Acceptable Technology for the Distribution of Organic Manure on Nigerian Farms

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Abstract

The nation loses a lot of its foreign exchange earning in coping with the high demand of chemical fertilizer annually yet there is great availability of organic manures across the country. Investigation revealed that major factors militating against the use of organic manure on Nigeria farms are the problems associated with its bulk handling and distributions. Manual distribution of the manure consumes considerable time, cause unevenness of distribution and stresses resulting from the weight of the manure. Also health hazard may result from direct contact with the manure. Most of the machines available for manure distributions were imported from developed nations creating problems of adaptability to the peculiar nature of Nigeria conditions. This study identified soil factors, nature and physical properties of manures, farmer financial capability and the local technological capacities as the most valuable inputs into the design of acceptable manure spreaders for small-scale farmers in Nigeria.

Keywords: **Organic manure, Acceptability, Chemical fertilizer, Manure spreader, Distribution**

I. Introduction

Organic manures are categorized into farm-yard manure, green manure, compost manure, liquid manure, municipal waste and various others waste products of plants and animal origin. In recent years the demand for chemical fertilizer has greatly overshadowed the supply in Nigeria. Also the high price of inorganic fertilizer, in recent years has virtually placed this fertilizer out of the reach of the small-scale farmers who today are responsible for Ninety per cent of Nigeria agricultural production (Sobulo 1990).

In the circumstance, attention must now be focused on the possibility of substituting a substantial fraction of farmer's fertilizers used with organic manures. Other countries such as India, Japan, and China have demonstrated the feasibility of this idea.

An experiment conducted by Nigerians department of agriculture at umudike in eastern Nigeria between 1937 and 1939 on the effect of farmyard manure on the yield of yam and maize, it was shown that in all the years of trial for both yam and maize farmyard manure affected a very striking increase in the yield of both crops (Igbokwe, et al 1982).

In an ultisol at Agega in south western Nigeria maize yield was doubled from 1.2t/ha to about 2.5t/ha for the duration of the study (1962-1967) by addition of 5t/ha of dung annually. The use of poultry dung, cow dung and household refuse increases the efficiency of chemical fertilizers when mixed by providing secondary micronutrients not present in the inorganic fertilizer. Long term studies in north Nigeria showed that 5t/ha of dung annually combined with 100kg of $P_2 O_6$ will retain yield under continuous cultivation (Lombin and Abdullahi, 1977). A major factors militating against the use of organic manure in a developing country like Nigeria are the problems associated with its bulk handling and distribution. Where the distribution is undertaken manually there will be considerable loss of time, unevenness of distribution, stresses resulting from the weight manure and in some cases health hazard may result from direct contact of the manure.

Most of the manure spreaders on Nigerian farms are capital intensive imported technologies and are in appropriate and irrelevant to the relatively capital scarce, labour-abundant and less developed country like Nigeria. It is therefore recommended that Nigeria should select and utilize acceptable technologies in the production of manure spreader for its small-scale farmers. Acceptable in this context is variable defined as the kind of cheap, small-scale locally produced, reliable or at least mendable technology, which make use of available resources in a given environment.

II. Operating Characteristic of Manure Spreader

Manure are usually broadcast of over the land with manure spreaders before seed bed preparations. It is then worked in to the soil either by ploughing or by disk harrow. Manure spreaders is a machine for carrying organic manure to the field shredding it and spreading it uniformly over the land. It could be wheel driven or power driven. In the former all the mechanism of the machine is driven by land wheels, whilst the latter are driven by p.t.o shaft from the tractor. Below is the dismantled parts of the designed manure Spreader.

