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Article

Management approach of livestock manure in present farming system of Bangladesh

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Abstract: Laying aside manure meat, milk and egg is considered as key performance indicator of livestock farm profitability of Bangladesh till yet whereas manure contains minimum 45-55% feed nutrient fed to animals. A survey based research work was conveyed to find out the major channel of using this valuable livestock manure by farmers from twelve selected district of Bangladesh. Results showed that most of the cattle and buffalo farmers prefer solid storage system to manage their manure. From this stored manure, about 35% was used for land fertilization, 47% for burning fuel preparation, 8% for composting and remaining 10% become completely wasted. A very few of cattle manure (4.65) was utilized by the care of anaerobic digestion. But this improved system was completely absent in case of buffalo and small ruminants manure management. Dung produced from small ruminants fully goes for solid piling. About 20% of poultry manure managed in improved way and the remaining portion was mostly utilized in a very disparage way. In anaerobic digestion system, the produced gas went for home consumption and bio-slurry creates havoc for both farmer and environment. Land fertilization and aquaculture coves its utilization but the amount is too low compared to its production. Above 52% of total bio-slurry become wasted due to limited knowledge and lack of appropriate handling techniques. The scenario of urine and liquid slurry management was very melancholic. About 0.37 and 0.203 kg methane emission per head per year was calculated from solid storage system of cattle and small ruminant animal manure. The value is also high in burning fuel preparation (5.46 kg) and liquid slurry (5.81 kg) and a bit low in anaerobic digestion system (1.24 kg) per head per year.

Keywords: livestock manure; solid storage; burning fuel; anaerobic digestion; methane effusion

1. Introduction

Livestock is the integral component of Bangladeshi agriculture which mostly supports the increasing national demand of highly valuable animal protein requirement. Harnessing the full potentiality of livestock to accelerate economic growth for reduction of rural poverty is the major objective of national livestock development policy in Bangladesh. But this livestock rearing system possesses both positive and negative effects on natural resource, public health and economic growth (World Bank, 2009). In one side they are producing valuable animal protein and another side every year about 18% of total Greenhouse Gas (GHGs) is being emitted from them (SAPPLPP, 2009; Steinfeld *et al*., 2006) through enteric fermentation and manure production which are directly involved with their feeding management. Feeding, the most vital and maximum cost bearing management practice of livestock farming and up to 55% of feed nutrients fed to livestock (ruminant and poultry) passes through the digestive tract as undigested form. This outcome product is known as dung or manure. In traditional practice livestock manure is being used as an excellent source of available plant nutrient and soil organic matter by farmers since a long time ago. But the amount of used dung is too low compared to its total production. Every year Bangladesh produces 155.8 million ton (ILMM Policy, 2015) livestock manure and major portion of it become wasted and polluting environment. But this waste could be turned into valuable

