

Study on Characteristics of Bioslurry and FYM for Mechanized Application

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ABSTRACT: The great variability of animal manure characteristics is due to the large diversity of livestock storage, storage type and handling equipment. The performance of spreader is related to the physical and frictional characteristics of the material being spread out. When testing a spreader or researching spreading technique, it is necessary to know the main physical and frictional characteristics of the manure viz. bulk density, moisture content, dry matter content, angle of repose and angle of friction. A study was carried out to determine the various characteristics of Bioslurry and Farmyard manure (FYM) at laboratory of SVCAET&RS, FAE, IGKV, Raipur. The moisture content, bulk density and dry matter content observed for bioslurry was 63.084%, 1004.25 kg/m³ and 36.916% respectively. The physical property of FYM were determined at different depth of manure pit viz. 0-20, 20-40, 40-60, 60-80 and 80-100 cm. The moisture content observed in FYM was 23.55, 24.63, 26.81, 29.73 and 33.65% at different depth of manure pit. The bulk density measured in FYM was 346.75, 379.86, 403.57, 433.48 and 461.63 kg/m³ at different depths of manure pit. The dry matter content measured for FYM was 76.45, 75.37, 73.19, 70.27 and 66.35%. The angle of repose of FYM was 29.52°, 32.57°, 35.71°, 36.55° and 38.04° at different depths of manure pit. The angle of friction with MS sheet was found to be 29.05°, 31.74°, 33.29°, 34.64° and 35.86°.

KEYWORDS: Angle of friction, Angle of repose, Bioslurry, Bulk density, Farmyard manure, Manure pit, Physical characteristics

I. INTRODUCTION

Traditional farming was the original type of agriculture also called organic farming, and has been practiced for thousands of years using different type manure. Artificial fertilizers had been created during the 18th century were cheap, powerful, and easy to transport in bulk. But these new agricultural techniques, while beneficial in the short term, had serious longer term side effects such as soil compaction, soil erosion, and declines in overall soil fertility, along with health concerns about toxic chemicals entering the food supply. The major principals of organic farming includes a) To maintain the long-term fertility of soils, b) To avoid all forms of pollution that may result from agricultural techniques, c) To produce foodstuffs of high nutritional quality and sufficient quantity, d) To reduce the use of fossil energy in organic agricultural practice to a minimum, e) To give livestock conditions of life that confirm to their physiological need and f) To make it possible for agricultural producers to earn a living through their work and develop their potentialities as human being. So keeping all the principal of organic farming in view bioslurry and FYM are major source which can be used as organic fertilizer for organic farming. Being tropical country, Indian soils are often deficient in humus which is an extremely important material formed after decomposition of FYM. The preparation of FYM offers one of the best manure for utilizing farm and other agricultural wastes and simultaneous production of humus. A good proportion of plant nutrients contained in bioslurry and FYM are allowed to be wasted through improper handling, storage, etc. with the result that the bioslurry and FYM prepared and used by our farmers at present is of minimum value in increasing crop production.

The adoptions of agricultural technologies are increasing rapidly day-by-day. Most of the farmers have biogas plant and compost pit at their home for biogas and FYM production. Application of the slurry obtained from biogas plant and

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farmyard manure in the field is very difficult for farmers. So development of suitable machine must be needed for application of these manures. But before designing any machine, various physical characteristics of manure must be determined for proper functioning of machine. These characteristics includes moisture content, bulk density, dry matter content, angle of repose and angle of friction. Various machine parameters like flow rate of manure inside storage box, capacity of manure storage box, uniformity of application, field capacity of machine may influenced by these characteristic. So the study was carried out with major objectives as:

1. To study the physical characteristics of Bioslurry and FYM.
2. To study the frictional characteristics of FYM.

II. MATERIALS AND METHODS

The physical characteristics of solid manure cannot be defined simply according to its origin. Many factors may impact on these characteristics, for example in the same shad, the density may vary from 300 kg/m^3 where the cattle is used to rest, to 700 kg/m^3 where the movement of cattle has compacted the manure. But in case of liquid manure like bioslurry the characteristics did not vary as much. The physical properties i.e. bulk density, moisture content, dry matter content, angle of repose and angle of friction for bioslurry and FYM were studied and measured.