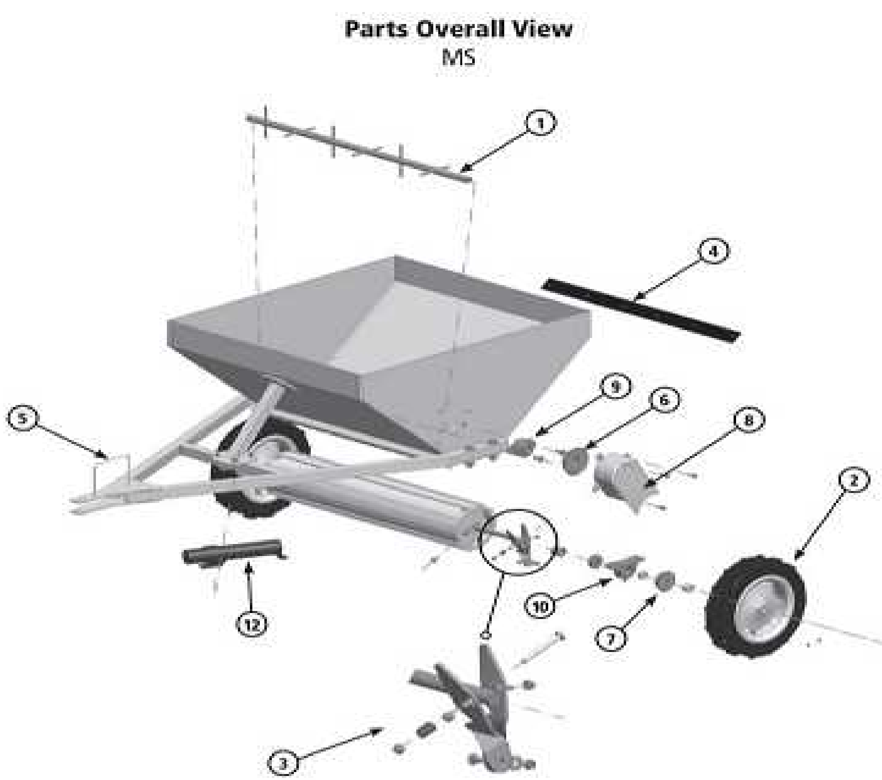

Figure 1 The dismantled parts of the designed manure Spreader.

Table 1: Parts description of the designed manure Spreader.

Item Number	Part Number	Description
1	2000116	Agitator Bar
2	2000117	Tire/Wheel Combo
3	9000021	Axle Locking Mechanism w/ Hardware
4	2000118	Rubber Seal Strip
5	9000022	Handle w/ Hardware
6	2000119	Large Agitator Sprocket
7	2000120	Small Axle Sprocket
8	2000121	Chain Guard
9	2000122	Agitator Block Bearing
10	2000123	Axle Pillow Block Bearing
11	4000008	Decal Sheet (Not Pictured)
12	9000023	Small Manual Holder w/ Hardware

