

Development of animal operated farm yard manure applicator

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■ **ABSTRACT** : FYM 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. Development of animal operated manure applicator include the different components viz., bullock cart chassis and frame, main axle shaft, steel wheels with rubber padding, agitator, manure box, sliding plate and power transmission system. A pair of bullock acts as power sources for hauling purpose. Power is transmitted by 1:3 ratio of power reduction (main axle shaft: agitator shaft). The animal walking speed is mainly decided to the power transmission of manure applicator, because agitator rotation is directly related to the main axle shaft. This research work briefly describes the development and evaluation animal operated manure spreader.

■ **KEY WORDS** : Bullock cart, Agitator, Pair of bullock, Power reduction, animal walking speed

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In India, farm yard manure is mainly being applied through manual broadcasting, resulting more labours and time per unit area with poor application uniformity and wide variation in the application rate. The bullock-cart/tractor-trailers are being used to transport the FYM from the compost pit to the field and manure is stack piled in the field. The spreading of stack piled manure is performed manually with spade, which involves human drudgery. Research has been shown that the stack piled manure loses about 21% of its nitrogen to the atmosphere. Proper spreading and incorporation in the soil residues the loss to only 5%. The small and marginal farmers have a pair of bullocks instead their limited use in tillage, sowing, inter-cultural and transport operations about 58 days/year and high maintains cost in slack period (Rs.55/day). Hence, there is need to increase the working hours of bullocks for other agricultural operations, viz., spreading of farm yard manure in the field. The existing bullock carts used for transport of manure to the field could be modified for the FYM spreading operation also (Singh and Singh, 2006). In recent days, organic farming is a promising solution in agriculture farming, rather than the use of chemical fertilizers.

Keeping of all these facts in mind, an animal drawn FYM applicator to be developed for uniform spreading of manure and eliminate the human drudgery involved in spreading of

FYM in field. Utilization of bullocks for manure spreading in field will increase the additional working hours of 24-36 hour per year for two seasons and lower the maintenance cost of animals about Rs.400-600 per pair per year (Singh and Singh, 2006). All solid manure applicators discharge at varying rates depending on ground and auger or PTO speeds, equipment settings and manure moisture content (Koenig *et al.*, 2010). In agriculture, manure, compost, or sewage sludge are generally applied with manure applicators. Keeping in view of drudgery involved, a suitable animal drawn manure applicator is need of hour for usage.

■ METHODOLOGY

Development of bullock drawn FYM applicator :

The bullock drawn FYM applicator has been developed at CAE, Raichur during 2012-2013. The functional components of applicator were fabricated and assembled them in the laboratory. The functional components of applicator are given below:

Bullock cart chassis and frame :

The bullock cart chassis has been developed to support two steel wheels with rubber padding. On the chassis, a rotary agitator and slanting platform have been mounted for delivery of farm yard manure to the field. A rectangular chassis is a

combination of main frame and two steel wheels with rubber padding. The main frame of the machine was made from mild steel, consisting of both sides C channel section of 80 x 40 x 2 mm. The frame of the machine is rectangular in shape having dimensions 2800 x 900 x 2 mm (length x width x thickness) and is hitched to a pair of bullocks with the help of beam and yoke. The beam is 1800 mm in length and its diameter as 80 mm. The operator seat is provided over the beam. All the functional components of the machine were placed over main frame. In the middle of rectangular chassis frame, agitator is provided with two pedestral bearings on either side of chassis. The chassis is divided 4 equal parts with 2 triangular and 2 circular M S angles.

Main axle shaft :

The main axle shaft was mounted on the frame with the help of two pedestral bearings and supports two sprockets and two steel wheels with rubber padding. Total length of main shaft is 1800 mm and its diameter as 50 mm. Main shaft contains two sprockets containing 40 teeth's and the another sprocket containing agitator shaft having 12 teeth. The both main shaft and agitator shaft sprockets were connected with chain sprocket assembly. The power transmission is carried out by main shaft to agitator shaft, at the speed ratio of 1:3 ratio of sprockets. Two steel wheels with rubber padding were on either side of main shaft. The distance between two steel wheels with rubber padding is kept as 1500 mm. 90mm x 5mm rectangular key is provided on both side of main shaft for proper sitting of sprockets. Main axle shaft is directly related to the bullock travel speed.

Steel wheels with rubber padding :

Steel wheels with rubber padding were attached with main axle shaft at distance of 1500 mm. The cart wheel diameter is 1400 mm. the periphery of wheel consists of 50 mm thickness of rubber pad. The black rubber pad avoids the damage of transportation on roads and give better traction during operation of applicator. Steel wheels with rubber padding contains 14 numbers of spokes. Two steel wheels with rubber padding were provided for transportation purpose which in turn operate the power transmission system of applicator.

