Economic Affairs, Vol. 67, No. 03, pp. 257-262, June 2022
DOI: 10.46852/0424-2513.3.2022.15

AESSRA

Research Paper

Field Evaluation and Economic Feasibility of Tractor Mounted FYM Spreader

M. Vinayak[1]*, C. Ramana[2], B. Hari Babu[1] and K. Madhusudhana Reddy[3]

[1]Department of Farm Machinery and Power Engineering, Dr. NTR CAE Bapatla, Acharya N.G Ranga Agricultural University, Guntur, Andhra Pradesh, India
[2]RARS Tirupathi, Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh, India
[3]SV Agricultural College Tirupathi, Acharya N.G Ranga Agricultural University, Guntur, Andhra Pradesh, India

*Corresponding author: vnaikcae29@gmail.com (**ORCID ID:** 0000-0003-0824-7799)

Received: 25-02-2022 **Revised:** 24-04-2022 **Accepted:** 30-05-2022

ABSTRACT

A FYM spreader can do operations like shredding and spreading simultaneously in a single operation. Such a machine developed and its' performance was evaluated at the field. The theoretical field capacity of the machine was determined to range between 0.36 and 0.54 ha h^{-1} whereas, the effective field capacity remained between 0.28 and 0.432 ha h^{-1}, respectively. The cost of FYM transportation and application has been calculated according to conventional practise, and a comparison of labour savings has been made in order to assess the economic feasibility of the FYM spreader. In comparison to traditional FYM spreading method, the machine operating costs were estimated to be lesser by 75%. The break-even point (BEP) calculated on a time and area basis for the FYM spreader was calculated to be 263.5 h and 53.50 ha, respectively. The pay-back period of FYM spreader was calculated as 1.2 years on a time basis.

HIGHLIGHTS

- Using FYM spreader, farmer can save upto ₹ 1465 per ha over the manual methods of FYM application.
- The payback period for the FYM spreader is estimated to be 1.2 years on a time basis.

Keywords: Cost of operation, breakeven point FYM spreader, field capacity, payback period

The FYM is transported to field and placed as a heap for further distribution. The FYM was traditionally applied 15–20 days before sowing or transplanting, to allow time for the ammonification and nitrification of the manure. Application of avoid using uncomposted manure. Soil should have sufficient dampness at the time of application so that appropriate microbial behavior takes place. Usage levels span between 2-5 t ha^{-1} for most of the crops, however it may go high as 25 to 50 t ha^{-1} (Khanpara *et al.* 2010) for vegetables, sugarcane, etc. For spreading of FYM, farmer still depends on the manual labour or animal drawn blade harrow. This leads to dearth of nutrients or excess of nutrients spreading which plant doesn't utilize. Hence the applied manure becomes waste due to poor quality of manure spreading. Proper and uniform use of manure avoids depletion of C: N and other important supplements from the manure (NCOF. 2012). The operation is also labour intensive, costly, and time taking. Hence, there was a need to develop an efficient manure spreader, so as to reduce the losses and complete spreading in shortest possible time, in which use of manpower for application of FYM become less (Baoming *et al*. 2011). In many countries, the field activities are mechanized, whereas in India the traditional and manual methods are performed to carry out the field activities like use of bullocks and trolleys to carry and drop the manure as heap, wherever

How to cite this article: Vinayak, M., Ramana, C., Babu, B.H. and Reddy, K.M. (2022). Field Evaluation and Economic Feasibility of Tractor Mounted FYM Spreader. *Econ. Aff.*, **67**(03): 257-262.

Source of Support: None; **Conflict of Interest:** None

it is required in the field manually. Nutrient loss occurs when manure is left in small piles scattered around the land for a very long time prior to field application. Spreading the manure right away can minimise these losses.. There are many advantages of FYM use in the field. The warmness produces at some stage in FYM composting can killa number of weeds, which is a crucial advantage as herbicide use is managed. FYM also retain soil moisture, which helped to prevent leaching of nutrients (Choudhary, 2016).