wealth through its judicial and scientific management approaches. Being an over populated country our country has to face several crisis like energy, fuel and power. Around 33% and 4% of total population are consuming electricity and natural gas facilities respectively and about 82% of total electricity originates from natural gas (Salma *et al*., 2015). Though major national power stations are currently run by natural gas so, it could be assumed that very soon the limited reserve of natural gas (439×10^9) will start to decline (Hasan and Khan, 2012). The scenario is much more appealing in rural areas and about 87% of people have no provision to get entry into the national power grid and natural gas network (Hjorth *et al*., 2008). As a result people are getting highly dependent on primitive sources like biomass fuel wood, agricultural residue, cow-dung and kerosene to meet their energy demand. The arbitrary use of wood as fuel for year after year causes the reduction of forest area at an alarming rate as the estimated value of annual fuel wood consumption of Bangladesh is 40 million tons (BCSIR) and the value is increasing per year. All of the primordial approach of having energy threatens natural resource, environment and public health as well. The increase of fuel price in international market and reduction of gas reserve of the country obtrude us to generate energy from alternative renewable source. On the other hand Bangladeshi crop land is losing her organic matter gradually due to become forced to satisfy the food demand of ever increasing people from limited cultivable land through the intensive use of chemical fertilizer and somewhere it goes down to 0.5% where the standard is value is minimum 3% (Islam *et al*., 2008). Under this circumstance there is no alternative of adding organic matter to soil for sustainable and increased crop production. Because it is already established that improvement of soil physical and chemical properties along with organic matter status could be attained through the recycling of different organic wastes in agriculture (Chongrak, 1996). Searching of sustainable renewable energy source to meet the challenges is another global concerning issue now where livestock manure is getting highest preference as a potential source. Being a livestock concentrated country compared to our neighboring countries biogas production from bio-degradable material could be a promising solution in this regard from where gas, power and organic fertilizer could be produced at a time. Government of Bangladesh is much more concern now about altering the energy source and they has implemented the National Domestic and Manure Program (NDBMP) since 2006 with an aim of developing and disseminating biogas technology in rural areas where the maximum livestock population are existent. Moreover the Ministry of Power and Energy has decided to attain the enormous potential of renewable energy to generate 10% of total required electricity (About 2000 MW) by 2020 (Renewable Energy Policy, 2015; SAPPLPP, 2009). Moreover, according to IFRD report, the amount of per annum produced manure of Bangladesh is potent to establish minimum 4 million biogas plant in the country from where 105 billion cubic feet of biogas could be produced per year which is equivalent to 1.5 million ton kerosene or 3.08 million tons of coal and could serve the cooking and lighting demand of about 20% of total national household. Moreover more than 200000 ton of bio-slurry will be produced from expected amount of biogas chamber which is 20-30% rich in nutrients than traditional organic fertilizer particularly suitable for horticulture, pisciculture and agriculture. A case study report of Nepal showed that utilization of bio-slurry increases crop yield 68% and vegetable yield 42% (Katuwal and Bohara, 2014). All these offshoot of manure facilitate our nation to serve the people with energy, power and organic fertilizer and also farmers to be besteaded more than their regular economic profile. (Hasan and Khan, 2012, Nielsen *et al*., 2002; Hjorth *et al*., 2008) stated that when the profit from biogas externalities (energy selling and fertilizer value of slurry) is integrated with the quantified value of human, animal and environment then the total farm economy and social status of farmer become uprising. At the same time the emission rate of several greenhouse gases will be minimized and ultimately the environment will be clean. To harvest the maximum potentiality of manure it is essential to explore the present scenario of existing management system first to look forward for improving it. To satisfy this goal a baseline survey based research plan was designed for specifying the management system of livestock manure in present farming system of Bangladesh and signify the management difference of farmers having biogas digester or not.

2. Materials and Methods

A survey was conducted by the researcher group of Bangladesh Livestock research Institute (BLRI) to reflect the present scenario of managing manure at farmers' level of Bangladesh. The work was collaboratively done with University of Wageningen, Netherlands and SEI (Stockholm Environment Institute), Asia. Total twelve districts - Gazipur, Dinajpur, Nilphamari, Jessore, Bagerhat, Sunamganj, Sirajganj, Bogra, Naogaon, Potuakhali, Chittagong and Rangamati were selected area to collect data based on species concentration. Dinajpur, Sirajgonj, Bogra, Potuakhali, Chittagong and Rangamati were selected as cattle concentrated area, Bagerhat for Buffalo, Naogaon for sheep, Jessore for goat and Gazipur, Nilphamari and Sunamgonj were selected as poultry concentrated area. The questionnaire used for collecting data on this aspect was prepared by the collaborative participants of BLRI. After pretesting the constructed questionnaire was filled up through personal interview

