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BAHIR DAR UNIVERSITY INSTITUTION OF TECHNOLOGY (BiT)
FACULTY OF MECHANICAL AND INDUSTRIAL ENGINEERING



Multipurpose oxen driven self-sowing and Tillage machine

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Abstract

This is a multipurpose seed and fertilizer sowing and tillage machine which is targeted to sow maize and fertilizer together while it plows. The machine contains two shares which able to make two furrow lines in one pass while sowing the seed and fertilizer. The document contains introduction, literature, geometry and force analysis, cost analysis, manufacturing process, part design, result and conclusion. It also contains part drawing of each component and feasible assembly drawing.

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1. Introduction

1.1. Background and Justification

Agriculture in Ethiopia is backbone of people allowing her people to continue in life. Understanding the importance of agriculture lead government of Ethiopia enacts agriculture lead to industrialization for better standard living of the people. But still the product obtained is low .it cannot able address the existing needs. Ethiopian agriculture has been suffering from various external and internal problems. It has been stagnant due to poor performance as a result of factors such as: - low technical farming techniques. (Wooden plough by oxen and sickles.)[1]So it is important to support small scale farmers by providing functional, practical, productive education and improved technologies. [2]

This is because farmers in Ethiopia still uses ordinary equipment for centuries which takes much time to plow their land and broadcasting of seeds on their land is of low quality. So we are determined to do this project under agriculture machine courses addressed by teacher Zemenu Thehay to alleviate the existing problems in agriculture for many centuries mainly focusing on Ethiopia Farmer

1.2. Problem statement

The ploughing and broadcasting processes in Ethiopia is so backward.

- it takes much time.
- It takes much power of the farmers and families.
- It produces more fatigue on their oxen.
- Seed broadcasting is of low quality.

1.3. Objectives

1.3.1. Major objective

Design a multipurpose self-sowing tillage machine (each parts).

1.3.2. Specific objective

- Modify the old and traditional tillage in terms of their design
- Save the time and resources of the people of Ethiopian farmers.
- Save the farmers power.

- Incorporate and regulate seed placement.

1.4. Methodology

2. Selecting of problem
3. Problem identification
4. Data collection (literature review)
5. Introduction
6. Problem statement
7. Setting objectives
8. Methodology
9. Conceptual design
10. Embodiment design
11. Solid work simulation and animation
12. Probably prototype testing

1.5. Working principle

- The machine gets its power from two oxen and the machine itself puts the seed and fertilizer at proper place in the furrow while ploughing.
- At a time it cans able make two furrows according to the force of oxen and soil resistance.
- Incase no need of sowing seeds to thefurrow; seed bucket is removed and ploughing action.
- Can be continued for preparation of the land.
- The machine can be important for any seed broadcasted in a furrow line like maize, wheat, bean, pepper, rice and probably for teff.

1.6. Action Plan

Table 1: action plan

Time frame	Activities
Week 1,2	Introduction
Week 3,4	Conceptual design
Week 5,6,7	Embodiment design
Week 8,9	Solid work modeling and simulation

1.7. Specification

Structural component requirement

- Seed and fertilizer bucket.
- Ground wheel.
- 4 seed cum wheel.
- Ground wheel shaft and seed cum shaft.
- 4 tubular lines (for seed and fertilizer travel to furrow).
- Beam (mofer).
- Bar (rod).
- Frame (for seed bucket settling).
- Bearings.

Technical requirement

- Seed bucket and tubular line can be removed in case only tillage operation is required.
- Only one furrow plow action is operated if soil resistance is high.
- Not complicated.
- Operated by unskilled person.
- Able to make two furrows at a time.
- Materials must be corrosion resistance.
- Easy to assemble and disassemble.

Parameter requirement

- Soil resistance = 0.75kg/cm^2 .
- Animal power required = 1.4hp.
- Furrow width = 30cm.
- Furrow depth = 20cm.
- Speed of travel = 0.4m/s .
- Row spacing=50cm.
- Light weight (not more than 25kg).
- Total length= 3m

- Width = 90cm
- Total height = 1.25m

2. Literature review

In our country, farmers use ordinary plowing equipment which makes one furrow at a time of movement. Every farmer can produce their plowing equipment without any scientific calculation.

As well farmers in our country sow maize in rows and use 3 people. One for maize, one for fertilizer and the other is for plowing. From those, two people follow each tilled furrow while bowing down from their abdomen to put down the maize and fertilizer at the same place. Also they use simple eye observation to determine the distance between two consecutive maize plants.

Our machine is designed to alleviate the existing problems for centuries. This machine still obtains its power from oxen as ordinary equipment's as do today and targeted to perform tillage and sowing of maize seed and fertilizer together at predetermined distance between two consecutive maize seed. So the distance between two consecutive maize plants is always constant.

The machine is light in weight in which the farmers can able to hold and move it to their farm land. It has different components to perform its task. Mainly: - seed and fertilizer cum, seed and fertilizer bucket, ground wheel, share, tubular lines for seed and fertilizer traveling and mofer. This machine has two shares which are directly connected to the horizontal bar. The mofer (beam), which it is connected with screw to the horizontal bar, is used for an attachment between the yoke and share assembly.

There is also seed and fertilizer bucket in which the seed and fertilizer is stored respectively. On the side of it there is simple rack and pinion mechanism which opens the door and allows continuous flow of the seed and fertilizer to the seed cum. The ground wheel which has long projected teeth rotates due to friction with the ground. This power transmitted to seed cum by belt connection. The seed cum picks single seed at a time and fixed amount of fertilizer to tubular lines both seed and fertilizers are mixed and put at the same place on the furrow. The sowing assembly can be disassembled and removed in case only plowing action is needed. This machine works until soil resistance of 0.75kg/cm².

By so doing the machine needs only one person to control the direction of movements of the oxen placed at the back of the share by catching the handle. The general component and layout of this machine is shown below.

Maize (*Zea mays* L.) is the most important grain crop in Ethiopia and is produced throughout the country under diverse environments. Successful maize production depends on the correct application of production inputs that will sustain the environment as well as agricultural production

Tillage is defined as a set of operations performed on the soil to prepare a seedbed, control weeds and improve soil physical conditions for enhancing the establishment, growth and yield of crops, as well as conserving soil moisture [1]. In Ethiopia, the land preparation is characterized by the use of backward traditional farm implements.

These include simple hand tools and animal drawn implements such as *Maresha*, which are used by peasant farmers for seedbed preparation, weeding and cultivation purpose [2]. The traditional farm implements used by the peasants are considered to be among the main factors that retarded the agricultural productivity in the country.