Agitator :

The agitator assembly is fixed below the manure box for agitating the manure during working position. A manure spreading agitator is fixed at middle portion of main frame of rectangular chassis. The agitator assembly has the dimensions of 400 x 850 x 500 mm (length x width x height). The agitator mainly consists a 900 mm length of shaft having a 37mm of diameter. The agitator contains 28 numbers of agitator rods at 4 x 7 no circular pattern. The rod to rod

distance is at 100mm. The agitator shafts consist of 12 teeth sprocket attached with main axle shaft, which consists 40 teeth sprocket attached with the chain. The main function of agitator is to agitate the manure from manure box. The power transmission of main shaft to agitator shaft is at 1:3 ratio of power reduction of sprocket speed. The agitator rod having a "T" shape consisting of 150mm of length and 15mm of rod diameter. The agitator break down of manure clods at the impact velocity of 0.2 to 1.5 ms⁻¹ (Singhand Singh, 2006). The impact velocity of agitator is directly related to the speed of main axle shaft consists of Steel wheels with rubber padding. The sliding plate maintains a flow rate of manure to the ground.

Manure box :

The manure box is in trapezoidal shape having dimensions of 2400 x 940 x 750 mm (length x width x height). Manure box is fabricated using 18 gauge mild steel sheet. To facilitate flow of manure freely from box, the box has been given trapezoidal shape with slanting sides. The manure box contains 40° of sliding angle at front and back sides of manure box. The manure box is attached with the rectangular drum which covers the agitator and each corner of manure box contains a M S angle. The manure box has opening at the bottom side and opens a 400 x 850 mm of opening drop manure over agitator assembly. The manure box is placed at slanting to position for easy movement of manure.

Sliding plate :

Sliding plate is mainly used for adjustment of opening area in the manure box. Sliding plate is made from MS sheet and has on the bottom of platform below the agitator to control the manure delivery rate. It consists of a mild steel sheet of 3mm thickness and size 500mm x 840mm (length x Width). Two handles were provided to the sliding plate, which helps the push or pull (forward and backward direction) the sliding plate inside the manure box. Thus by increasing or decreasing the opening width the manure delivery rate is controlled. The sliding plate controls the opening for dropping the manure.

Power transmission system :

For rotating the agitator, chain and sprocket assembly an arrangement has been made for power transmission. The axle shaft consists a one sprocket (40 teeth) on axel shaft of cart has been connected with the one more sprocket (12 teeth) and other sprocket has 12 teeth. Power is transmitted by 1:3 ratio of power reduction (main axle shaft : agitator shaft).

■ RESULTS AND DISCUSSION

The results of the present study as well as relevant discussions have been presented under following sub heads:

Development and description of animal operated farm yard manure applicator :

The development of bullock drawn manure applicator has been carried out for spreading of over the agricultural field. The manure applicator is mainly used for spreading different types of manure in agricultural fields to maintain a uniformity of spreading and also maintain a uniform width of spread of manure. The specifications of animal operated manure applicator are given in Table 1.

A pair of bullock acts as power sources for hauling purpose. The development of agitator mainly agitate the manure and spread over the field. The incorporation of agitator assembly mainly cause the agitation of manure which in turn gave better swath width, improves application rate and also make better uniform application over the field. The procedure followed for the development of manure applicator is in agreement with the findings of Lawrence *et al.* (2005) and Singh and Singh (2006).

Bullock cart chassis and frame :

The bullock cart chassis development and dimensions of frame of cart are in fully agreement with the findings of Lawrence *et al.* (2005) and Singh and Singh (2006). The chassis supports platform for manure box and it is attached to the steel wheels with rubber paddings. All functional components manure applicator are fixed over to the chassis.

Main axle shaft :

The length of main axle shaft is 1200 mm. Main axle rotation is directly related to the animal walking speed while applicator is in operation in field. The main axle shaft rotates at 12-14 rpm and it provides the power transmission system from ground wheel. The main axle shaft development and

dimensions of manure applicator is in fully agreement with the findings of Lawrence *et al.* (2005) and Singh and Singh (2006). The main axle is 1200 mm in length. The main axle shaft supports the agitator assembly and steel wheels with rubber paddings are fitted to main axle shaft.

Steel wheels with rubber padding :

The Steel wheels with rubber paddings provided with rubber pad produce grip while operation of spreading in agricultural fields. The road damage was avoided as the Steel wheels with rubber padding rim is provided with hard rubber pad all along the periphery of steel wheels with rubber padding. Two steel wheels with rubber paddings are provided in applicator. The steel wheels with rubber paddings development and dimensions of manure applicator are fully agreement with the findings of Lawrence *et al.* (2005) and Singh and Singh (2006).