The bioslurry after proper digestion is homogeneous mixture and its moisture content will same at all depth of outlet tank of biogas plant, but the FYM is heterogeneous mixture and its moisture content varies at different depths stored in manure pits. For measuring the physical characteristics, five depths of manure pits viz., 0-20, 20-40, 40-60, 60-80 and 80-100 cm were used.

A. Bulk density

Bulk density affects handling of manure in the machine. The bulk density was found out by measuring the volume of given weight of the sample. Bulk density influences the volume requirement of manure box and moisture content. The FYM samples were collected by using core cutter method at different depths in storage pits and of bioslurry were from outlet tank of 5 different biogas plants after proper steering. It was calculated by dividing mass of manure (kg) by volume of cylinder (m^3). Bulk density of Bioslurry and FYM was calculated by placing the samples of Bioslurry and FYM in a cylinder container which has 18 cm of diameter and 31.4 cm of length. (Madamaba et al. 1993). The sample placed in the cylinder is then weighed by using electronic balance with least count of 1g. Bulk density was calculated by using the following relationship.

$$b_d = \frac{W_t}{L \times \left(\frac{\pi d^2}{4}\right)}$$

Where, b_d = Bulk density (kg/m^3), W_t = Weight of sample (kg), L = Length of cylinder (m) and d = Diameter of cylinder (m).

B. Moisture content

The moisture content of bioslurry and FYM was determined by using oven drying method. The samples were weighed by electronic balance with least count of 1g before and after drying, keeping the samples inside the oven at 55°C for 24 h (Reddy and Dronachari, 2014). It is expressed using the formula as:

$$M_c = \frac{W_2 - W_3}{W_3 - W_1} \times 100$$

Where, M_c = Moisture content (%), W_1 = Weight of crucible (g), W_2 = Weight of crucible + wet soil (g) and W_3 = Weight of crucible + oven dried soil (g).

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C. Dry matter content

The dry matter content (solid matter content) of the manure represents the proportion on a mass basis of the dissolved and suspended materials in the manure. The dry matter contents are lower than 5%, liquid or slurry manure behaves as a Newtonian fluid. Manure gradually becomes non-Newtonian with increasing total solids content (Lague et al., 2005). It is expressed using the formula as:

$$DM_c = 100 - M_c$$

Where, DM_c = Dry matter content (%) and M_c = Moisture content (db) (%).

D. Angle of repose

Angle of repose is a term used to describe the maximum angle, measured upwards from the horizontal, at which a pile of a particular material will remain stable without any of the material sliding downward. It is useful in designing storage and transportation machinery for granular materials as it can give an engineer insight into the appropriate size and shape of such devices. So for FYM it was calculated by pouring the FYM on a plate of 90 cm diameter from height of 50 cm, the material get settled in conical form. After the material get settled the height of the cone was measured. Finally the angle of repose was measured by following relationship (Whittington et al. 2005).

$$A = \tan^{-1} \frac{H}{R}$$

Where, A = Angle of repose ($^{\circ}$), H = Height of cone (cm) and R = Radius of base of cone (cm).

E. Angle of friction

For measuring angle of friction of FYM with MS sheet, the FYM filled in a rectangular frame was placed on a MS sheet placed on flat surface. The coefficient of friction of frame material and MS sheet was negligible. One end of the MS sheet was tilted until the frame containing FYM just tends to slide. The angle formed by the sheet with horizontal is called angle of friction of FYM and calculated by following relationship.

$$B = \sqrt{L^2 - H^2}$$

$$F = \tan^{-1} \left(\frac{H}{B} \right)$$

Where, B = Base width of triangle formed (cm), L = Length of MS sheet (cm), H = Vertical height of free end of MS sheet from ground (cm) and F = Angle of friction ($^{\circ}$).

