

# Study on Attributes of Farm Yard Manure for Paddle Operated Mechanical Applicator

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## ABSTRACT

Farm yard manure has a great diversity characterized for storage and application. Moisture content, bulk density, dry matter content, angle of repose and angle of friction are the major characteristics which are related to the performance of manure spreader. A study was carried out to determine different frictional as well as physical attributes of farm yard manure at laboratory of MCAT at Maya Group of colleges, Dehradun. The Physical attributes of farm yard manure were determined at different depth of manure pit. The size of pit was calculated as 300 cm × 90 cm × 75 cm. The different depths were taken as 0-18, 18-36, 36-54, 54-72, 72-90 cm respectively. The moisture content was obtained 27.96, 35.47, 38.46, 45.05 and 46.94 % at different depths and bulk density was observed as 1.66, 1.72, 1.80, 1.80 and 1.89 kg/m<sup>3</sup> respectively. The dry matter content measured for farm yard manure was 72.04, 64.54, 61.54, 54.95 and 53.11 % at different depth of manure pit. The angle of repose was found to be 35.062°, 39.193°, 39.869°, 47.478° and 53.737° at different depths of manure pit.

**Key words:** Angle of repose, Farm yard manure, Manure pit, bulk density, Compost spreader mechanisms

## Introduction

As India is a tropical country, the soil is deficient of humus content. Manure added in the beds of soil is excellent source of organic matter as it enhances quality of soil after application. To increase the social acceptance of livestock products it is a need to recycle the animal residue. Now a days, biogas plant and compost pit are present at home of farmers for production of farm yard manure and biogas. For maintaining long term fertility of soil and reduce major forms of pollution, concept of organic farming is introduced. Organic farming also produces quality which is high in nutrient content and adequate quantity. Organic farming also reduces conventional sources of energy and develops potentialities in human beings. By understanding the above stated

points organic fertilizers that is farm yard manure becomes a better option for growth of crops. In order to improve the soil structure and suitability of soil fertility, soil organic matter is the key tool. The agricultural technologies are enhancing rapidly, but application of farm yard manure still remains a tedious and difficult task for crop growers. Previous studies depict that equipment which are designed to control and apply the manure on land reveal large coefficient of variation in distribution (Bisang, 1987 and Thirion and Chabot, 2003). In order to design an efficient machine for operation of different systems of compost applicator, suitable knowledge of physical properties is a need. Former review of available chemical properties is present, but very less researchers focus on the physical properties of farm yard manure. It is found that there is a significant increase with total solid of all manure products and

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on bulk density too (Landry *et al.*, 2004). Studies also reveal that angle of repose and friction angle was correlated and they also stated the angle of repose can correspond to the internal friction of sand and for the interaction, two empirical expressions was presented and enabled the users to estimate the friction angle of sand in the field. These series of experiments were carried out at three types of sand and resulted in the above findings (ASAE 2002). A range of 25° to 39° was observed as mean value of angle of wall friction (AWF) or angle of repose of poultry litter on friction surface. It was also remarked that an increase in moisture content percentage and particle size, angle of wall friction dropped significantly. At various moisture contents *viz.* 20.5 %, 27.2 % and 36.4 %. Bulk density of farm yard manure was found 292, 510 and 680 kg/m<sup>3</sup>, respectively. The angle of repose was noted as 32°, 37° and 42° respectively, whereas the angle of friction with MS sheet was 33°, 37° and 42° with rise of moisture content and when GI sheet was used, angle of friction was 33° 36° and 44° respectively (Valari *et al.*, 2012). Some researchers also studied the effect of manure property on performance of various mechanisms. Spreading distances have effect on particle size and it depends on spreader distribution of poultry litters. They observed that on the comparison of smaller particles, the large particles were distributed more uniformly and on larger width. The small particles landed closer to the spreader (Wilhoil *et al.*, 1993 and Wilhoil *et al.*, 1994). It was observed in design of a manure applicator which had characteristic properties to apply solid waste, maximum lump size and moisture content presents problems in conveying manure due to physical properties (Glancey and Hoffman, 1996). Design and development of spreader and there handling purpose, physical properties were demonstrated in relation with moisture content percentage. The trends of physical properties of poultry manure and compost was investigated (Glancey and Hoffman, 1996). It was observed that wet bulk density was dependent on moisture content and static friction had variability for different products, but above stated factors created hindrances in development of manure applicator. To assess the volume and density of compost, an air pycnometer was used. At various moisture content and different compressive loads, free air spaces and bulk density of manure compost municipal solid waste compost and mixture of bio-solids with amendment materials were measured. Free air

space decreased with loading and moisture content increased with same as results demonstrated, while the wet bulk density increases as compressive load and moisture content was increased. Hence, a linear relationship was observed between free air space and bulk density for all materials tested under loads (ASAE 2002). So, for development of a satisfactory manure applicator, there is a need to incorporate a study on major characteristics which will include Moisture content percentage, bulk density, dry matter content, angle of repose, angle of friction. These attributes control the different machine parameters *viz.* flow rate of manure inside feed box, application uniformity, capacity of manure storage box, field capacity of machine.