MATERIALS AND METHODS

Development of FYM spreader

The developed machine consists the manure tub, FYM conveyor unit, manure discharging gate, shredding and spreading unit. The designed conveyor unit consists of the rollers (diameter 150 mm and length 1800 mm) and spacers' arrangement (diameter 63 mm and length 1700 mm); two rollers are placed at each end of the trailer and spacers used for supporting the belt conveyor unit. The manure discharge gate allows to adjust opening levels from the conveyor belt base. The designed shredding cum spreading unit is mainly consists of main frame, beating roller (one), beating elements (22) and spreading mechanism. The shredding unit is mount on the mainframe. Main frame was fabricated in rectangular shape with 63 mm iron L-angles of 1800 mm × 470 mm. Provision was made to the main frame unit to connect and disconnect from tractor three-point hitch system. Two rows consists of 6 flanges and remaining rows fitted with 5 flanges at equal spacing. The beating roller diameter is 200 mm and length of 1800 mm. The beating elements are having flexible chains with 102 mm length flanges by using fasteners (Kothari *et al.* 2018). The entire assembly was mounted on the main frame using thrust bearings at a height of 300 mm. The shredder unit collected FYM material at top surface from conveyor unit through discharge gate and further directed to the bottom and openings, which are designed in such way that the material is evenly spread on the field. Except for the conveyor assembly, every part of the FYM spreader was mounted on a rectangular housing and allowed to rest on the trailer connection shank. This included the gear box and associated power transmission assembly.

Conceptual Design of FYM Spreader

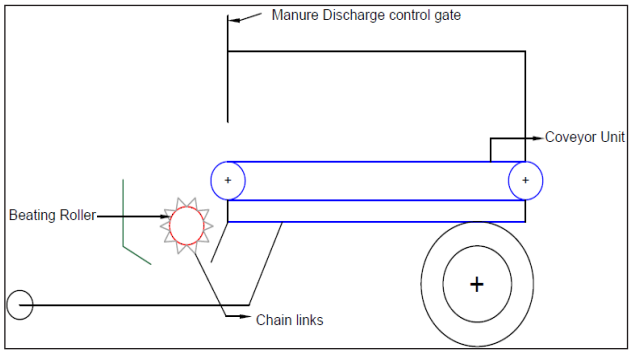
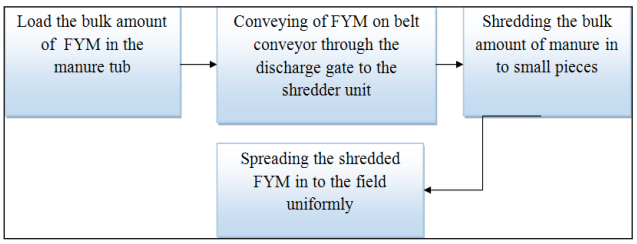


Fig. 1: Conceptual diagram of FYM spreader

Flow Chart of the Functional Aspects of Tractor Mounted FYM Spreader



Performance Evaluations of Tractor Mounted FYM Spreader

The machine was tested for pulverization of manure and uniformity of spreading of farm yard manure into the field. The parameters like field capacity, payback period and break-even point were calculated as below (Naveenkumar *et al*. 2017).

Field Capacity

The field capacity of farm implement is worked out by measuring the area covered in a specified time or weight of output obtained in a specific time period (Jain *et al.* 2015).

(i) Theoretical field capacity: It is the rate of field coverage assuming that the machine performed to its 100% of the capacity and calculated by using formula:

$$\text{Theoretical field capacity } \left(\frac{ha}{h}\right) = \frac{\text{width of coverage (m)} \times \text{speed}\left(\frac{\text{km}}{\text{h}}\right)}{10}$$

(ii) It is the real average rate of coverage by the machine based on the total field time, which was calculated by using formula:

Effective field capacity =

$$\frac{\text{width of coverage (m)} \times \text{length of strip (m)}}{\text{time taken (h)} \times 10000}$$

Cost Economics of the Operation

Two types of costs involved viz. fixed cost and variable cost. Fixed costs comprises the items of costs which are fixed in nature like taxes, shelter and insurance. Variable costs includes repair and maintenance, fuel, oil or lubrication and labor costs. The cost of operation of FYM spreader per hour and per hectare were determined considering both fixed and variable costs. The following concepts were used for calculation of economic of the machine (Mehta *et al.* 2019).

Fixed Costs

(i) Depreciation (straight line method)

This method is used to estimate costs over a non-specific period of time and the amount of depreciation value is calculated by (Venkat *et al.* 2020).

$$D = \frac{P - S}{L \times H}$$

Where,

D = Average annual depreciation (₹ h^{-1})

P = Purchase price (₹)

S = Salvage value, taken as 10% of purchase price.