These implements usually result in hand to mouth and non-market oriented production. Tillage tools and practices are indigenous and chosen by the farmers themselves based on their resources and requirements. However, these indigenous tools and practices pose constraints such as inefficiencies, drudgery and poor quality of work, which results in low yields. Promoting and upholding productivity of farmers beyond subsistent level is closely related to the use of improved farm implements and tools (mechanization of agriculture) to till and cultivate land



Figure 1: local maresha.

In addition to this, tillage in Ethiopia is carried out with a breaking ard plough, locally known as “*maresha*”, whose shape and structure have remained unchanged for thousands of years (McHugh, 2006; Nyssen et al., 2000; Temesgen et al., 2012).

Smallholder farmers in Ethiopia practice traditional tillage systems using an ard plow called Maresha. Traditional tillage systems that involve repeated cultivations with the Maresha plow have caused land degradation (a.o. formation of a plow pan) and poor utilization of rainwater that led to low crop productivity. On the other hand, lighter and low cost implements have been developed in Ethiopia as modifications to the Maresha plow. These implements are the Subsoiler, the Tie-ridger, and the Sweep. Field tests were carried out to evaluate the modified implements

2.1. The tie rider

In semi-arid regions, rain fall is erratic, which means high intensity rain fall is followed by long dry spells. As a result more water is lost through run off and soil dries out quickly. So tied rides are a series of basins formed in the field by tilling furrow at a certain intervals. They reduce run off by creating obstacles to the movement of water here by storing more water in the field and maintains the soil moisture during dry spells. Tie rider is made by attaching a blade to the tip of the maresha plow. The blade is designed to make wider furrows with reduced draft power requirement and lower lifting force as compared to conventional tillage.



Figure 2: the maresha modified tie-ridger

2.2. The sweep

The sweep is made by replacing the wooden board of maresha plow by a pair of rods and a 55 cm wide blade. The main purpose of the sweep is to improve the timeliness of operation. It operates shallowly there by reducing draft power requirements and increasing speed of operation. It has got a larger width of operation and hence more area is covered per unit of time. Moreover, the

sweep can be used to mix fertilizers with the soil during teff planting. traditionally farmers used to broadcast fertilizers on the surface and do not mix it with the soil. The reason is that if they mix it using maresha plow, the fertilizers will be buried too deep for the shallow-rooted teff crop. the draw back of leaving fertilizers on the surface includes losses due to volatilization and sheet erosion.



Figure 3: maresha modified sweep.

2.3. The maresha modified plow

The maresha modified plow(MMP) is the result of incorporation of bottom of a mold board plow with the frames of the maresha plow. The incorporation of the bottom of the mold board plow in to the maresha plow is an opportunity to make the plow simple, light and cheap such that it is affordable by farmers in Ethiopia. the v shaped furrow created by the maresha plow has been identified to be the main cause of repeated plow by farmers in Ethiopia. It is therefore necessary that the implement be modified such that it forms u shaped furrow that are more effective in weed control thus reducing the need for repeated and cross plow. it is therefore hypothesized that MMP can form a U shaped furrow which would then lead to reduced tillage frequency.



Figure 4: The maresha modified plow

2.4. The semi-automatic row planter

Too much labor and time required for manual planting forces farmers to broadcast maize leading to uncontrolled and often too high plant density. Too high plant population leads to low water uptake per plant. More over farmers do not apply fertilizers in broadcast maize in addition to practicing poor tillage system the result are stunted growth and low yield.

Animal drawn row planter that were developed based on the design of the tractor drawn row planter that involve ground wheel for metering seed and fertilizer were not found to be effective under poorly prepared field of the small holder farmers .the rather light weight row planter equipped with small diameter wheel skidded and unable to deliver seed uniformly resulting in large un planted gaps [6]. Asemi-automatic maresha mounted row planter was developed in Ethiopia with aseed metering mechanism maneuvered by the operator instead of ground wheels [7].



Figure 5:the semi automatic row planter.

Although there is a national recommendation on spacing of maize from research centers, most of farmers in East Hararghe zone especially in Kombolcha District do not use the recommended spacing. Most of farmers in the stud area use their own spacing and agronomic practices rather than the recommended spacing. Most of them use from 50 to 60 cm inter row spacing and 20 to 30 cm intra row spacing even for tall and late.

3. Design analysis

3.1. Geometric analysis

Geometry analysis shows the dimension of the object. Such dimension may be either assumed or calculated using the assumed dimension.

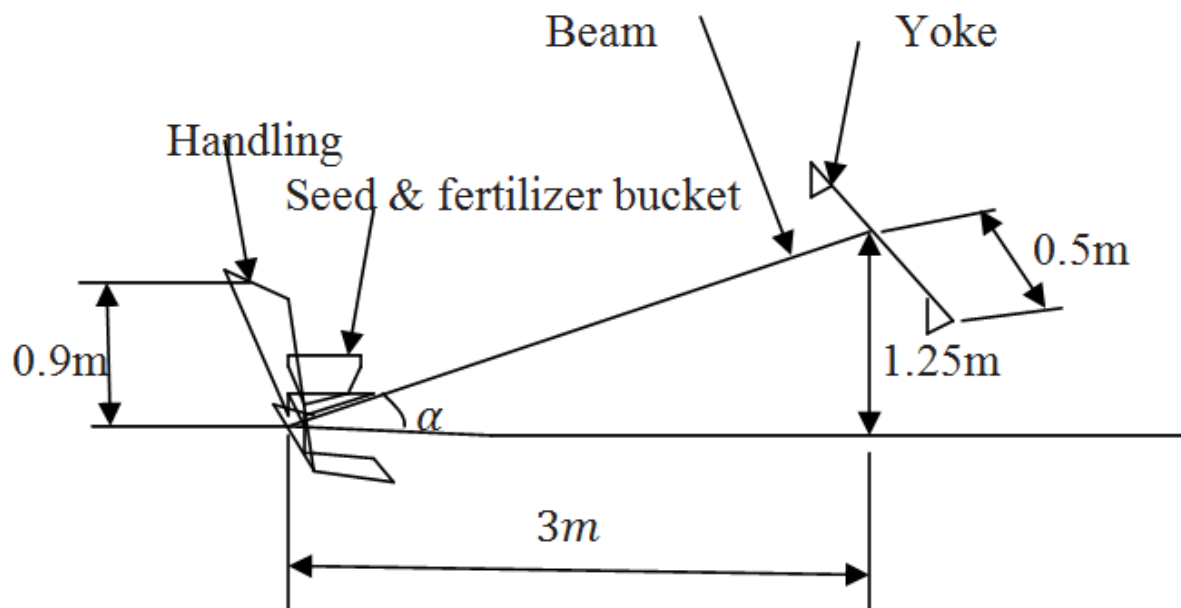


Figure 6: geometrical dimension.