with farmers. A farmer having minimum 50 cattle or 40 goat or sheep or 10000 bird was considered as commercial farmer. In case of subsistence farmer the minimum range of cattle is 2, goat or sheep is 3 and poultry is 9 in number. Farmers having minimum 16 cattle, 31 goat and 591 poultry were dignified as medium farmer. Random selection method was followed to select farmers of targeted areas based on prior fixed category. Total 120 farmers (10 from each district) were interviewed under this survey. Mainly two types of manure management systems were seen to be followed by the farmers at field level of Bangladesh. One group was managing their manure in improved way by using biogas digester who were considered as digester having farmer group and another group was managing their manure in conventional way, they were considered as non-digester group. Though the vision of this research work was getting introduced with the present manure management system and differentiating the conventional system with the improved management system so, after having all collected data they were inserted into MS Excel spread sheet according to farmer's category (having digester or not) and statistical analysis were done using SPSS 17.0 statistical package program where it was necessary. Among the interviewed farmers the number of digester having farmer was only 29 and remaining 91 was non digester having farmer. Moreover, the methane emission factor for different livestock species under different manure management system defined by Intergovernmental Panel on Climate Change (IPCC, 2006) was calculated from the collected data. To calculate the methane emission factor from livestock manure management the equation of IPCC (Equation 10.23: $EF_T = (VS_T . 365) . [B_{o(T)} . \frac{0.67Kg}{m^3} . \sum_{S,k} \frac{MCF_{S,k}}{100} . MS_{(T,S,k)}]$) specified for Indian sub-continent and the default values of volatile solid (VS), maximum methane producing capacity for manure (Bo) & % methane conversion factor (MCF) was used here.

3. Results

3.1. General information of the respondents

Table 1 describes the farm area, agriculture and grassland occupying area, number of animals and required number and time of labour to manage the farm of interviewed farmers. Land engaged with farm, agriculture and fodder cultivation purpose owned by digester having farmer was comparatively higher (2.2, 3.6 and 0.7 ha respectively) than non-digester farmer (1.2, 1.46 and 0.2 ha respectively). Data shows that the farmers who manage their livestock manure in improved way own comparatively higher number of animals and their minimum value was either 15 cattle or 6043 chicken. But comparatively lower number of animals (4 cattle or 3 goat or 200 chicken or in combination of them) reared by non-digester group of farmers. Mainly cattle and poultry rearing farmers were observed to be involved with anaerobic digestion system to manage manure. In some cases, digester having farmers were seen to rear some other species (goat or duck) of animal with their cattle or chicken to serve their home consumption purpose. Buffalo rearing is very neglected and sporadic to our farmers till to date. Among the interviewed farmers a very few reared buffalo. Scant number of animal was reared by them in operable rearing system. Similar trend was also observed in small ruminant (sheep and goat) farming. Duck rearing system of our country is somewhat area specific, seasonal and totally customary.

Table 1. Feature of the interviewed respondents.

Parameter	(Mean ± SD)		*p*-value
	Digester N=29	Non-digester N=91	
Farm area (ha)	2.2 ± 5.2	1.2 ± 3.8	0.153
Agricultural land (ha)	3.6 ±8.1	1.46 ± 6.8	0.417
Grassland (ha)	0.7±2.6	0.2 ± 0.8	0.004
Livestock Composition			
Dairy cattle(nos.)	15.2 ± 23.2	3.9 ± 9.1	<0.001
Buffalo (nos.)	-	1.1±5.0	-
Sheep(nos.)	-	1.4 ± 5.2	-
Goat(nos.)	3.5 ± 15.1	2.8 ± 7.8	0.428
Chicken(nos.)	6043 ± 28666	200.2 ± 772.4	<0.001
Duck (nos.)	4.8 ± 12.4	113.4 ± 276.8	<0.001

