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RESEARCH MANUSCRIPT

# Physical and Frictional Properties of Donkey Manure at Various Depths in Compost Pit

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## Abstract

Donkey manure is the oldest organic manure used by man ever since involved in farming. It consists of litter, waste products of crops mixed with animal dung and urine. Therefore, it contains all the nutrient elements present in the plant itself and returns these nutrients to the soil when it is applied to the field for the benefit of succeeding crop. Physical and frictional properties of donkey manure based on different depths of compost pit like viz., 0-12, 12-24, 24-36, 36-48 and 48-60 cm were studied. Physical properties like bulk density (kg $m^{-3}$), moisture content (%), dry matter content (%) and frictional properties namely angle of repose (°) and coefficient of friction have been studied at laboratory conditions. The bulk density measured in donkey manure was 261.91, 334.94, 404.92, 439.57 and 452.48 kg $m^{-3}$ at different depths of manure pit. The moisture content observed in donkey manure was 22.82, 23.09, 24.6, 24.98 and 31.89% at different depths of manure pit. The dry matter content measured for donkey manure was 77.18, 76.91, 75.4, 75.02 and 68.11%. The angle of repose of donkey manure was 41.87°, 43.42°, 45.93°, 47.46° and 49.77° at different depths of manure pit. The external coefficient of friction for donkey manure was 0.69, 0.73, 0.78, 0.8 and 0.83 at different depths of manure pit. The internal coefficient of friction for donkey manure was found to be 0.6, 0.62, 0.74, 0.75 and 0.77.

**Keywords:** Donkey manure, physical properties, frictional properties, bulk density, angle of repose.

## Introduction

Manure is a valuable and renewable resource used as nourishment in crop production. However, in many cases it is applied to crops as a method of waste disposal. Organic manure is considered as the eco-friendly bio-fertilizer for the highly polluted modern era. Proper application of manure to the land is essential to prevent pollution of land, surface water and to prevent loss of ammonia and other nutrients from the manure. Livestock manure is also an organic fertilizer that is beneficial to soil and crops by providing macronutrients such as nitrogen, phosphorus and potassium along with various micronutrients. The urgency of using organic manure has been gaining ground in the wake of increasing cost of fertilizer with every passing year and certain other inherent limitations with the use of chemical fertilizers. Being tropical country, Indian soils are often deficient in humus which is an extremely important material formed after decomposition of farmyard manure. The preparation of farmyard manure 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 it are allowed to be wasted through improper handling, storage, etc. with the result that the farmyard manure prepared and used by our farmers at present is of minimum value in increasing crop production.

The large number of results obtained show that farmyard manure (FYM), when properly prepared, can give increased yield ranging from 10-60%. Still better results can be obtained when it is used in combination with other agricultural practices such as improved seeds, proper crop rotation, good soil management and supplementary dose of chemical fertilizers. Donkey manure contains cow dung, cow urine, waste straw and other dairy wastes. It is highly useful and some of its properties are useful, FYM is rich in nutrients. A small portion of nitrogen is directly available to the plants while a larger portion is made available as and when the FYM decomposes. When cow dung and urine are mixed, a balanced nutrition is made available to the plants. Availability of potassium and phosphorus from FYM is similar to that from inorganic sources and application of FYM improves soil fertility. Against these backdrops, this study briefly describes the physical and frictional properties of donkey manure and its role in study of animal operated manure spreaders.

## Materials and methods

*Physical and frictional properties of donkey manure:* The physical properties i.e. bulk density, moisture content, angle of repose, dry matter content and frictional properties namely angle of repose (°) and coefficient of friction for donkey manure were studied and measured.

The manure is a heterogeneous matter and its moisture content varies at different depths stored in stock pits. For measuring the engineering properties, five depths of manure pits viz., 0-12, 12-24, 24-36, 36-48 and 48-60 cm were used.