L = Life of machine (year)

H = annual use of machine (h)

(ii) Interest (I) - The formula used as:

$$I = \frac{P + S}{2} \times \frac{i}{H}(rupees/h)$$

Where, I = Interest cost, ₹/h

P = Purchase price of the machine, rupees

S = Salvage value of the machine, rupees

H = Annual Working hour, hr

i = Interest rate, %

(iii) Shelter and insurance costs = @ 5% purchase price

Variable Cost

(i) Repair and maintenance

The cost for repairing and maintenance was taken 6% of purchase price of the tractor (IS 9164:1979).

(ii) Fuel

Fuel costs can be approximate by using standard fuel consumption for field operations in litres per hour. Costs for fuel is calculated by using the following formula:

Cost of fuel per hour = fuel consumption for the FYM spreader × cost of fuel per litre

(iii) Lubrication costs

The cost of engine oils and lubricants was estimated as 15% of fuel consumption cost.

(iv) Wages and labour charges

The cost of labour was assumed to be ₹ 300/- by taking the prevailing rate for labour a day.

Computation of cost economics of the developed unit

The cost of operation calculated was compared with the cost of practice of manual spreading of the FYM. The labour force required by the traditional FYM spreading was collected and compared with the labour required for developed machine spreading.

Fig. 2: Testing of tractor mounted FYM spreader at field level

Payback Period

It is the length of time required to get back the investment on the project. The payback period was

calculated from the following equation (Venkat *et al.* 2021).

$$PBP = \frac{\text{Initinal investment}}{\text{Average net annual benefit}}$$

Where,

PBP = Payback period, year,

ANB = Average net annual profit, ₹ year^{-1},

= (*CH* – *C*) × *AU*

AU = Annually used in hours.

C = Operating cost, ₹ h^{-1}

CH = Custom hiring charges, ₹ h $^{-1}$

Break-even point

Break-even analysis indicates cost-volume-profit relations in the short run. This analysis relies on the assumption of constant factor prices, constant technology and constant selling prices. The break-even point is the intersection of the two curves, the total expense curve and the total revenue curve. At this phase in the production cycle, the producer is neither making a profit nor incurring losses.

$$BEP = \frac{FC}{CHC - C}$$

Where,

BEP = Breakeven point, h yr^{-1}

FC = Annual fixed cost, ₹ yr^{-1}

C = Operating cost, ₹ h $^{-1}$ and

CH = Custom hiring charges, ₹ h $^{-1}$

Annual utility

It is the average usage of farm machinery or any machine annually, which depends upon how many working days are available for a particular operation with the machine in a year. Annual utility of tractor and the spreader was considered as 1000 and 400 hours, respectively (Rahul *et al*. 2015).

RESULTS AND DISCUSSION

Field Capacity

The performance of machine was assessed during the field trials from its working efficiency in the field and area covered per unit time.

Theoretical field capacity and field efficiency

Theoretical field capacity found to vary from 0.36 and 0.54 ha h^{-1} for the forward speeds of 1.8 km h^{-1} and 3.2 km h^{-1}, respectively and effective field capacity obtained values were 0.28 and 0.432 ha h^{-1} as the change in speed of operation from 1.8 km h^{-1} and 3.2 km h^{-1}, respectively (Singh *et al.* 2013). The field capacity was increased with increase in speed of operation, which might be due to the increase in rated time of operation. The effect of operating speed on field capacity of developed planter is as shown in Fig. 3.

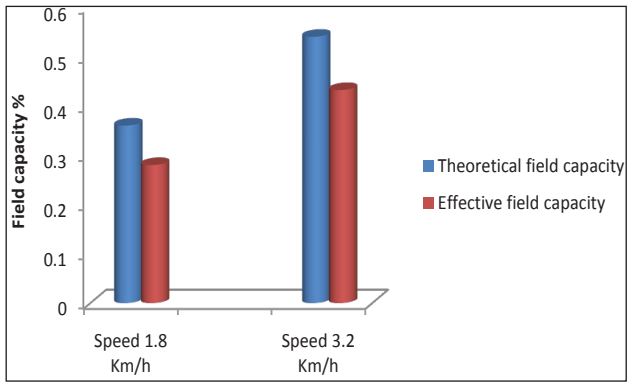


Fig. 3: Effect of speed on the field capacity of the FYM spreader

Field capacity of the FYM spreader

The field capacity was computed by considering forward speed of the machine as 3.2 km h^{-1} and spreading width of the machine as 1.8 m and computed field capacity was 0.432 ha h^{-1} (Sapkale *et al.* 2010).

Estimation of Cost of Operation of FYM Spreader Machine

The cost of operation of the machine was estimated as ₹ 1465, which is lesser by 75% when compared with the traditional FYM spreading method.