3.2. Utilizing avenues of livestock manure

3.2.1. Available management systems of livestock manure in Bangladesh

According to the classification of IPCC (IPCC, 2006) the whole manure management system followed by Bangladeshi farmer was categorized into four namely solid storage, liquid slurry, burned fuel and anaerobic

digestion for large and small ruminants. For poultry droppings management two systems are mentioned there-anaerobic digestion and without litter system. Cow dung piling beside residential area (solid storing) or drying manure on open field for burning is a very familiar scenario of Bangladesh. Urine and flush water namely liquid slurry are mostly being wasted because of the barbarism of the farmers about its management process and advantageous wing. About 34.71% of the respondent farmers of targeted area were involved in preparing burned fuel (dung cakes, dung sticks) with their livestock manure and 33.68% farmer were storing it in solid form to use in accordance to their requirement. About 25% farmers were engaged in anaerobic digestion management system and only 7% of farmers utilized their liquid slurry (Table 2). This data reveals slightly magnifying view than practical scenario due to the biasness on farmers having digester during selection. The digester having farmers owned only one digester of average $4m^3$ capacity (Data is not shown).

Table 2. Percentage of farmers under different manure management system.

Management systems	% of farmers
Solid storage	33.68
Liquid slurry	6.61
Burned fuel	34.71
Anaerobic digester	25

3.2.2. Share percent of livestock dung under mentioned management system

Table 3 represents the % contribution of total produced manure from different species under different management system. Data shows that, major portion of large ruminant (cattle and buffalo) dung goes for solid storage and burning fuel preparation and their respective value is 54 and 38.85% for cattle and 57.31 and 42.69% for buffalo. Only 4.65% of cattle manure goes for anaerobic digestion. In case of small ruminant 100% feces was used as solid store and about 20% poultry manure was digested an-aerobically (Table 3). No anaerobic digestion system was observed in buffalo and small ruminant farm.

Table 3. Amount of manure under different management system (% of manure).

Management system	Cattle	Buffalo	Small Ruminant	Poultry
Solid storage	54.0	57.31	100.0	-
Burned fuel	38.85	42.69	-	-
Liquid Slurry	2.5	-	-	-
Anaerobic digestion	4.65	0	-	20.08
Without litter	-	-	-	79.92

3.2.3. Mode of using dung and urine by digester and non-digester group farmer

Table 4 describes the possible ways of using solid dung by the farmers of both group and their respective share in each. From this table it is clear that an enormous amount of manure become stored in solid form in both group and the storage amount is comparatively much higher in non-digester group (78.02%). Tendency of storing manure was also seen in digester having farmers group as because their bio-gas digester was not so capacious to utilize their total produced manure. About 58% of digester having farmer under this study was found to store solid manure for need based utilization after fulfilling their digester demand. 24% farmer of the same group was used to dry manure for preparing and selling burning fuel. In case of non digester group, they prefer to store whole produced manure in solid form as they have no provision of further processing. About 36.06% farmer of this group dried manure to use it as fuel for cooking (Table 4). Moreover, composting is a somewhat familiar process to rural farmers to manage cow dung. Composting is mostly preferred by the farmers who have no appliance to manage manure in improved way and about 7.69% farmers of such group was found to practice composting scheme to manage dung. Only 3.45% digester having farmers were seen to manage their remaining stored manure in the same management process. The stored and composted manure is further utilized in different ways. Figure 1 ascertains the further utilizing route of stored solid manure and composted dung. Data evolves that stored solid manure was used for land fertilization (34.64%) and sold to others (47.14%) whereas composted manure was mostly used as fertilizer (81.25%). A very few amount of manure from both category (0.24 and 1.25%) was used for aquaculture. 3.33% of stored solid manure was for off farm agriculture whereas the value was 5% in case of composted dung utilized in the same sector. In Bangladesh, till now farmers are not so learned about the beneficial outcome and convenient pathways of utilizing urine and liquid

manure. Under this study only 6.90 % of interviewed digester having farmers stored animal urine to use it in digester where as the number was nil in the following group.

Table 4. Ways of using solid manure and urine (% farmer).