As the standard, the distance between the share and yoke is taken as 3m and the average height of oxen is taken to be 1.25m.

Thus we have to find the angle (α) between the horizontal and the beam (mofer) as follows

$$\alpha = \tan^{-1}\left(\frac{1.25m}{3m}\right) = 22.62^\circ \approx 23^\circ$$

3.2. Force analysis

Force analysis means calculating the force distribution from the force source (oxen) to yoke and then throughout the main parts of the object.

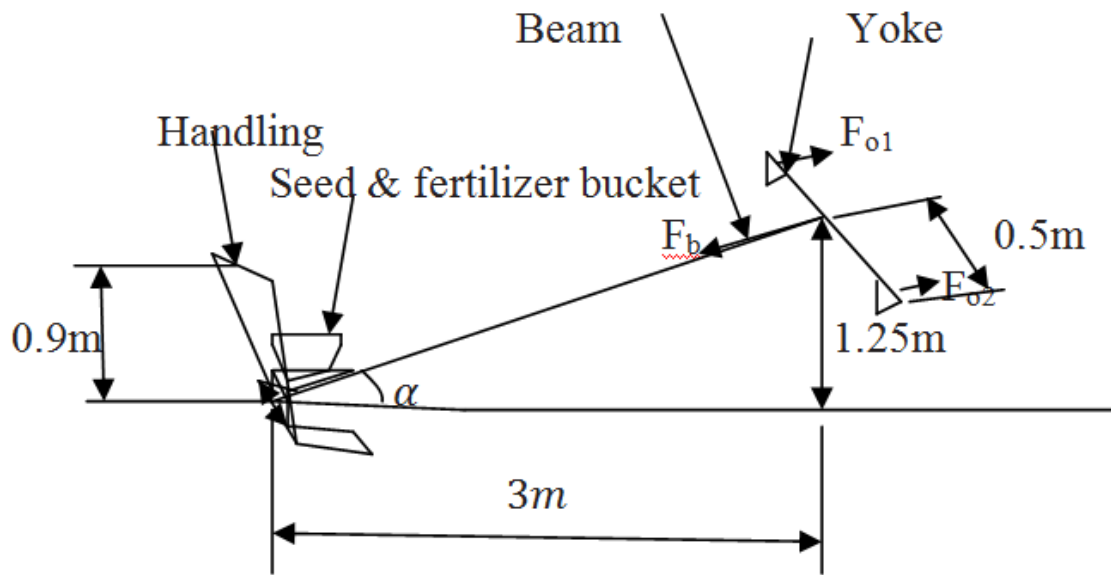


Figure 7: force transition.

Thus the force at the yoke and beam is related as;

$$\sum F = 0;$$

$$F_b = F_{o1} + F_{o2}$$

Where; F_b =force applied on beam

F_{o1} =force applied by ox_1 which is assumed to be equal to F_{o2} (force applied by ox_2)

$$F_b = 2F_{o1} = 2 \times 1305.5N = 2611N$$

3.3. Selection of chain and sprocket

The chain drive is designed as discussed below:

1. First of all, determine the velocity ratio of the chain drive.
2. Select the minimum number of teeth on the smaller sprocket or pinion from Table 21.5. from khurmi and gupta text book.
3. Find the number of teeth on the larger sprocket.
4. Determine the design power by using the service factor, such that

Design power = Rated power $\times$ Service factor

5. Choose the type of chain, number of strands for the design power and rpm. of the smaller Sprocket from Table 21.4. of khurmi and gupta text book

6. Note down the parameters of the chain, such as pitch, roller diameter, minimum width of Roller etc. from Table 21.1. From khurmi and gupta text book.

Step 1: Transmission ratio = $\frac{N_1}{N_2} = \frac{T_2}{T_1}$

Where: N_1, N_2 = speed (rpm) of smaller and larger sprocket respectively.

T_1, T_2 = no of teeth for smaller and larger sprocket respectively.

Take transmission ratio (i) = 2

Step 2: using (i) from table -type of chain- roller.

-no of teeth = 27

Step 3: no of teeth on larger sprocket

$T_2 = i \times T_1 = 2 \times 27 = 54$ teeth.

Step 4: Design power = Rated power $\times$ Service factor.

The service factor (K_s) is the product of various factors, such as load factor (K_1), lubrication Factor (K_2) and rating factor (K_3). The values of these factors are taken from the following.

1. Load factor (K_1) = 1, for constant load

= 1.25, for variable load with mild shock

= 1.5, for heavy shock loads

2. Lubrication factor (K_2) = 0.8, for continuous lubrication

= 1, for drop lubrication

= 1.5, for periodic lubrication

3. Rating factor (K_3) = 1, for 8 hours per day

= 1.25, for 16 hours per day

= 1.5, for continuous service

So, $k_s = 1.25 \times 1.5 \times 1 = 1.875$

Design power = $1.875 \times 1.4 \text{ hp} = 1958.25 \text{ watt}$.

Step 5: from table using power, - types of chains = 12B.

-Speed of smaller sprocket (rpm) = 100.

Step 6: note down parameters.

$h(p) = 19.05 \text{ mm}$

Roller diameter, $d = 12.07 \text{ mm}$.

Minimum width of roller; $w = 11.68 \text{ mm}$.

Breaking load, $W_B = 28.9 \text{ kN}$

We know that pitch circle diameter of the smaller sprocket or pinion,

$$d_1 = p \operatorname{cosec} (180/T_1) = 19.05 \operatorname{cosec} (180/27) = 164 \text{ mm}$$

Pitch circle diameter of the larger sprocket (d_2)

$$d_2 = 19.05 \operatorname{cosec} (180/54) = 327.6 \text{ mm}.$$

The minimum center distance between smaller and larger sprocket should be between 30 to 50 times the pitch. Take 30 times. $X = 30 \times 19.05 = 571.5 \text{ mm}$. In order to accommodate sag the value is reduced by 2 to 5 mm

So, $X = 567.5 \text{ mm}$.