III. RESULTS AND DISCUSSION

A. Physical characteristics of Bioslurry

The sample of bioslurry was taken from outlet tank of 5 different biogas plants after proper stirring and various physical characteristics were determined. The detail observation is shown in Table 1.

Moisture content: The average moisture content of bioslurry was found to be 63.084 % and ranges from 61.39 to 65.23 %. The range of moisture content is less so the variation in moisture content of bioslurry from one plant to other was also less. It is shown in Table 1.

Bulk density: The average bulk density of bioslurry was found to be 1004.25 kg/m³ and ranges from 990 to 1020 kg/m³. The range of bulk density indicates that the variation in bulk density of bioslurry from one plant to other is also less. It is shown in Table 1.

Dry matter content: The average dry matter content of bioslurry was found to be 36.916 % and ranges from 34.77 to 38.61 %. Variation of dry matter content in bioslurry from different biogas plant was also less. It is shown in Table 1.

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Table 1: Physical characteristics of bioslurry

Observation No.	Moisture content db(%)	Bulk density (kg/m ³)	Dry matter content (%)
I	63.27	1012.50	36.73
II	62.93	995.00	37.07
III	62.60	1020.00	37.40
IV	61.39	1003.75	38.61
V	65.23	990.00	34.77
Average	63.084	1004.25	36.916

B. Physical characteristics of FYM

Physical characteristics of FYM have been studied at different depths of manure pit. The physical properties of FYM are shown in Table 2. The manure is a heterogeneous material and its moisture content varies at different depths of manure pit. For measuring the physical characteristics, five depths of manure pits viz., 0-20, 20-40, 40-60, 60-80 and 80-100 cm were used. The measured physical characteristics of manure are in close agreement with the results of Thirionet *et al.* (1997), Landry *et al.* (2004), Singh and Singh (2006) and Reddy and Dronachari (2014).

Table 4.2: Physical characteristics of FYM

Depth of samples (cm)	Moisture content db (%)	Bulk density (kg/m ³)	Dry matter content (%)	Angle of repose (°)	Angle of friction (°)
0-20	23.55	346.75	76.45	29.52	29.05
20-40	24.63	379.86	75.37	32.57	31.74
40-60	26.81	403.57	73.19	35.71	33.29
60-80	29.73	433.48	70.27	36.55	34.64
80-100	33.65	461.63	66.35	38.04	35.86

Moisture content: Moisture content observed in farmyard manure was 23.55, 24.63, 26.81, 29.73 and 33.65 % at respective depths of manure pit. The moisture content of FYM at different depths of manure pit is shown in Table 2 and Fig. 1(a). The moisture content of FYM is more at bottom of manure pit. The moisture content also varies from manure to manure.

Bulk density: Bulk density measured in FYM was 346.75, 379.86, 403.57, 433.48 and 461.63 kg/m³ at different depths of manure pit. The bulk density measured at different depths of manure pit is shown in Table 2 and Fig. 1(b). The bulk density varies with manure to manure and also at different depths of compost pits. It was noted that bulk density increases as the depth of compost pit increases.

Dry matter content: Dry matter content measured for farmyard manure was 76.45, 75.37, 73.19, 70.27 and 66.35%. As the moisture content of manure increases, dry matter content decreases rapidly. The dry matter content of manure was measured at different depths of manure pit is shown in Table 2 and Fig. 1(c).

Angle of repose: The angle of repose for FYM was 29.52°, 32.57°, 35.71°, 36.55° and 38.04° at different depths of manure pit. The angle of repose of manures at different depths of manure pit is shown in Table 2 and Fig. 1(d). The angle of repose influences the design of manure box.

Angle of friction: The angle of friction for FYM with MS sheet was 29.05°, 31.74°, 33.29°, 34.64° and 35.86° at different depths of manure pit as shown in Table 2 and Fig. 1(e). The angle of friction also influences the design of manure box.