Ways of utilization	Digester	Non-digester
In digester	100	-
Store solid manure	58.62	78.02
Dry solid manure	24.14	36.16
Compost solid manure	3.45	7.69
Store urine	6.90	-

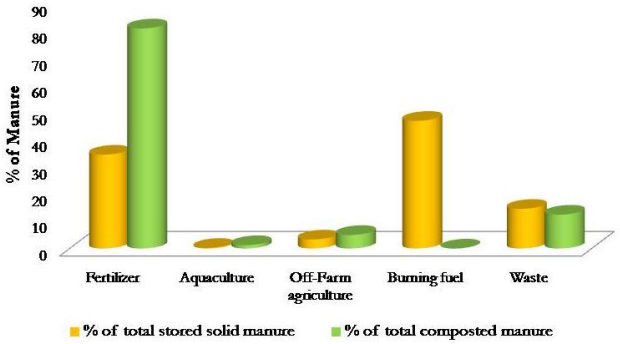

Figure 1. Route of using stored and composted dung.

3.2.4. Directions of bio-slurry management at farmers' level

Bio-slurry, a valuable resource comes from biogas digester as residue of complete fermentation of organic components. It containing higher amount of plant essential nutrients (N, P and K) in available form is considered as a blessing for soil. The bio-slurry utilization pattern at farmers' level was studied under this research and the generated data regarding this aspect is presented in Figure 2. Land fertilization and aquaculture mostly covers the major utilization of bio-slurry. About 43% of produced slurry used as fertilizer (both solid and liquid) and 5% in aquaculture as fish feed. A big total of remaining bio-slurry (52%) was being wasted due to having no capacity to store or further processing of it.

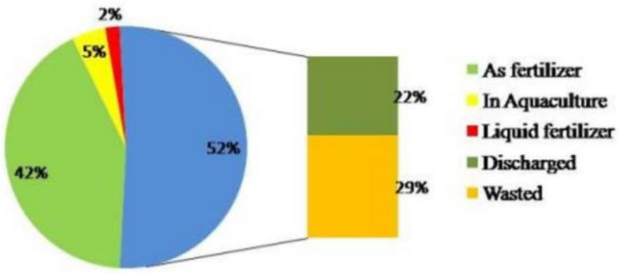

Figure 2. Percentage of total bio-sluury.

3.2.5. Calculation of methane emission factor from different management system

An attempt was taken to calculate the annual methane emission factor of different livestock manure management system of Bangladesh using IPCC equation from the collected data. Table 5 represents the quantified amount of emitted methane from annual per animal manure of different species remaining under different management system. Data shows that highest amount of methane is releasing through liquid slurry (5.81 and 5.33 kg/head/year) and burning fuel (5.46 and 5.01 kg/head/year) management system from cattle and buffalo manure respectively. Emission of methane is comparatively lower in solid storage (0.37 and 0.34 kg/head/year) and anaerobic digestion (1.24 and 1.14 kg/head/year) system. Although apparently solid storage

system shows minimum emission but the cumulative factor of emission from mounded manure for long time is much higher than remaining three systems.

Table 5. Methane emission from different management system.

Management System	Annual methane emission (Kg CH_4/head/year)			
	Dairy Cattle	**Buffalo**	**Small ruminants**	**Poultry**
Solid storage	0.37	0.34	0.203	-
Liquid Slurry	5.81	5.33	-	-
Burned fuel	5.46	5.01	-	-
Anaerobic digester	1.24	1.14	-	0.001
Without litter	-	-	-	0.023