## Materials and Methods

Physical and frictional attributes of Farm Yard manure:

The physical characteristics such as

1. bulk density,
2. moisture content,
3. angle of repose,
4. solid matter content and

The Frictional properties such as

1. Angle of repose (°)
  2. Coefficient of friction for Farm yard manure
- were studied and measured.

The farm yard manure is a heterogeneous matter and its moisture content varies at different depths stored in manure pits. For measuring the engineering attributes, five depths of manure pits *viz.* as 0-18 cm, 18-36 cm, 36-54 cm, 54-72 cm, 72-90 cm are employed. Farmyard manure was composed from the crop research farm of MCAT at Maya Group of colleges, Dehradun. Cow dung was cast off into the pit daily. The manure becomes ready for use in about four to five months <sup>[10]</sup>. Samples of FYM were not treated for separation, screening etc. prior to testing. Samples were collected at different depths of manure pit 0-90 cm. The dry matter content was measured with all physical properties.

**Bulk Density:** bulk density is generally used to analyze the stability, bearing capacity and degree of compaction of manure. Handling of farm yard manure in mechanical applicator is affected by bulk density and it was found by calculating the volume of the given sample weight. The volume required for filling the manure box and moisture content influences the bulk density of the manure feed hop-

per. In order to determine the bulk density of the manure, a rapid method named as core cutter method was applied. The total weight of manure mass ( $W$ ) per unit of its total volume ( $V$ ) is defined as the bulk density ( $\tilde{\alpha}$ ). At different depths in manure pits, samples were collected and was calculated by taking the ratio of mass of manure with respect to volume of cylinder. The cylindrical core cutter was with diameter 100 mm and of height 130 mm. The steel dolly had measurements of 100 mm diameter and was of height 25 mm. The steel rammer weighed 9 kg. By using electronic balance with least count of 1 g, the manure sample was placed in the cylinder is then weighed. Bulk density was calculated by using the following relationship:

$$\gamma = \frac{W}{V}$$

Where,

$$W = W_1 - W_2,$$

$W_1$  = Initial weight of manure before laboratory drying (kg),

$W_2$  = Final weight of manure after laboratory drying (kg),

$W$  = Bulk mass of manure (kg)

$$V = \frac{4W}{\pi D^2 H}$$

Where,  $V$  = Bulk volume of cylinder core ( $m^3$ ),  $D$  = Diameter of cylindrical core sampler (m) and  $H$  = Height of cylindrical core sampler (m).

**Manure Moisture Content:** In procedure of making manure, water particles are also present. Hence it becomes very important to know the moisture content. For measuring the moisture content of farm yard manure, oven drying method becomes definitive method, which can be defined as the mass of water in a sample of manure expressed as the percentage of dry mass. By applying Oven drying method the moisture content was determined. Before keeping the samples were kept inside the oven at 60 °C for 24 h, the samples were weighed with the help of electronic balance to avoid oxidation of organic matter. Least count was 1g before and after drying (Reddy and Dronachari, 2014). The expression used for calculating moisture content:

$$M_c = \frac{M_w}{M_c} \times 100$$

Where,

$M_w$  is the mass of moisture and  $M_D$  is the mass of dry soil and  $M_C$  is the manure moisture content.

**Angle of Repose:** The angle which an inclined plane makes with a horizontal plane where manure placed on it starts to slide is said to be angle of repose. If manure of mass 127 m is placed on a rough inclined plane with angle of inclination  $\theta$  and having coefficient of friction  $\mu$ . The expression for angle of repose is

$$\theta = \tan^{-1} \mu \quad \text{where } \mu = \frac{H}{R}$$

Here,  $\theta$  is the angle of repose in ( $^\circ$ , degree),  $H$  is the height of cone (in cm) and  $R$  is the radius of base of cone (in cm).

Because, designing storage and transportation of any manure applicator, calculations of angle of repose in very essential. So, for estimation of angle of repose the manure was spurt on a plate of 90 cm diameter from a height of 55 cm and the material get accumulated in conical form. Then, the manure particles settle at a height of cone hence the angle of repose is measured by above relationship. (Whittington *et al.* 2005)

**Solid Matter Content:** A mass basis of dissolved and suspended materials in the manure is proportional and represents solid matter content, sometimes also called as dry matter content. When the solid content increases, it becomes a non-Newtonian fluid and is also expressed as

$$S_{Mc} = 100 - M_c$$

Where,

$S_{Mc}$  is the solid matter content (%) and

$M_c$  is the moisture content (db) (%).