Agitator :

The agitator is mainly attached in agitator box and has 12 teeth sprocket directly attached to the main axle shaft which consists of 40 teeth sprocket. The agitator rotates a 36 rpm during spreading operation. The speed reduction accrues from main axle shaft to agitator at 1:3 ratio. The agitator development and dimensions of manure applicator are in fully agreement and closely related to the findings of Lawrence *et al.* (2005) and Singh and Singh (2006).

Manure box :

The volume of manure box is observed as 1.46 m³. The detailed line diagram of manure box has been shown in Fig. 1 and 2. The manure box contains manure and flows gradually by gravity. The calculation of volume of manure box has been

Table 1 : Specifications of Animal operated FYM applicator

Sr. No	Parameters	Value
1.	Name	Animal operated FYM applicator
2.	Source of power	A pair of bullocks
3.	Overall size, mm	2040 x 4600 x 1000 (Height x length x width)
4.	Beam length, mm	1980
5.	Chassis frame, mm	2800 x 900 x 2 (Length x Width x Thickness)
6.	Total length of main shaft,mm	1800
7.	No. of Steel wheels with rubber padding	2
8.	Total no. of agitator rods	28
9.	Capacity of manure box, kg	700-1100
10.	Sliding plate, mm	500 x 840 x 3 (Length x Width x Thickness)
11.	Power transmission (Ratio)	Chain and sprocket (1:3)
12.	Ground clearance, mm	700
13.	Total weight, kg	350
14.	Volume of manure box, m ³	1.46
15.	Cost of unit, Rs.	42000