4. Discussion

Anaerobic digestion system of livestock manure was the only improved method of livestock manure management found under this study and the number of this type of farmer was very low and species specific (only cattle and chicken rearing farmers). The farmers having comparatively higher number of animals and birds along with homestead and cultivable land area are mostly interested to manage their manure through anaerobic digestion system. But in our country maximum animals are reared by rural farmers who own only 2-3 animals per household and they follow the traditional method (solid store and burning fuel preparation) to manage their manure. But the report of (Gofran, 2008) shows the linings for small holder farmers, to achieve the maximum potentiality from their reared animals. He stated that manure of 3-4 cattle is enough to run a family biogas digester of 2 m^3 capacity which could be operated by the smallholder farmers. While the animal number of non-digester group under this study was ranged by 4-13. So a huge possibility is shining there to be explored through the scientific management of manure as more than half of Bangladeshi farmers are small-holder in nature. But buffalo and small ruminant farmers are very much far behind from it. Buffalo farming is not so consumer demanding in our country till yet, so farmers don't feel interest to invest more on buffalo. They pay very little attention to rear it. Same scenario was observed in case of duck farming as its farming was seasonal and scavenging. Usually a small number of commercial farm of small ruminants are available throughout our country and most of the farmers are poor. They are not so conversant about the beneficial effect of livestock manure and its management process. This is why they prefer to store manure in a pit or open space beside their residential area. Moreover the amount of produced manure from small ruminant is comparatively minute than large ruminants. So, introducing anaerobic digestion management system for small ruminant animal manure is somewhat difficult. So, appropriate management system development for small ruminants of our country irrespective to farmer, climate and economy is a time burning issue now. Livestock manure collection for open piling storing and drying for cooking by farmer is a very common scenario for Bangladesh especially in small holdings (Biswas and Lucas, 1997). A small amount of cattle dung and poultry litter is used as a biogas feedstock in Bangladesh (SNV, 2005). Though Bangladesh is a remarkable livestock concentrated country than any other neighboring country and produce a huge amount of manure every year so, a lot of opportunity is remaining there to be achieved (minimum 4 million biogas plant) via the systematic approach of managing it through producing biogas and bio-slurry (Waste Concern, 2005). Bio-slurry is a water rich (above 90%) material. This is why farmer feels uncomfortable to carry bio-slurry to their crop field as it is far from their slurry tank. Beside this farmer can't use the higher volume of produced bio-slurry at a time due to the shortage of their cultivable land. They don't have any processing or preserving technology in their hand for further use. Ultimately a higher amount of valuable resource becomes attenuated. So, proper technology intervention on bio-slurry preservation is a crucial need of today's farmers. At present 200000 tons of bio-slurry on dry weight basis is being produced every year from the available bio-gas plants of Bangladesh operated by livestock wastes and it is equivalent to about 9,000 tons of urea, 25,000 ton TSP, 3200 ton MOP along with other secondary and micronutrients (Islam, 2006). So it can be expected that if the total produced amount of livestock manure could be managed under anaerobic digestion system it would become a national benison for Bangladesh. Despite of being a valuable resource manure creates some threatening causes to environment and public health due to its conventional management practices (Gerber *et al*., 2005). Report of (Steinfeld *et al.,* 2006) proves that livestock and poultry manure management operations account 18% of all human-caused greenhouse gas emission. So, it is obvious that the usual practice followed by Bangladeshi farmers like solid storing of dung, burning fuel and open removal of liquid slurry is injurious to environment and public health. Because when manure is spreader or piled up in open space then it emits GHGs that pollutes environment. On the other hand when dung cakes are

prepared to use it as fuels for burning then it becomes exposed to hand directly which is unhygienic and causes several infection mostly by *E. coli*. Cooking smoke from this burning fuel causes several respiratory diseases too. In the final project report of (Waste Concern, 2005), it was mentioned that traditional use of dung and litter of Bangladesh impacting high on environment and cultivable land because when it is dumped on low ground adjoining dwelling houses then it causes them to be affected by smell, dust and surface water pollution.

4. Conclusions

It can be concluded that the total livestock manure management system of Bangladesh is in very vulnerable condition till yet. Solid storage and burning fuel preparation is much more preferred method by the farmers to handle manure through which a huge amount of methane is emitted to the environment annually, polluting our surroundings and creating public health hazards. Amount of utilized manure is very low and major portion of this valuable wealth becomes wasted. Farmers have no concern about the utilization of urine and flush water. They have no knowledge on technology of improved manure management system. So, farmer awareness and knowledge dissemination program through extension service should be ensured first to develop sustainable improved livestock manure management system and harvest maximum potentiality of livestock rearing.

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Conflict of interest

None to declare.

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