

DEVELOPMENT OF A MANUALLY OPERATED FERTILIZER BROADCASTER

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Abstract

A manually operated fertilizer broadcaster was designed, constructed and tested. Design considerations were low initial cost, ease of construction and operation as well as three different application rates (low, medium and high). At average walking speeds of 0.7 and 0.9 ms⁻¹, the hand-cranked broadcaster spreads between 4.23 and 18.7 gm⁻² for 7 m swath of urea fertilizer and 6.24 and 28.2 gm⁻² for 9 m swath of compound fertilizer respectively.

1. Introduction

In crop production, the application of fertilizer is important and this is considered as one of the essential operations carried out. The application of fertilizer is usually carried out in areas or regions where the soil fertility is low. Akinsanmi (1988) stated that fertilizer application to the soil depends on factors such as: - texture and density of fertilizer, stage of crop development, time of application, labour and equipment available.

As the demand for food increases due to increase in population, better ways of improving food production becomes desirable. One of the ways to achieve this is to adopt more efficient means of fertilizer application by modifying and to inventing machines that can achieve this objective.

The knapsack sprayer was first manufactured for application of fungicides in the late nineteenth century (Lodeman, 1996). It consisted of a tank and a lever-operated system that fits comfortably on the operators back. This machine was also used for spraying liquid and later powdered fertilizer. A modified knapsack sprayer with a 3m long plastic tube at each end, was constructed in Japan to improve dust and micro granular fertilizer distribution (Takenaga, 1971).

Over the years, modifications and changes have been made on broadcasters and this resulted in the production of different types of both manually- and mechanically-operated fertilizer broadcasters. For example, the Bamlett/ Boybake, Tasker and Chafer types are mechanically operated broadcasters that are mounted on the tractor (Culpin, 1981).

Usually, the mechanically operated are expensive and beyond the reach of ordinary farmers in this area. As such, there is the need to develop cheap and readily available broadcasters that can be used by the farmers. The objective of this work is to design, construct and test a manually operated fertilizer broadcaster.

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2. Materials and methods

Materials used for the construction of the broadcaster are plastic, galvanized iron sheet and mild steel. The choice of these materials was based on their unique properties that are adaptable to particular components of the machine. Such properties include lightweight, transparency and resistance to chemicals and weathering for plastic and cost and malleability for mild steel. Similarly, one of the unique properties of galvanised steel is corrosion resistance. The machine comprises the following: container (or hopper), cranking and distribution systems.

2.1 Design

The dimensions of the crank length, connector and link were determined using the free body mechanism. The module (M_o) chosen (from table) was 1.5 and this gives a gear ratio of 1:7 (Spotts, 1988). The pitch diameters for the driver and driven gears were found to be 30 and 200 mm respectively.

Taking the force generated by an average person (power transiting force) to be 294.3 N (Abbot, 1985), the power calculated using Equation 1 was 183.4 W.

$$P = F_p V \quad (1)$$

Where F_p = Power transiting force that is the force that could be generated by an average person, N

V = pitch line velocity, ms^{-1}

Using a pressure angle (ϕ) of 14.5° (Spotts, 1988), the radial force (F_r) and base circle velocity (V_b) were determined to be 76.1 N and 0.64 ms^{-1} (Equations 2 and 3) respectively.

$$F_r = F_p \tan \phi \quad (2)$$

$$V_b = V \cos \phi \quad (3)$$

Using a combined error value of 0.043 mm (Spotts, 1988) the torsional moment (M_t) was calculated as 4.4 Nm. The shaft diameter (d_s) was calculated from Equation 4 below and was found to be 8.0 mm:

$$d_s = \sqrt[3]{\frac{16M_t}{\pi F_s}} \quad (4)$$

Taking a factor of safety of 2, the shaft diameter chosen was therefore 16 mm. Figure 1 shows the isometric drawing of the complete machine. The flow of fertilizer from the hopper onto the distributor plate is due to gravity. Flow rate of the fertilizer is controlled by adjusting the opening beneath the hopper. The overall cost of the distributor was estimated to be N 2,149.00.