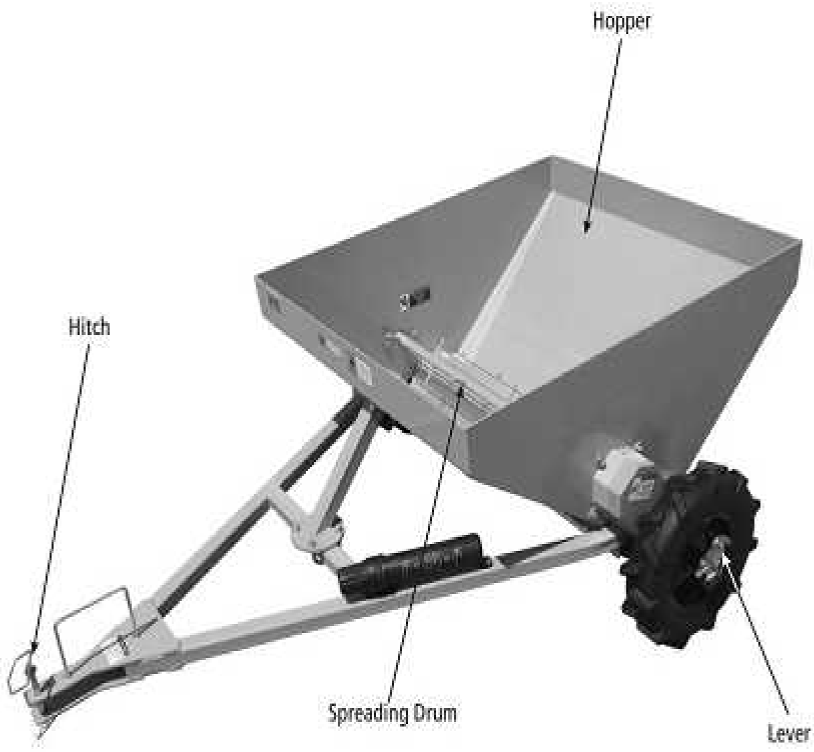

Figure 2. The fully assembled manure Spreader.

Spreading speed of organic manure ranges from 4 to 10km/h. The largest machine can spread up to 3 tonnes. Per minute (spot-working rate), but common rate are3/4 to 2 tonnes per minute (culphin 1992). Spreading width depends on the size and type of spreaders. It rends to be fairly narrow 2.0 to 2.5m mostly.

The p.t.o driven type is designed to operate from the tractor power-take-off having 540 rev/min or 1000 rev/min. The rate of removal of the manure from the storage unit can be obtained using.

$q = Yr\ A.\ V_{Av}$.................. (1)(Klenin et al,1985)
q = Rate of removal of the manure from the storage tank (Kg/s)
A = The window area of the storage tank (m^2)
Yr = Density of the manure (Kg/m^3)
V_{AV} = Velocity of the manure particles as it is moves round the rotary cylinders (m/s)

The manure speeds are defined as the angular speeds as it spins round the storage unit and the linear speeds as it is thrown out of the machine to the field.

$V_F = DN$............................ (2)
V_F = Periverial speed (m/s)
D = diameter of the rotations (m)
N = speed of revolutions (rad/s)
Linear speed $V_L = \frac{2N}{60}$...................... (3)

The length of throw of the manure is a measure of the horizontal length covered by the manure as it is thrown out of the spreaders. The horizontal components of the manure velocity are used to obtain the horizontal distance over time. The performance power of the spreader can be obtained using:
$P = \frac{2\ R\ FN}{60}$......................(4)
P = spreader power (W)
F = friction force against the wheel (m)
R = radius of the wheel (m)
N = Speed of revolution (rad/m)
The field efficiency of the machine can be obtained using:
$Fe = \frac{10C}{SW}$.......................(5) (Acher,1988)

Where

S = actual travel speed (km/hr)
W = width of operation
C = productivity in (m^3/hr)

III. Relationship between the Physical Properties of Manure and the Spreader

The grain size of organic manures, their hydroscopicity, dispersibility, density, tendency to scatter and cake, and moisture content are the properties, which influence the functioning of machines designed for their applications (Kleninand Popou, 1985). These properties vary with locations depending on the types, age, and the conditions of the animal, which produce the manure, the food consumed, the litter used and the way in which the manures are stored. The effect of grain size of the organic manure on the machine operation is significant. Often the grain size of manure for spreading is between 1 and 5. Grain size of more than 5mm will lead to poor spreading (Smith and Lambert, 1989).

The coefficient of friction and adhesion of manure depends upon moisture contents, specific pressure and the quantity of straw matter. It has been established that the coefficient of friction increases with increase of straw matter and decreases with higher moisture content and specific pressure. The average values of the coefficient of friction of manure on metal surface are between 0.35 and 1.0. Adhesion of manure depends on its humus contents, the higher the amount of humus, and the greater the adhesion. Adhesion is maximum at moisture contents of 30 to 35%.

Tensile and shear resistance greatly depend on the amount of culmiferous components in the manure. When the quantity of culmiferous matter in the underlying layer of the manure increases its resistance to rupture increases. Experiments have established that clod of partly decomposed maize break up if impact velocity is 0.2 to 1.5m/s (Klenin and Popou, 1985).