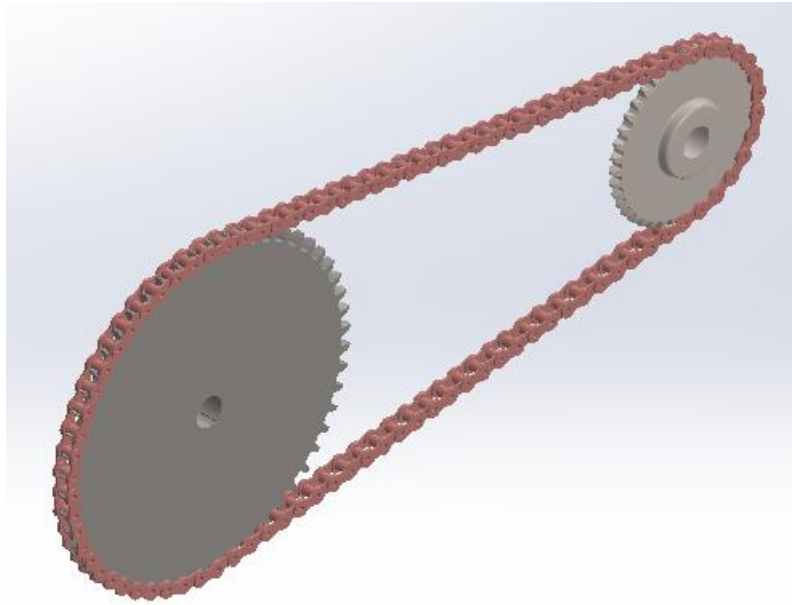


Figure 8: chain and sprocket

3.4. Design of beam

Material =rigid pvc (acetyl polymers).

Ultimate strength=120Mpa.

The beam is hallow structure with internal diameter of 8cm.

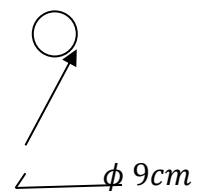
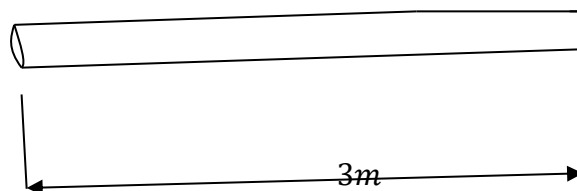
Factor of safety =2

Now; design stress = $\frac{\text{ultimate tensile stress}}{\text{Factor of safety}} = \frac{120\text{Mpa}}{2} = 60\text{Mpa}$

$$\text{Design stress} = \frac{\text{force}}{\text{area}} = \frac{4 \cdot \text{force}}{\pi \cdot (D^2 - d^2)}$$

$$D^2 = \frac{4 \cdot \text{force}}{\pi \cdot \text{design stress}} + d^2 = \frac{4 \cdot 2611\text{N}}{3.14 \cdot 60 \cdot 10^6 \text{pa}} + 0.08^2 \text{m}^2$$

D=8.83cm=9cm.



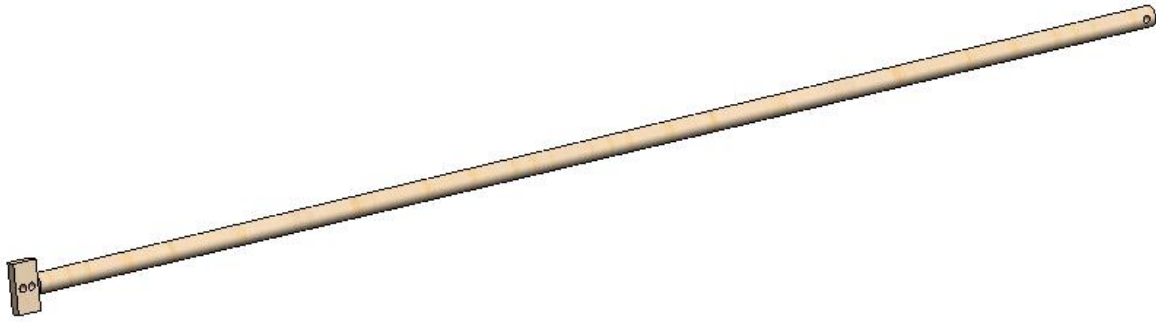


Figure 9: the beam (mofer).

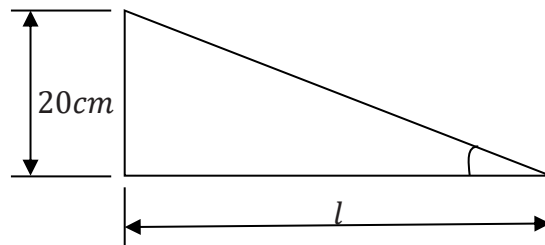
3.5. Design of share

Material used is mild steel.

Assume: - θ is share setting angle which has taken from 30° - 40° , take $\theta=30^\circ$

ϕ =angle of inclination of f in transverse plane with the horizontal (ϕ = from 14° – 18°), take $\phi=15^\circ$

Depth of share= 20cm (given parameter)



$$\tan 30^\circ = \frac{20\text{cm}}{l}, l = 20\text{cm} \times \tan 30^\circ = 34.65\text{cm} \cong 35\text{cm}$$

Draft (kgf)

$$\text{Power (p)} = \frac{\text{draft(kgf)} \times \text{speed(m/s)}}{75}$$

$$\text{draft(kgf)} = \frac{75 \times p}{\text{speed}} = \frac{75 \times 1.292\text{hp}}{0.4\text{m/s}} = 242.3\text{kgf} = 2376.96\text{N}$$

$$\text{horizontal draft(kgf)} = \text{pull force(kgf)} \times \cos \theta \cos \phi$$

$$= 242.3\text{kgf} \times \cos 30^\circ \times \cos 15^\circ = 202.68\text{kgf}$$

$$\text{vertical draft(kgf)} = \text{pull force(kgf)} \sin 30^\circ \cos 15^\circ$$

$$= 242.3\text{kgf} \times \sin 30^\circ \cos 15^\circ = 117.02\text{kgf}$$

The important force is the component of force in horizontal direction.

$$\text{Horizontal power} = \text{Hp} \times \cos 25^\circ = 1.4\text{hp} \times \cos 25^\circ = 1.289\text{hp}$$

$$\text{Efficiency} = \frac{\text{horizontal power}}{\text{total Hp}} \times 100\% = \frac{1.289\text{hp}}{1.4\text{hp}} \times 100\% = 92.02\%$$

Draw bar efficiency for mold board plow=60%, but we approximately did the efficiency like shown above.