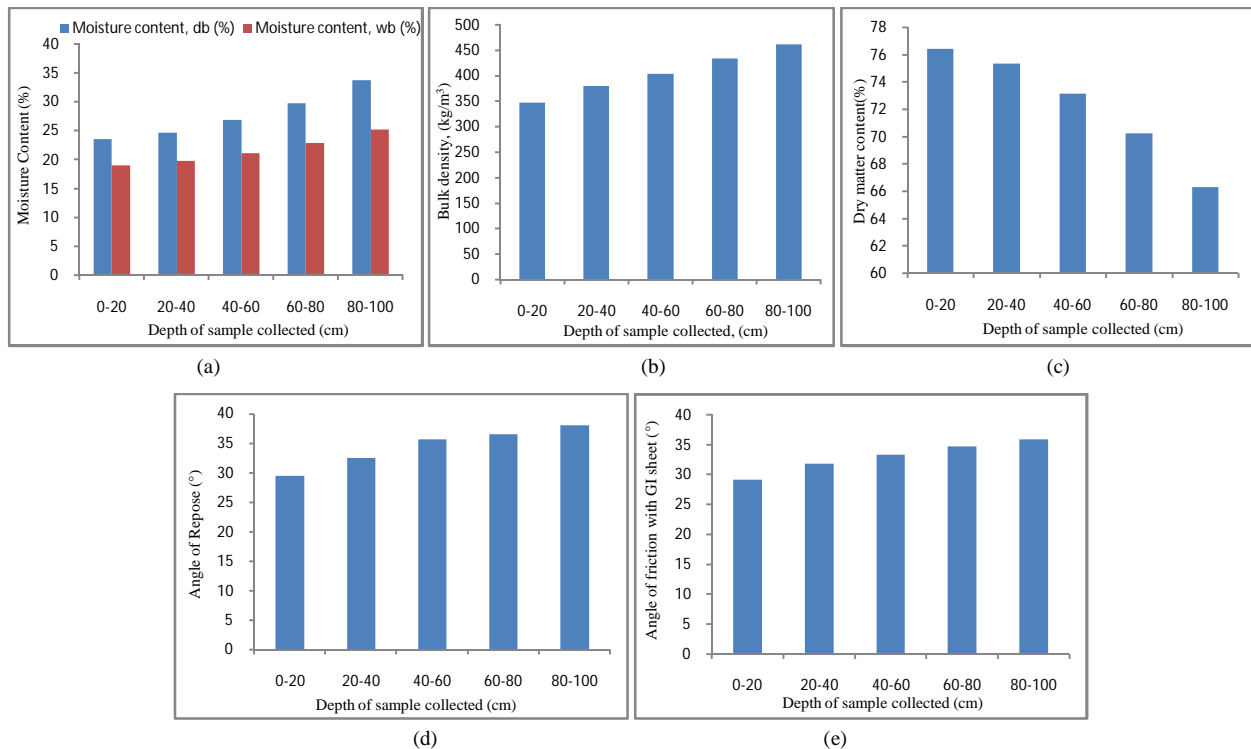


Fig. 1: Physical properties of Farm Yard Manure (a) Moisture content at dry and wet basis of FYM at different depth of manure pit (b) Bulk density of FYM at different depth of manure pit (c) Dry matter content of FYM at different depth of manure pit (d) Angle of repose of FYM at different depth of manure pit (e) Angle of friction of FYM with MS sheet at different depth of manure pit

IV. CONCLUSION

Based on laboratory study of physical characteristics of bioslurry and FYM, it is concluded that bulk density and moisture content of manure influences the design volume of the manure box and agitator mechanisms especially in solid manure spreaders. When moisture content of the manure increased, the dry matter content of the manure decreased rapidly. Angle of repose and angle of friction influences the flow characteristics of manure in the design of manure spreaders.

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