IV. Relevant Factors in the Design of Acceptable Spreader for Nigeria's Farmers

The fact that there exist considerable variations in the nature and properties of soil and organic manures from one location to another, and the differences in the nature of farming and also the variances in the financial capacities of farmers makes it only acceptable to design manure spreaders relevant to a given function in a given environment.

In Nigeria, the design of acceptable spreaders for the small-scale farmers must critically examined the following factors:

i. Physical properties of the locally available manures as it relates to the machine design for its spreading.
ii. Analysis of the general operating condition of the manure spreader on local soil.
iii. Selection of locally available materials in the constructions of the spreader.
iv. Selection of the fabrication procedure that will ensure that local craftsmen and artisans can construct the spreader.
v. Critical assessment of the farmers' capital base and labour availability in selecting the power source for the spreader.

Nature of Manures

The nature of manure greatly influences the design of machine for its disposal. Machine for spreading liquid manures on the farm cannot be equally applied for solid manures. Municipal waste manure spreaders must be designed to take into considerations the glass, iron and other hard objects in the waste. Manures are subjected to various physical treatment during the spreading operation. It is therefore necessary to understand the physical laws governing the interactions of the manure and machines for the design of effective spreader.

Soil Factors

The nature of soil played a prominent role in the design of manure spreader for farm operation. Physical properties of soil such as depth, texture and structure differs significantly from place and from time to time. Organic materials should be applied to the land in a manner so that all or most all of the nutrients are available to crop plant and not lost through erosion or other means. It is most appropriate to apply these organic materials over a large area instead of using large amounts in one small area (Zane, 1989).

Manure spreader should be designed in a manner that will prevent excessive compaction of farmland during operations. Low compaction is a very important factor for good crop production for it ultimately improved water-holding capacity and aeration. Other factors such as soil cohesion and adhesion, slippage and inclination must be determined to constitute valuable inputs into the design appropriate manure spreader.

Financial Potentials of Farmers

It has been established that small-scale farmers, who mostly reside in rural areas, undertake about 90% of Nigerian Agricultural Production (Sobula, 1990). The financial capacities of these farmers are low and they are mostly uneducated. A manure spreader that will receive wide acceptability within this group must be cheap and simple to produce and easy to operate and maintain. Such spreader must utilize locally available materials in its construction and must contain parts and components that can be easily fabricated by local craftsman and artisans.

Local Technological Capacity

A developing nation like Nigeria with abundant of human resources should encourage the development of labour intensive technology. This is the appropriate technology that will ensure massive employment. Manure spreader could be powered by a tractor or animal trailed. The latter is the most suitable designed option for the Nigerian farms. Animal drawn spreader will ease the cost of operation, eliminate the problems associated with fuel costs, and reduce the cost in waiting time for tractor hiring service. In addition, operation is easy and less capital intensive.

V. Conclusion and Recommendations

Agricultural output can be improved considerably in Nigeria by monitoring closely the acceptable method of handling and distributing manure on the farmland. Soil re-fertility could be made cheaper in Nigeria by reverting to the use of organic wastes as manures. Organic waste obviously has the potential to be utilized for replacement of fertilizer nutrients. These has to be a direct effort on the part of government at various levels and the agricultural institutes in the country to refocus the attention of the rural farmers to the use of organic manures.

Design of acceptable manure spreaders for Nigeria's farms shall require an adequate understanding of the nature and physical properties of the manure available for spreading and proper study of the soil available for farmland. The local technological capacities and farmer's financial abilities are equally valuable inputs in deciding acceptable manure spreader for design.

Based on the findings from the research so far, the following recommendations are made:

1. Cottage industries should be encouraged to manufacture manure spreaders for Nigeria's farmers.
2. Adequate ad vocation should be conducted for farmers on the best method of handling and transporting organic manure.
3. Relevant research into the properties of local manure and nature of farmland.
4. Needs for data bank on the various types, quantities and nature of manures available in the country and the locations of their existence.

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