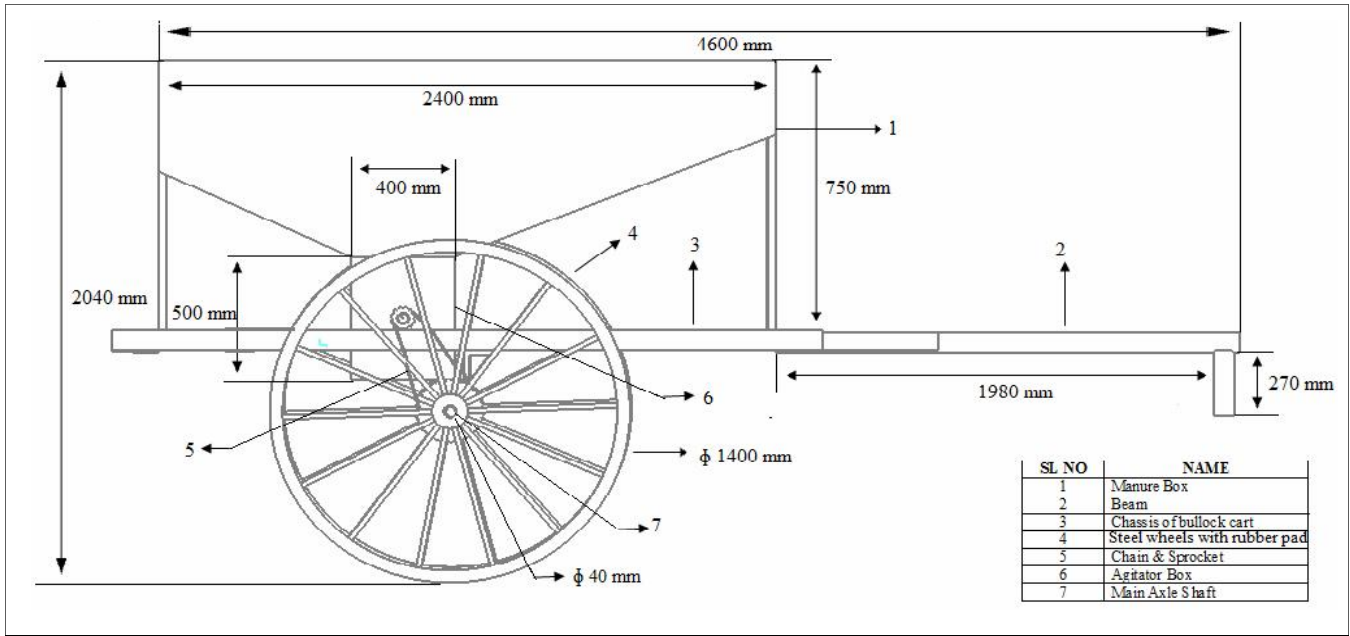


Fig. 1 : Side view of animal operated manure applicator

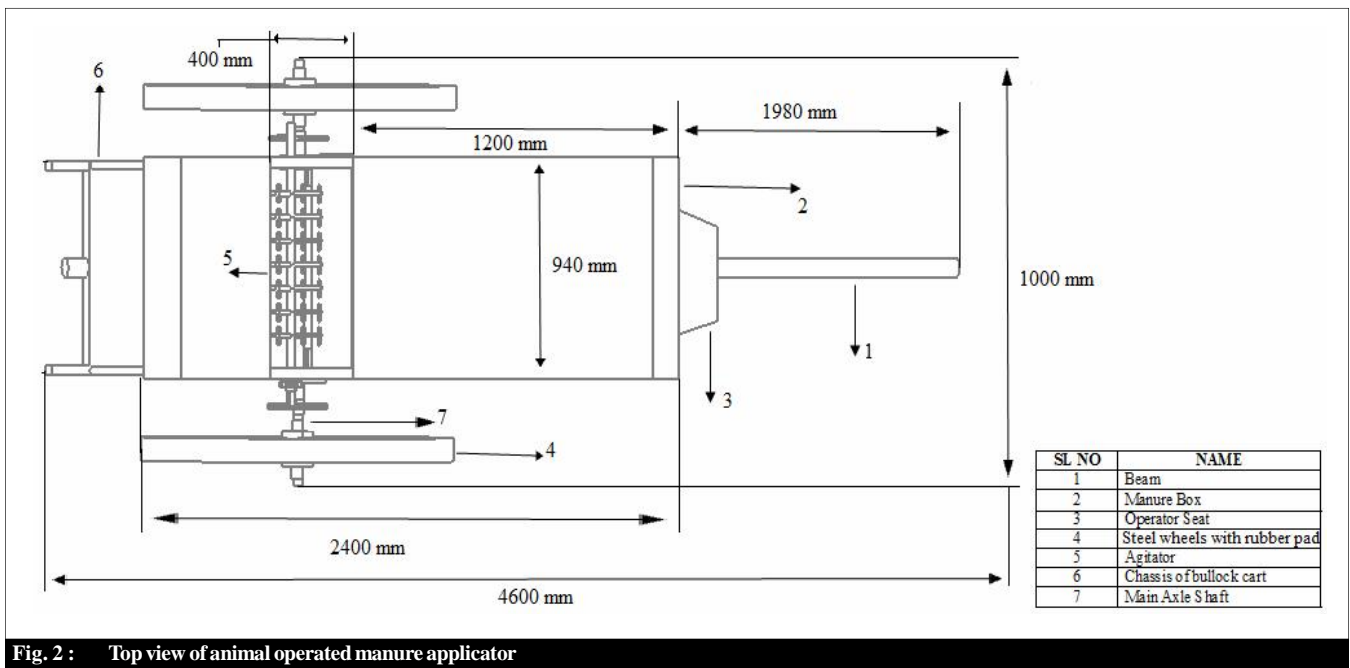


Fig. 2 : Top view of animal operated manure applicator

given below. The evaluation of manure applicator carried at three levels of filling of manure box. The manure box development and dimensions of manure applicator are in agreement with the findings of and closely related to the Lawrence *et al.* (2005) and Singh and Singh (2006). The manure box is placed at an inclination of 40° slope for easy movement of manure towards the agitator assembly.

Sliding plate:

Two sliding plates are used for controlling of falling of manure from manure box to agitator box. The evaluation of manure applicator is carried out at three levels of openings. In the manure applicator two sliding plates are used for controlling of falling of manure from manure box to agitator assembly. The sliding plate development and dimensions of

manure applicator are fully in agreement and closely related to the findings of Lawrence *et al.* (2005) and Singh and Singh (2006). The opening of the sliding plate controls the movement of manure downwards.

Power transmission system:

The animal walking speed is mainly decided to the power transmission of manure applicator, because agitator rotation is directly related to the main axle shaft. The rotation of main axle shaft is directly related to the steel wheels with rubber padding speed. The power transmission system occurs smoothly in the applicator through chain and sprocket assembly. As the bullocks pull the applicator, the ground wheel rotates and provided power transmission system. The power transmission development and dimensions of manure applicator are fully in agreement and closely related to the findings of Lawrence *et al.* (2005) and Singh and Singh (2006).

Conclusion:

Modernization of agriculture depends on use of appropriate machinery for enhancing resource use efficiency and productivity in agriculture. It would be difficult for farmers in the developing countries to meet the food production targets of the coming decade without access to more and better farm power and improved implements and equipments to utilize that power effectively and efficiently. Agricultural machines play the role of exponents of progress in agricultural pursuits and welfare of farming community.

The present investigation was carried out towards the development of prototype, economically feasible, eco-friendly and simple method of operation. The manure applicator is useful to marginal and small scale farmers. In organic farming, manure applicator is promising solution for uniform spreading of farm yard manure over the field.

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