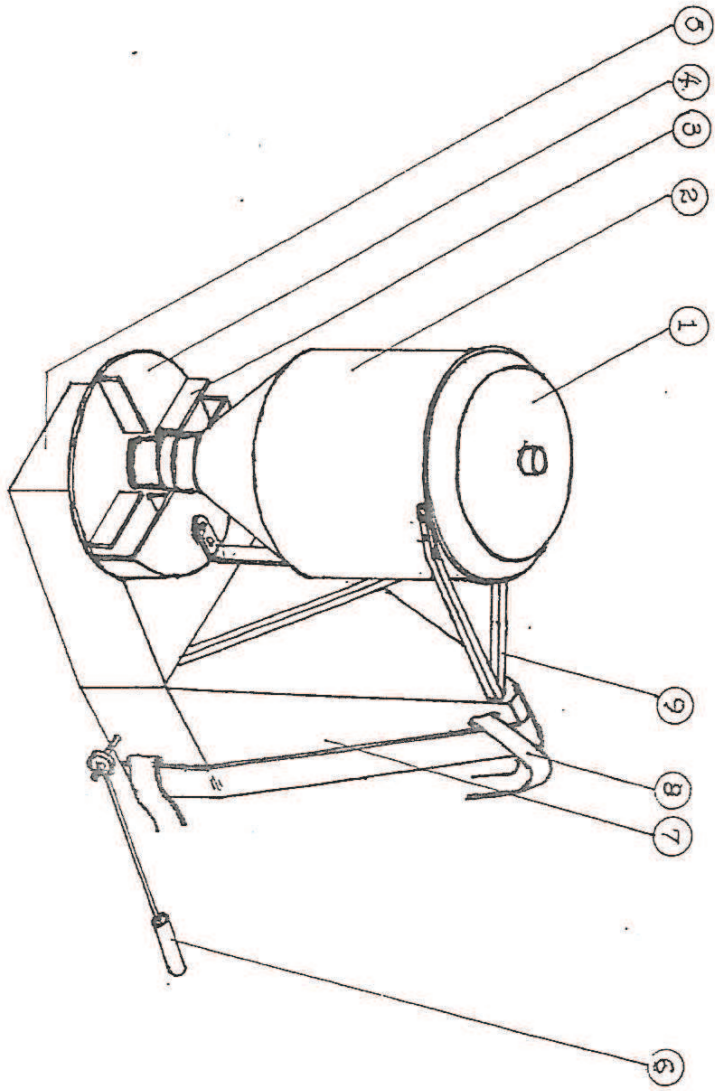


FIG. 1 ISOMETRIC DRAWING OF BROADCASTER

S/No	ITEM	MATERIAL
9	FRAME	MILD STEEL
8	BELT	FERRIC
7	BODY	THERMOPLASTIC
6	HANDLE	MILD STEEL
5	DISTRIBUTOR	THERMOPLASTIC
4	FINS DISC	"
3	FINS	"
2	HOPPER	"
1	COVER	THERMOPLASTIC

2.2 Testing

Three index positions A, B and C for urea and compound fertilizer were used for testing the broadcaster (Hawker and Keenlyside, 1977) on an area of 1m^2 and the application rate determined for each position. The result for the test is shown in Tables 1 and 2.

Table 1: Test data for urea with an average of 0.7 ms^{-1}

Feed Index	Replicate	Weight of urea (g)	Average application rate gm^{-2}
A	1	4.30	4.23
	2	4.40	
	3	4.00	
B	1	10.33	10.32
	2	10.29	
	3	10.35	
C	1	18.68	18.70
	2	18.72	
	3	18.74	

Table 2: Test data for compound fertilizer with an average of 0.9 ms^{-1}

Feed Index	Replicate	Weight of fertilizer (g)	Average application rate gm^{-2}
A	1	6.25	6.24
	2	6.26	
	3	6.21	
B	1	13.86	13.90
	2	14.64	
	3	13.80	
C	1	27.40	28.20
	2	29.19	
	3	28.03	

At an average walking speed of 0.7 and 0.9 ms^{-1} , it could be seen from the tables that the average application rates for urea and compound fertilizer at the three index positions range between 4.23 to 18.7 and 6.24 to 28.20 gm^{-2} respectively.

3. Conclusion

A manual fertilizer broadcaster was designed and constructed. Application rates of between 4.23 and 28.20 gm⁻² could be achieved for urea and compound fertilizer. The cost estimate for the broadcaster was N2,149.00.

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