The furrow created by the share is half U shape because half U shape inverts the soil at 180° so weed is reduced and there will not any unplowed soil line between two furrows.

V-shape furrow needs cross plow.



Figure 10: U-shape furrow

The machine is assumed to work for 8 hours per day.

$$\text{The field capacity of the machine (FCT)} = \frac{\text{depth} \times \text{speed} \times 36}{10000} = \frac{30\text{cm} \times 0.4\text{m/s} \times 36}{10000} = 0.0438 \text{ ha/hr}$$

$$\text{Distance travel} = \text{speed} \times \text{time} = 0.4 \text{ m/s} \times 8\text{hr} = 115200\text{m}$$

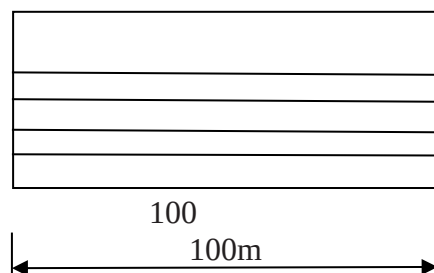


Figure 11: Land plowed in hectare

$$\text{No, of turn } \frac{\text{distance}}{100m} = \frac{115200m}{100m} = 1152 \text{ turns}$$

By asking farmers the average time elapsed in turning is 5sec.

$$\text{Total time elapsed} = 5\text{sec.} \times 1152\text{turns} = 5760\text{sec.} = 1.6\text{hr}$$

$$\text{Efficiency} = \left(\frac{8\text{hr}_{1.6\text{hr}}}{8\text{hr}} \right) \times 100\% = 80\%$$

$$\text{Effective field capacity (FCA)} = \frac{s \times w}{10} \times \frac{2}{100} \left(\frac{\text{ha}}{\text{hr}} \right) = 0.0438 \times 80\% = 0.03454 \text{ ha/hr}$$

$$\text{For two furrow, FCA} = 0.03454 \text{ ha/hr} \times 2 = 0.06908 \text{ ha/hr}$$

$$\text{Volume of soil cut per day} = 1200\text{cm}^2 \times 115200 \text{ m/day} = 1.38924 \times 10^{10} \text{ cm}^3/\text{day}$$

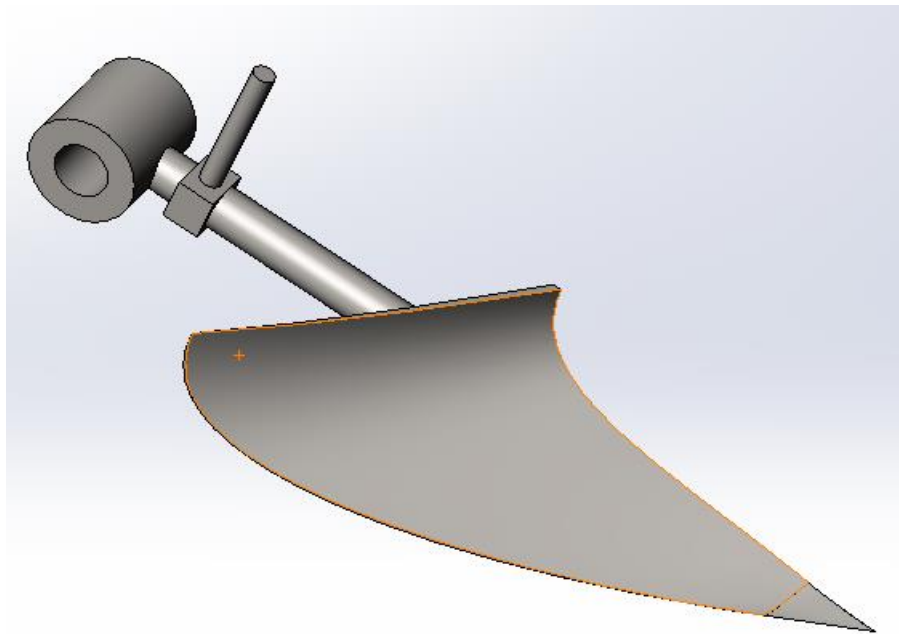


Figure 12: the share

3.6. Design of Seed cum and Fertilizer metering

Spacing of seed = 20cm (from specification).

Distance covered by ground wheel in Ng revolutions.

$$Ng = \frac{\text{distance between two consecutive seed}}{\pi \times \text{diameter of ground wheel}}$$

$$\frac{20\text{cm}}{\pi \times 50\text{cm}} = 0.127 \text{ revolution}$$

$$\text{Transition ratio (velocity ratio)} = \frac{N_g}{N_p}$$

N_p = number of revolution of seed cum to drop one seed.

$$\text{Velocity ratio} = \frac{27 \times 27}{54 \times 54} = 0.25$$

Power is transmitted by chain and sprocket.

Ground shaft has sprocket of teeth = 27.

Seed cum shaft has sprocket of teeth = 54.

Intermediate shaft have two sprocket of teeth = 27 and 54.

$$N_p = \frac{0.127}{0.25} = 0.508 \text{ revolution.}$$

$$\text{Number of cell required on seed cum (n)} = \frac{1}{N_p}$$

$$n = \frac{1}{0.508} = 2 \text{ cells}$$

$$\text{T.R (velocity ratio)} = \frac{V_p}{V_g}$$

V_p = peripheral velocity of seed cum.

V_g = peripheral velocity of ground wheel.

$$\Pi \times D_g \times N_g \times T_r = \pi \times D_p \times N_p$$

$$D_p = \frac{D_g \times N_g \times T_r}{N_p} = \frac{50 \text{ cm} \times 0.127 \text{ rev} \times}{0.504} = 3.5 \approx 4 \text{ cm}$$

Where D_p = diameter of seed cum.

Width of seed cum = assume that 0.5cm.

Shaft diameter = 1cm.

$$\text{Volume of seed cum} = \frac{1}{4} \times \pi (D^2 - d^2) \times b.$$

$$= \frac{1}{4} \times \pi \times (4^2 - 1^2) \times 0.5$$

$$\text{Volume} = 5.8875 \text{ cm}^3$$

The material is made of rigid PVC. Which have

$$\text{Density} = 1.375\text{g/cm}^3$$

So; mass = volume $\times$ density

$$= 1.375\text{g/cm}^3 \times 5.8875\text{cm}^3$$

$$\text{Mass} = 8.083\text{g}$$

Peripheral distance between two cells:

$$= \frac{\pi \times D}{n} = \frac{\pi \times 4}{2} = 6.28\text{cm}$$

The same type of hopper is also used for material the fertilizer for easy fabrication. The arrangement and position of drill is like a seed hopper. Dimensions are also the same. The fertilizer cup has a diameter of 2cm able to take enough fertilizer to the seed.