The cost of operation of Labour requirement for the developed spreader of FYM operation was 2 labours per hectare, whereas the requirement for manual spreading was 20 labour per ha, hence, the saving of 90% of labour can be achieved through this machine. More over the spreading was done by the human labour in bending posture which was defined as drudgery intensive operation that can be completely eliminated.

Cost Economics of Tractor Mounted FYM Spreader

The cost economics of the developed FYM spreader was computed by taking the cost of the prime mover and considering an annual use of the spreader as 400 h year^{-1} the results indicated fixed and operational costs per ha as ₹ 1465.

Cost of Operation of Tractor

Fixed cost

Depreciation per hour = $\frac{450000-45000}{10\times1000}$ = 40.5

Interest rate per hour= $\frac{450000+45000}{2}\times\frac{10}{100\times1000}$ = 24.75

Annual insurance charges, taxes, and shelter charges (I/H)

I = (5 × 450000)/100 = 13500

H = 1000

So, I/H = 13500/1000 = 13.5

Total fixed cost = ₹ 40.5 + ₹ 24.75 + ₹ 13.5 = ₹ 78.5

Variable test

Repair and maintenance = (6 × 450000)/(100 × 1000) = 2.7

Fuel cost per hour = fuel consumption $\left(\frac{lit}{h}\right)$ × cost of fuel $\left(\frac{Rs}{lit}\right)$

= 4.5 × 80

= 360

Lubrication oil consumption cost per hour (lit/h) = 5 % of fuel cost

= (5 × 80)/100

= 4

Driver cost per hour = ₹ 100

Variable cost per hour = ₹ 2.7 + ₹ 360 + ₹ 4 + ₹ 100 = ₹ 466.7

Cost of Operation of FYM Spreader

Fixed cost

Depreciation per hour = $\frac{(75000-7500)}{8\times700}$ = 12.05

Interest rate per hour = $\frac{(75000-7500)}{2}\times\frac{10}{100\times700}$ = 5.89

Annual insurance charges tax charges and shelter charges (I/H)

I = (3 × 75000)/100 = 2250

H = 700

I/H = 2250/700 = 3.21

Total fixed cost = ₹ 12.05 + ₹ 5.89 + ₹ 3.21 = ₹ 21.15

Variable cost

Repair and maintenance = (6×75000)/(100×700) = 6.42

Labour cost per hour = ₹ 62.5

Total variable cost of the FYM spreader per hour = ₹ 62.5 + ₹ 6.42 = ₹ 68.9

Pay Back Period

$$= \frac{\text{Initinal investment}}{\text{Average net annual benefit}}$$

Initial investment = ₹ 75000

Average annual benefit = CHC – Total operating cost × Annual utility

CHC = Custom Hiring Charges

Total cost of machine per hour = Operating cost of tractor + Operating cost of spreader

= ₹ 466.7 + ₹ 68.92

= ₹ 611.12

Total fixed cost per year, rupees

= ₹ 78.5 + ₹ 21.15

= ₹ 99.65 per hour

= ₹ 99.65 × 400

= ₹ 39860

CHC = 25% over total cost of operation/h

= ₹ 611.12 × 1.25 = ₹ 763./hr

Average net annual benefit = (₹ 763.9 – ₹ 611.12) × 400 = ₹ 61112 /annum

Pay Back Period = 75000/61112

= 1.12 = 1.2 years

Breakeven point Calculation

Break-even point was determined by plotting graph annual operating cost and custom hiring cost against

the usage of the developed machine. The location of the intersecting point made by the two cost lines gives the number of hours of work required for break-even. In Fig. 4, "y = 611.2x + 39860" is the line of total operating cost and "y = 763.9 x" is the line of total custom hiring cost. In both, the lines "x" indicates the number of operating hours of machinery. From the graphical representation, break-even point of the machine was calculated as 260.89 hours per year.

