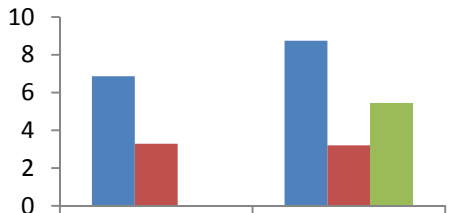
| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Burned fuel | 13.2 | 29.8 | 6.77 | p<0.05 | 62.2 | 48.5 | 22.4 | p<0.01 | 33.9 | 35.7 | 50.8 | NS |
| Anaerobic digestion | 4.04 | 7.38 | 1.18 | p<0.01 | 2.36 | 18.4 | 1.59 | p<0.01 | 0 | 22.4 | - | - |

Crop production system affects manure management systems in both commercial or subsistence production system of livestock (Table 4). The commercial farmers of all the region (humid, sub-humid or rain fed) store a significantly (p<0.01) higher proportion of manure (82.8%, 33.5% & 66.1%, respectively) in solid storage than subsistence farmers (53.3%, 26.9% & 41.9%, respectively) and both categories of farmers of humid (82.8% & 53.3%, respectively) or rain fed areas (66.1% & 41.9%, respectively) kept more manure in solid storage compared to those of sub-humid areas. The farmers of both commercial and subsistence system of the sub-humid region use a higher fraction of manure as burned fuel (62.2% & 48.5%, respectively) than that of other areas. A limited access of farmers to cooking biomass due to inundation of major cultivated area by the monsoon flood water of sub-humid region compels them to use cattle manure as burned fuel. The use of anaerobic digestion of cattle manure differed significantly (p<0.01) between the commercial and subsistence farmers of humid and sub-humid areas, and it ranged from 4.04% to 7.38% in the former and 2.36% to 18.4% in the latter area. A higher proportion of subsistence farmers (22.4%) of rain fed area (Table 4) was found to use anaerobic digestion system. Selection bias to farmers having biogas system during the survey may have resulted in an inordinate percentage of manure use for anaerobic digestion.

**Fig 2: Kg $CH_4$ emission/head/Yr by ruminants**




| | Commercial | Subsistence |
|---|---|---|
| Dairy Cattle | 6.87 | 8.75 |
| Other cattle | 3.28 | 3.21 |
| Buffalo | 0 | 5.42 |

Dietary feed composition, in addition to its effect on enteric methane emission, also affects manure composition that in turn, in addition to its farm management systems, affect the $CH_4$ emission of manure of farm animals. Fig 2shows that commercial dairying had less annual $CH_4$ emission (6.87 Kg/head) compared to subsistence dairy cattle (8.75 Kg/head). A higher input support, especially, in terms of feeding and nutrition [20] and improved management helped reduction of $CH_4$ emission from manure of commercial dairying.

### 3.4 Constrains of manure management

**Table5: Identified major constrains of manure management**

| **Technical and socio-economical (% farmers)** | |
|---|---|
| Lack of farm labor | 22.3 |
| Lack of manure storage capacity | 15.90 |
| Lack of manure treatment capacity | 52.89 |
| Lack of manure transport capacity | 14.88 |
| Lack of suitable equipment | 21.49 |
| Credit problem | 49.46 |

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| Institutional (% farmers) | |
|---|---|
| Lack of information | 87.88 |
| Lack of access to information due to illiteracy | 38.02 |
| Lack of access to loan | 38.84 |
| Lack of access to required equipment and machines | 20.65 |
| Lack of trading infrastructure | 41.31 |
| Lack of regulation | 30.58 |

Data on the farmers opinion about technical and socio-economical along with institutional constrains of manure management was recorded and they are summarized and presented in Table 5. According to the farmer's opinion the major technical and socio-economical constrains are the lack of manure treatment capacity (52.89%) and unavailability of credits (49.46%). About 87.88% of the respondent farmers stated that they were unaware of improved manure management of and 41.31% raised the problem of lacking trading infrastructure. Others supported the problem of absence of easy access to information due to illiteracy (38.02%), regulation (30.58%), and to required equipment and machineries (20.65%).

## IV. CONCLUSION

Solid storage, liquid slurry, burned fuel, anaerobic digestion and without litter, especially for chicken manure, are the major livestock and poultry manure management system found in Bangladesh, and 56.2% to even 100%, especially in case of small ruminant animals, of the total manure is kept in solid storage, followed burned fuel use of 37.3% to 47.0%. The total annual $CH_4$ emission from manure is estimated to be 176.75 Gg and emission from cattle manure was estimated to 87.85%. The manure management and the extent of emission varied according to farming system and region of the country. Lack of technical knowledge, credit support, and absence of policy are the major constraint to improved manure management in Bangladesh.

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