*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 manure samples were collected by using core cutter method at different depths in storage pits. It is calculated by mass of manure (kg) by volume of cylinder ($m^3$). The manure is dried for removal of moisture content and estimated based on mass factor and volume of manure using the following equation.

$$\text{Bulk density (kg m}^{-3}) = \frac{M_1\text{-}M_2}{V} = \frac{M}{V} = \frac{4M}{\pi D^2 H}$$

Where, $M_1$= Initial weight of manure before laboratory drying (kg), $M_2$= Final weight of manure after laboratory drying (kg), M= Bulk mass of manure (kg), V= Bulk volume of cylinder core ($m^3$), D= Diameter of cylindrical core sampler (m) and H= Height of cylindrical core sampler (m).

*Moisture content:* The moisture content of manure was determined by using dry hot air oven. The samples were weighed before and after drying, keeping the samples inside the oven at 55°C for 24 h. It is expressed using the formula as:

$$\text{Moisture content (\% dry weight basis)} = \frac{W_1\text{-}W_2}{W_2} \times 100$$

Where, $W_1$ = Weight of the wet sample (kg) and $W_2$ = weight of the oven dry sample (kg).

*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:

Dry matter (%) = 100 - Moisture content of manure (%).

*Angle of repose:* The angle of repose is the angle made by a pile of material with the horizontal. The device used to measure the angle of repose in the current study consisted of a metal conical funnel, fixed on a metal stand. For measuring the angle of repose, a conical funnel filled with manure was kept at horizontal position. The manure was allowed to fall on a horizontal circular disc kept below the funnel. The flow of manure was stopped after the manure was fully heaped on the disc. The radius of the heap and height of the heap was measured and angle of repose was calculated using the following expression:

$$\theta = \tan^{-1}\left(\frac{h}{r}\right)$$

Where, $\theta$ = Angle of repose, degrees, h= Height of heap, m and r = Radius of heap, m.

*Coefficient of friction:* The coefficient of friction apparatus consists of a horizontal plane and a bottomless open container and a pan. Known weights of manure were taken in the container. The weights were added in the pan and at the instant at which the pan weight exceeds the manure; the container starts to slide movement. The coefficient of friction measures both external and internal contact of manure with horizontal plane. Hence, angle of friction is more important for sliding the manure over a sheet as compared to angle of friction (Singh and Singh, 2006). Following equation was used for determination of coefficient of friction as:

$$\mu = \frac{F}{N}$$

Where, $\mu$= Coefficient of friction, F= Frictional force (force applied) and N= Normal force (weight of the manure).

## Results and discussion

*Physical properties of donkey manure:* Physical properties of donkey manure have been studied at different depths of compost pits. The physical properties of donkey manure are shown in Table 1. The manure is a heterogeneous material and its moisture content varies at different depths of storage pits. For measuring the engineering properties, five depths of manure pits viz., 0-12, 12-24, 24-36, 36-48 and 48-60 cm were used. The measured engineering physical properties of manure are in close agreement with the results of Thirion *et al.* (1997), Landry *et al.* (2004) and Singh and Singh (2006).

Table 1. Physical properties of donkey manure at different depths of manure pit.

| Depth of samples (cm) | Bulk density (kg $m^{-3}$) | Moisture content (%) | Dry matter content (%) |
|---|---|---|---|
| 0-12 | 261.91 | 22.82 | 77.18 |
| 12-24 | 334.94 | 23.09 | 76.91 |
| 24-36 | 404.92 | 24.60 | 75.40 |
| 36-48 | 439.57 | 24.98 | 75.02 |
| 48-60 | 452.48 | 31.89 | 68.11 |

Fig. 1. Bulk density of donkey manure measured at different depths of manure pit.

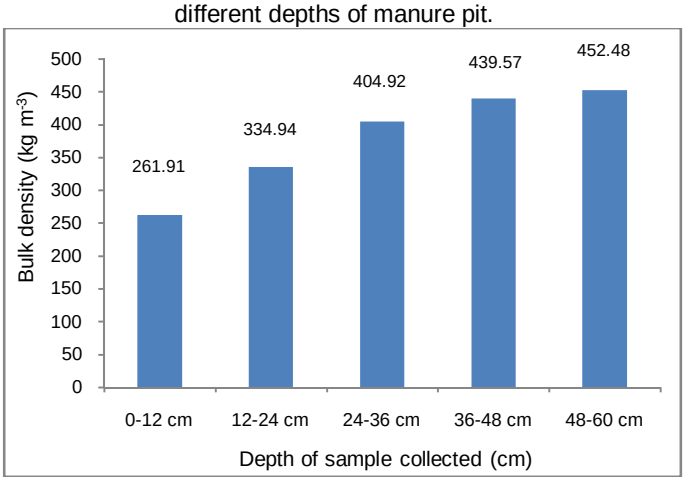



Fig. 2. Moisture content of donkey manure measured at different depths of manure pit.