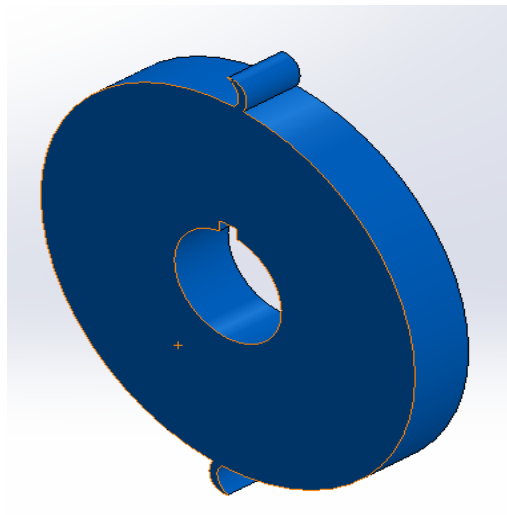
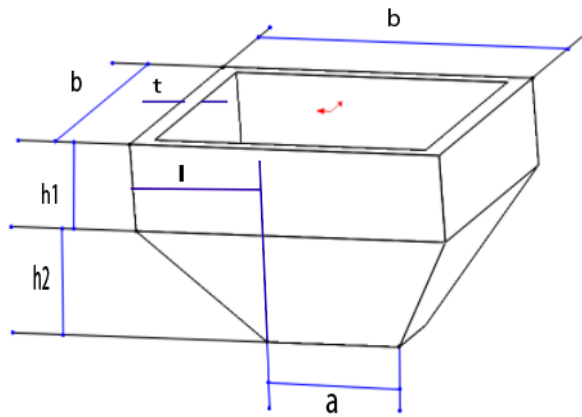


Figure 13: Seed cum and Fertilizer metering

3.7. Design of seed fertilizer box



The box is assumed to be square inside at the top whose sides are equal to b.

Assume a = 5 cm , b = 15cm , h2 = 10cm , t = 5cm , Angle of repose = 30°

$$l = \frac{a-b}{2} = \frac{15-5}{2} =$$

total volume (Vb) = Va + Vb

Va = upper section, Vb = lower section.

$$Vb = b \times b \times h1 + h2 \times b(a+l)$$

$$= 225\text{cm}^2 \times 10\text{cm} + (10 \times 15$$

$$Vb = 3750\text{cm}^3$$

The material is plastic (PVC) rigid to have light weight

$$\text{Density} = 1.375\text{g/cm}^3$$

Assume the shape of the box is trapezoidal for free flow of seed and fertilizer

Volume of seed box = 1.1 × volume of seed

$$\text{Volume of seed (Vs)} = \frac{Ws}{\gamma_s}$$

Where Ws = weight of seed in box. Let 2 kg seed is filled in the box.

γ_s = bulk density of seed

$$Vb = 1.1 \times \frac{2\text{kg}}{0.64\text{g/cm}^3} = 3437.5\text{cm}^3.$$

Bulk material	Bilk density (g /cm ³)
Barely	1.15
Bean	0.5606
Maize	0.64

The volume of empty space is greater than that of theoretical volume.

Design of fertilizer box.

For easy construction and balance the same size and shape of fertilizer box is used.

Dimensions.

$$a = 5\text{cm} , b = 15\text{cm} , h_2 = 10\text{cm} , t = 5\text{cm} , h_1 = 10\text{cm} , V_b = 3750 \text{ cm}^3$$

Bulk density of the fertilizer (γ_f) = 984kg/m³

Weight of fertilizer in the bucket (W_f) = $V_b \times \gamma_f$

$$W_f = 3750\text{cm}^3 \times 0.984\text{kg} = 3.69\text{kg}.$$

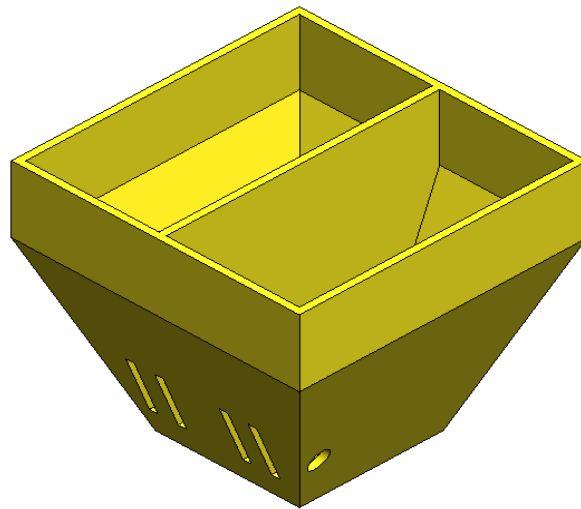


Figure 14: seed and fertilizer bucket

3.8. Design of ground wheel

The power is transmitted through the ground wheel to the seed metering device with the help of chain and sprocket.

Speed of operation = 0.4m/s.

Diameter of pegged ground wheel = 50cm.

$$Ng = \frac{Vg}{\pi Dg} = \frac{0.4m/s}{\pi \times 50} = 0.2547 \text{ rev/min; diameter}=50\text{cm.}$$

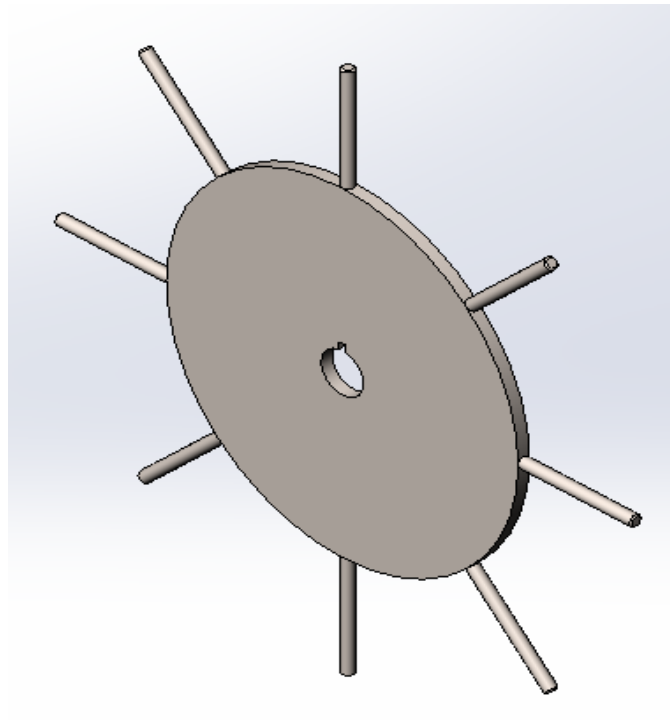


Figure 15: ground wheel.