$$\text{BEP} = \frac{FC}{CHC - C}$$

$$\text{BEP} = \frac{39860}{763.9 - 611.12} = 260.89$$

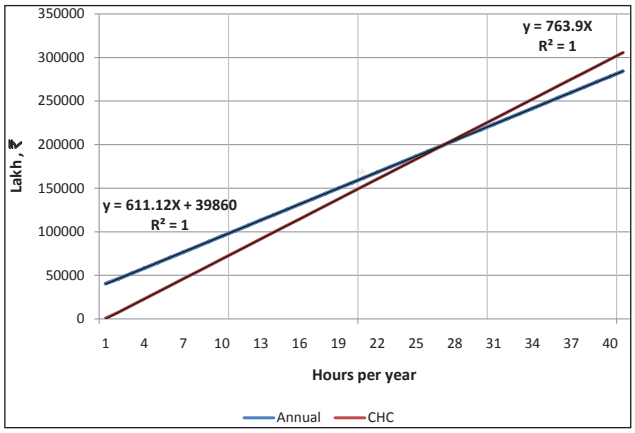


Fig. 4: Break-even point of FYM spreader

In y-axis, convert the cost in lakh rupees and in x-axis, I think the data is in tens, because intersection is showing near 25-26, and BEP calculated as 260 == (26 × 100).

CONCLUSION

The challenge faced in the application of manure through the farmer's method is the non uniform spreading and large manure lumps which will disintegrate very slowly. This operation requires labours and uniformity is not maintained in this operation. The tractor mounted FYM spreader was found to be profitable in terms of cost, labour requirement and timeliness for weeding and fertilizer application operations. Cost of operation by FYM spreader can save up to75 % as compared to the combined cost of existed FYM application methods.

REFERENCES

Baoming, S., Tadatoshi, S. and Shuji, M. 2011. Evaluation of travel tracks of tractor drawn manure spreaders. *Engineering in Agric. Environ. and Food,* **4**(4): 111-118.

Choudhary, S.M., Din and Sahu, P. 2016. Study on characteristics of bio slurry and FYM for mechanized application. *Int. J. Innovative Res. in Sci. Engine. and Techno.*, **5**(5): 6734-6738.

Jain, A.K. and Lawrence, A.K.A. 2015. Performance evaluation of bullock drawn farm yard manure spreader. *Int. Res. J. Engine. and Techno.*, **2**(3): 313-316.

Kothari, K.M., Jadhav,S., Lodha, M. and Priyanka, G. 2018. Design and fabrication of cow-dung spreader. *Int. J. Res. in Engine. Applic. and Manage.*, pp. 553-556.

Mehta, M.L., Verma, S.R., Misra, S.K. and Sharma, V.K. 2019. Testing and evaluation of agricultural machinery. *Daya Publishing House,* pp. 341-344.

Naveen Kumar, C., Prakash, K.V., Anantachar, M., Veerangouda, M. and Ravi, M.V. 2017. Development and evaluation of tractor operated farmyard manure spreader. *Int. J. Appl. Agric. and Horti. Sci.*, **8**(3): 732-735.

NCOF, 2012. National Project on Organic Farming Annual Report. National Centre of Organic Farming (NCOF), Department of Agricultural cooperation, Ministry of Agriculture, Govt. of India, Ghaziabad.

Rahul, B., Mahesh, K., Narang and Rupinder, C. 2015. Field and economic studies of tractor operated manure spreader with rear vertical rollers. *Int. J. Agric. Sci. and Res.*, **5**(6): 347-356.

Mohan, S.S. and Jayan, P.R. 2021. Livestock waste utilization through manure pulverizer cum applicator. *Int. J. Lives. Res.*, **11**(4): 19-27.

Mohan, S.S., Babu, P. and Jayan, P.R. 2022. Economic analysis of tractor powered manure pulverizer cum applicator over traditional manure application practices. *Agricultural Science Digest*., https://dx.doi.org/10.18805/ag.D-5341.

Sapkale, P.R., Mahalle, S.B. and Bastewad, T.B. 2010. Performance evaluation of tractor operated manure spreader. *Int. J. Agric. Engine.*, **3**(1): 167-170.

Singh, R.C and Singh, C.D. 2013. Development and performance testing of tractor trailer-cum-farmyard manure spreader. *Agric. Mechani. in Asia, Africa and Latin America.*, **37**(2): 1-6.

Venkat, R., Mohnot, P. and Dharmendra. 2020. Performance evaluation of mini tractor operated rotary weeder cum fertilizer drill. *Int. J. Cur Microb. and Appl. Sci.*, **9**(09): 2962-2974.

Venkat, R., Mohan, S.S., Mohnot, P. and Vinayak, M. 2021. Economic analysis and feasibility of rotary weeder-cum-fertilizer drill. *Econ. Aff.*, **66**(3): 451-457.

Vinayak, M., Rahaman, S., Ramana, C. Hari Babu, B. and Madusudhana Reddy, K.2022. Development of tractor mounted FYM spreader. *Indian J. Ecol.*, **49**(2): 405-409.