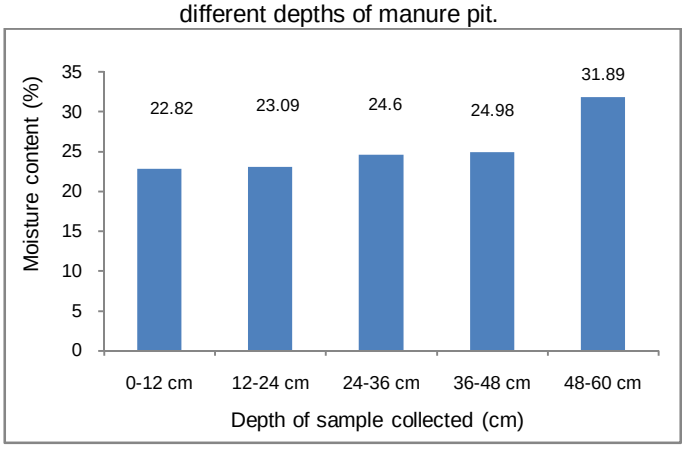
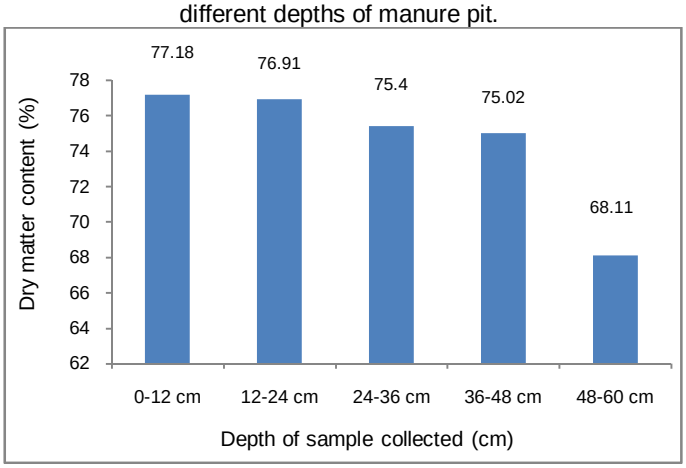



Fig. 3. Dry matter content of donkey manure measured at different depths of manure pit.




*Bulk density:* The bulk density measured in donkey manure is 261.91, 334.94, 404.92, 439.57 and 452.48 kg $m^{-3}$ at different depths of manure pit. The bulk density measured at different depths of manure pit is shown in Table 1 and Fig. 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. 4. Angle of repose of donkey manure measured at different depths of manure pit.

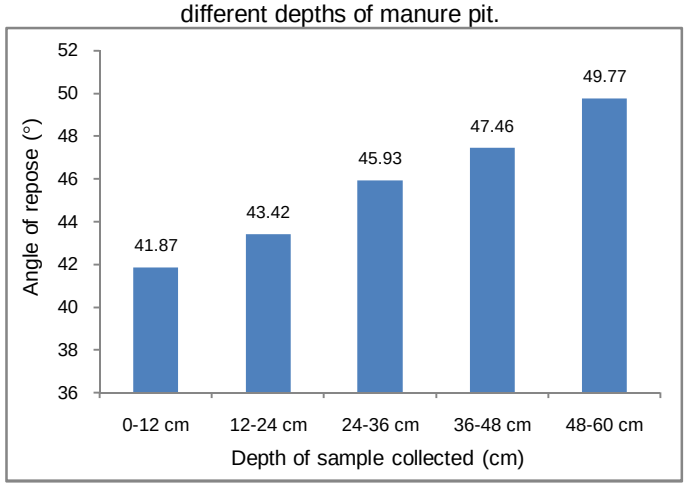



Fig. 5. Co-efficient of friction (external and internal) of donkey manure measured at different depths in manure pit.