## Results and Discussion

### Physical Attributes of Farm Yard Manure

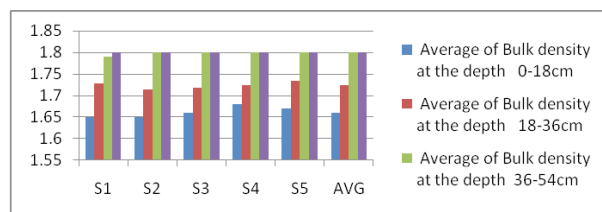
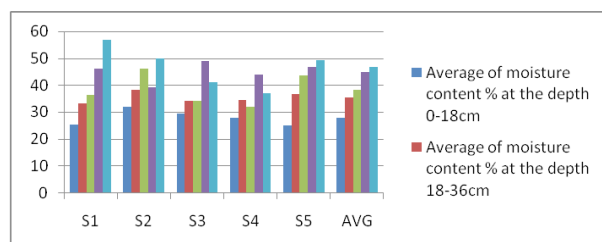
Physical attributes of farm yard manure have been observed at various depths of manure pit. The physical attributes of farm yard manure are shown in Table 1. The manure is heterogeneous in nature and its moisture content differs at different depths of manure pit. For measuring the physical attributes, five depths of manure pits *viz.*, 0-18 cm, 18-36 cm, 36-54 cm, 54-72 cm and 72-90 cm were used. The measured physical characteristics of manure are in close agreement with the results of Thirion *et al.* (1997), Landry *et al.* (2004), Singh and Singh (2004) and Reddy and Dronachari (2014).

**Bulk density:** Bulk density measured in FYM was 1.66, 1.72, 1.80, 1.80 and 1.89 kg/m<sup>3</sup> at different depths of manure pit. The bulk density measured at

**Table 1.** Physical attributes of farm yard manure

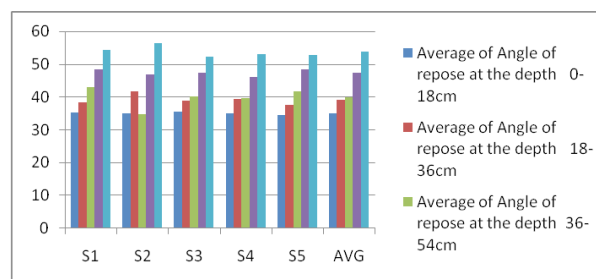
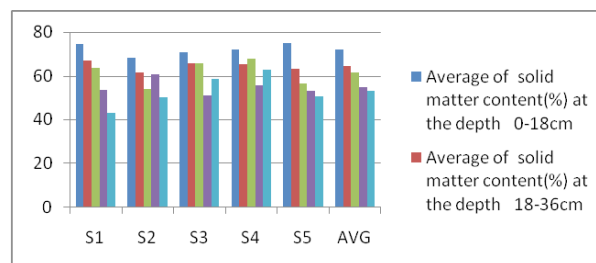
| Depth of Sample (cm) | Bulk Density | Moisture Content (%) | Angle of Repose | Solid Matter Content (%) |
|----------------------|--------------|----------------------|-----------------|--------------------------|
| 0-18                 | 1.66         | 27.96                | 35.06           | 72.04                    |
| 18-36                | 1.72         | 35.47                | 39.19           | 64.54                    |
| 36-54                | 1.80         | 38.46                | 39.87           | 61.54                    |
| 54-72                | 1.80         | 45.05                | 47.48           | 54.95                    |
| 72-90                | 1.89         | 46.89                | 53.74           | 53.11                    |

different depths of manure pit is shown in Table 1 and Figure 1. 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.

**Fig. 1.** Bulk density of FYM at different depth of manure pit**Fig. 2.** Moisture content (%) of FYM at different depth of manure pit

**Moisture content:** Moisture content observed in farmyard manure was 27.96, 35.47, 38.46, 45.05 and 46.89 % at respective depths of manure pit. The moisture content of FYM at different depths of manure pit is shown in Table 1 and Figure 2. The moisture content of FYM is more at bottom of manure pit. The moisture content also varies from manure to manure.

**Angle of repose:** The angle of repose for FYM was 35.06°, 39.19°, 39.87°, 47.48° and 53.74° at different depths of manure pit. The angle of repose of manures at different depths of manure pit is shown in Table 1 and Figure 3. The angle of repose influences the design of manure box.

**Fig. 3.** Angle of repose of FYM at different depth of manure pit**Fig. 4.** Solid matter content (%) of FYM at different depth of manure pit

**Solid matter content:** Dry matter content measured for farmyard manure was 72.04, 64.54, 61.54, 54.95 and 53.11 %. 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 1 and Figure 4.

## Conclusion

Based on laboratory study of physical attributes of FYM, it is concluded that bulk density and moisture content of manure influences the design volume of the manure hopper 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 influences the flow characteristics of manure in the design of manure spreaders.

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