3.9. Design of horizontal shaft

Assumption;

1. The material of the beam is perfectly homogenous.
2. The material of the beam obeys hooks law.
3. Each layer of the beam is free to expand or contract independently of the layer, above or below it.
4. The young's modulus is the same for compression and tension.
5. The load is applied in the plain of bending.

2611N

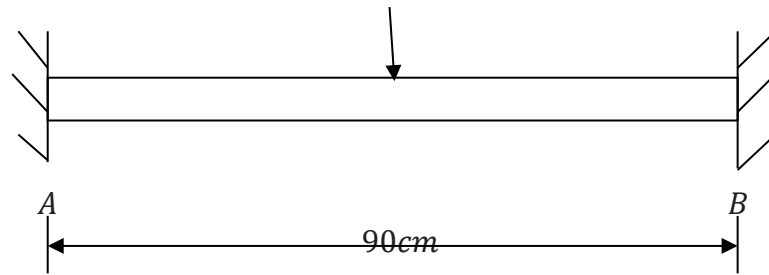
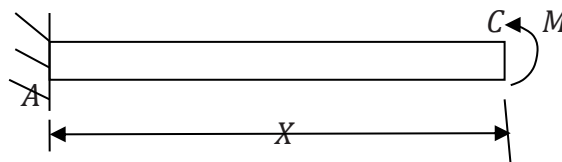


Fig: horizontal shaft under bending force

$$F_A + F_B = 2611\text{N}$$

The force is applied at the centre.

$$F_A = F_B = 2611\text{N}/2 = 1305.5\text{N}$$



For $0 \leq X \leq 45\text{cm}$.

Summation of bending movement at point c=0.

$$M = F_A X$$

The bending movement is maximum at $X = 45\text{cm}$

$$\text{Bending movement} = 0.45 \times 1305.5 = 587.5\text{Nm}$$

$$\text{Bending stress} = M/z ; z = \pi d^3/32$$

$$\text{Ultimate bending stress} = 250\text{Mpa}$$

$$\text{Factor of safety} = 2 . \quad d = 40\text{mm}$$

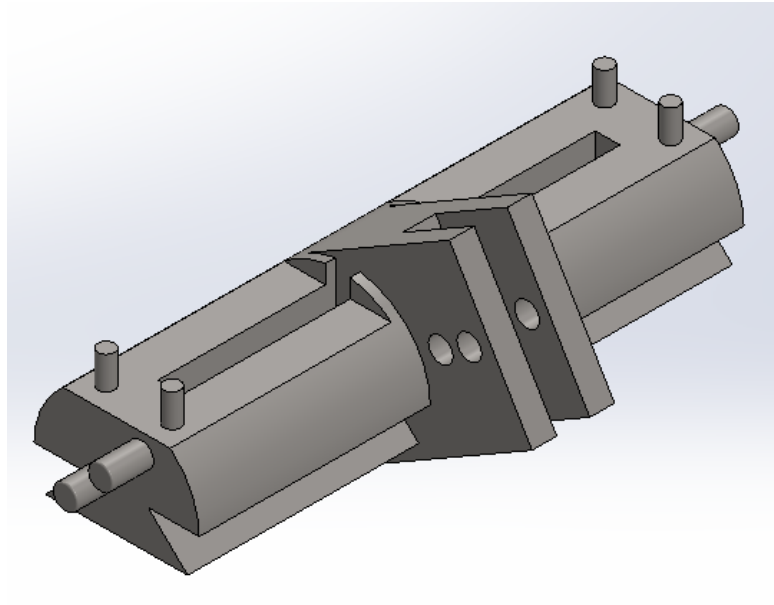


Figure 16: horizontal shaft.

4. Manufacturing process and assembly.

The knowledge of manufacturing processes is of great importance for a design engineer. The following are the various manufacturing processes used in Mechanical Engineering. The materials used and geometries of each component are available from the analysis. the raw materials bought from the market are cutted, bended, shaped, welded, polished etc to get the desired shape. We use different machines and tools to fabricate a proto type of manually operated seed cum fertilizer drill for maize. Lathe machine and drill machines are used to fabricate the machine component hopper and also use different cutters to cut different machine components which are power hacksaw, and cutter machines and we use welding and grinding machines for all components of the machine, those machines and tools which are used in fabrication are listed in a given table below.

Table 2: Machines and tools used for Manufacturing.

No	Machines and tools Used For Manufacturing
1	Bending Machine
2	Lathe machine
3	Drilling machine
4	Welding machine
5	Cutters
6	Grinder
7	Drill beat
8	Electrode
9	Power hacksaw
10	Paint