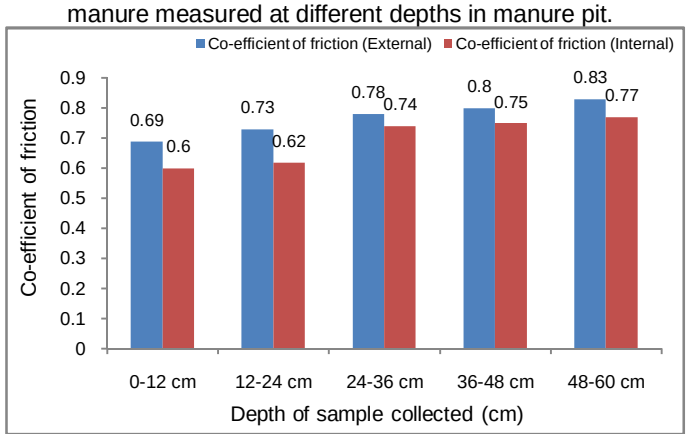



Table 2. Frictional properties of donkey manure at different depths of manure pit.

| Depth of samples (cm) | Angle of repose (°) | Coefficient of friction | |
|---|---|---|---|
| | | External friction | Internal friction |
| 0-12 | 41.87 | 0.69 | 0.6 |
| 12-24 | 43.42 | 0.73 | 0.62 |
| 24-36 | 45.93 | 0.78 | 0.74 |
| 36-48 | 47.46 | 0.8 | 0.75 |
| 48-60 | 49.77 | 0.83 | 0.77 |

The results of bulk density values are in agreement with the results of Thirion *et al.* (1997), Landry *et al.* (2004) and Singh and Singh (2006).

*Moisture content:* Moisture content observed in donkey manure is 22.82, 23.09, 24.6, 24.98 and 31.89% at different depths of manure pit. The moisture content of all manures at different depths of manure pit is shown in Table 1 and Fig. 2. The moisture content of manure is more at bottom depth of compost pit. The moisture varies from manure to manure also. The results are in agreement with the findings of Singh and Singh (2006).

*Dry matter content:* Dry matter content is measured for donkey manure is 77.18, 76.91, 75.4, 75.02 and 68.11%. 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 Fig. 3. The test results are in close agreement with the findings of Singh and Singh (2006).

*Angle of repose:* The angle of repose for donkey manure are 41.87°, 43.42°, 45.93°, 47.46° and 49.77° at different depths of manure pit. The angle of repose of manures at different depths of manure pit is shown in Table 2. The angle of repose influences the design of manure box. The findings are in agreement with Landry *et al.* (2004) and Singh and Singh (2006).

*Coefficient of friction:* The coefficient of friction (external and internal coefficient) of donkey manure was measured at different depths of manure pit. The external coefficient of friction for donkey manure is 0.69, 0.73, 0.78, 0.8 and 0.83 at different depths of manure pit. The internal coefficient of friction for donkey manure is found to be 0.6, 0.62, 0.74, 0.75 and 0.77 (Table 2). The findings are in agreement with the results of Landry *et al.* (2004) and Singh and Singh (2006).

## Conclusion

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

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## References

1. Lague, C., Landry, H. and Roberge, M., 2005, Engineering of land application systems for livestock manure: A review. *Can. Biosystem Engg.* 47(6): 17-28.
2. Landry, H., Lague, C. and Roberge, M. 2004. Physical and rheological properties of manure products. *Appl. Engg. Agric.* 20(3): 277-288.
3. Singh, R.C. and Singh, V.V. 2006. Development and performance testing of animal drawn manure spreader. *Prog. Rep.* (2006-2008), AICRP on UAE, CIAE, Bhopal centre (India), pp.65-79.
4. Thirion, F., Chabot, F. And Andeler, D. 1997. Physical characterization of animal manure. *98–FAO: 8th Int.* pp.457-468.