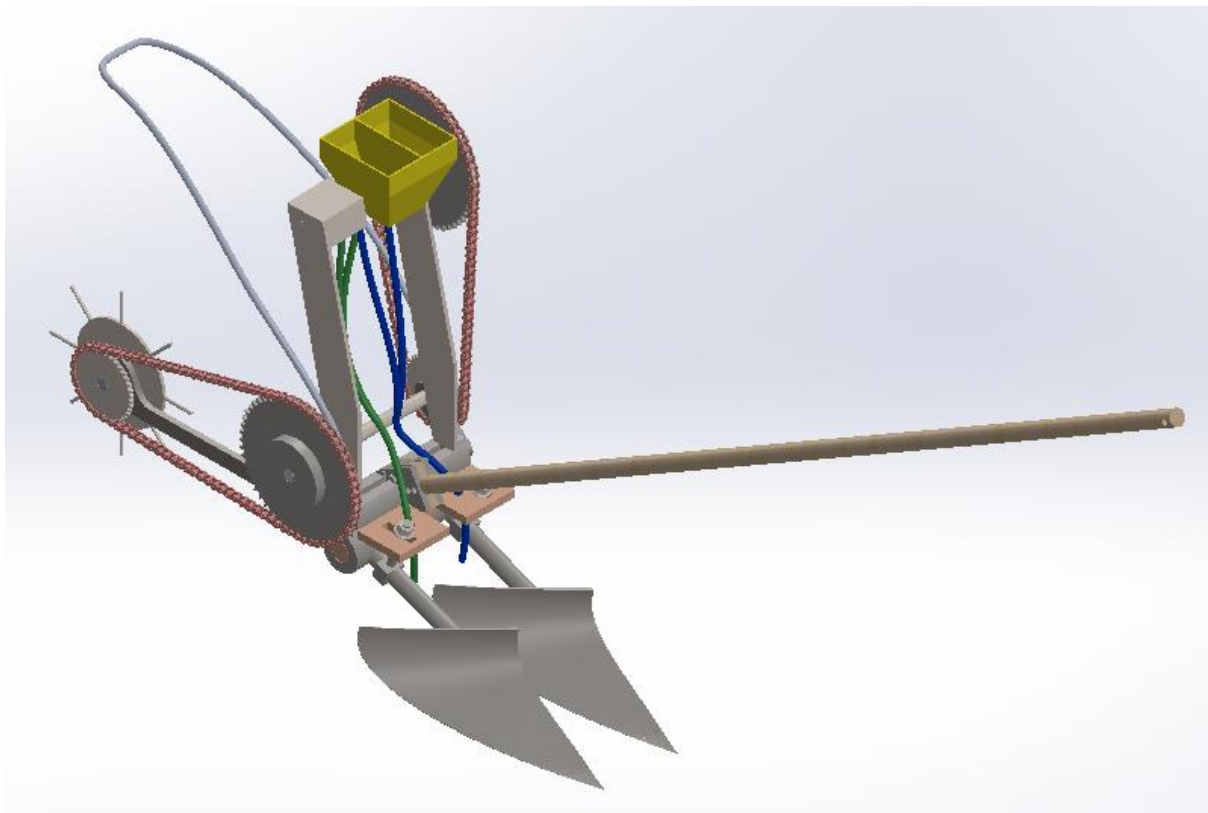


Figure 17: isometric and side view of assembly.

5. Cost analysis

1. Share. Material: mild steel

We need 25cmx25cm mild steel cross sectional area which has a thickness of 3mm.

1meter=760 birr. Cost of share = $0.25 \times 760 = 190$ birr

2. Beam (mofer): we need 3.25m length with internal and external diameter of 8cm and 9cm.

1 meter=31birr, cost of beam (mofer) = $3.25 \times 31 = 102$ birr

3. Seed and fertilizer bucket: 100cmx30cm sheet rigid pvl with a thickness of 4mm is required.at this thickness from standard market

Cost of bucket= $0.3 \times 320 = 96$ birr

4. Seed and fertilizer cum is also rigid plastic; cost=60 birr.

By so doing the cost is presented as follows.

Table 3: material and manufacturing cost.

NO		COST	
		Material cost(birr)	Machine cost(birr)
1	Share	190	70
2	Beam	102	25
3	Bucket	96	68
4	Seed and fertilizer cum	60	33
5	Ground wheel	83	120
6	Handle	45	25
7	Ground and seed cum shaft	102	100
8	Chain and sprocket	485	-
9	Screw and nut	25	50
10	4 Seed and fertilizer tube	24	-

11	Frame	120	120
	Total	1334	611

The total cost of materials and machining is 1945 birr.

Labor cost: 2 persons is able to finish the manufacturing and assembly process in one days.1 person works 8 hours and gets 200 birr per day.

Labor force = $1 \times 2 \times 200 = 400$ birr.

The total cost of this tillage and sowing machine is the sum of materials, machining and labor costs i.e. $1945 \text{ birr} + 400 \text{ birr} = 2345 \text{ Birr}$.

6. Result

The results obtained from calculations are presented as follows.

Table 4: result of analysis.

no	Parameters	value
1	Transmission ratio	0.25
2	No of teeth on smaller and larger sprocket	27 and 54
3	Pitch of sprocket	19.05mm
4	Center distance b/n sprocket	567.5mm
5	Thickness of the beam	10mm
6	Share setting angle	30
7	Depth of share	20cm
8	Horizontal draft	202.68kgf
9	Vertical draft	117.04kgf
10	Draw bar efficiency	60
11	angle of inversion of soil	180
12	Shape of furrow	Half U shape
13	Field capacity	0.0438ha/hr
14	Efficiency	80
15	Effective Field capacity	0.06908ha/hr
16	Volume of soil cut per day	$1.38924 \times 10^{10} \text{ cm}^3$

7. Conclusion

Multipurpose oxen driven seed and fertilizer sowing tillage machine is manufactured from locally available materials. And we believe this machine works very well which have a slop of less than 20 degree and non-stony fields. It able to reduce farmer's time by half compared to indigenous plow. The half u shape furrow also important in that there will not have unplowed land in between the furrow (it reduce cross plowing). Inversion angle of the soil is 180 shows that weeds are buried down in the soil (amount of weed reduced) compared to indigenous one.

8. Recommendation

We recommend to anybody of who is interested to works on this project.

- Reduce the dead weight of the component.
- Find ways which works above 20 degree sloppy fields.
- Design the yoke which suits to the oxen.

9. Reference

1. Aphale, A., N. Bolander, J. Park, L. Shaw, J. Svek and C. Wassgren (2003). Granular fertiliser particle dynamics on and off a spinner spreader. *Biosystems Engineering*, 85(3):319-329
2. Ball, B. C. (1986). Cereal production with broadcast seed and reduced tillage: a review of recent experimental and farming experience. *J. Agri. Eng. Res.* 35(2), 71-95
3. Hofstee, J.W. (1995). Handling and spreading of fertilizers: Part 5, the spinning disc type fertiliser spreader. *J. Agric. Engng. Res.* 62: 143-162
4. R.S. Kmurmi and J.K. Gupta (2005). A text book of machine design. S.I.(Metric) ed. Ram Nagar, New Delhi
5. Shigley, J.E (2011). *Mechanical Engineering Design*. Nine edition. McGraw-Hill. Newyork, USA
6. Mehta and Varshney (1970). Three row bullock-drawn-fertilizer drill for wheat crop.
7. Srivastava and Dubey (1985). Two row planter seed-cum-fertilizer drill.
8. Surendra Singh et al., (1985). Two row ridge planter for maize.

10.Appendix

10.1. Part drawing

10.2. Assembly drawing