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The Design and Fabrication of a Manually Operated Single Row Multi - Crops Planter.

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Abstract: *Manual method of seed planting, results in low seed placement, spacing efficiencies and serious back ache for the farmer which limits the size of field that can be planted. The cost price of imported planters has gone beyond the purchasing power of most of our farmers. Peasant farmers can do much to increase food production especially grains, if drudgery can be reduced or totally removed from their planting operations. To achieve the best performance from a seed planter, the above limits are to be optimized by proper design and selection of the components required on the machine to suit the needs of crops. This project work focused on the design and fabrication of a manually operated planter sowing for different crop seed that is cheap, easily affordable by the rural farmers, easy to maintain and less laborious to use. The multi-crop planter has the capability of delivering the seeds precisely with uniform depth in the furrow, and also with uniform spacing between the seeds .The seed planter consist of the main frame, adjustable handle, seed hopper, seed metering device, adjustable furrow opener, adjustable furrow closer, drive wheels, seed tube and ball bearings. Most of these were fabricated from mild steel material, except for the metering mechanism which was made from good quality nylon and the seed funnel tube, was made from rubber material. Seed metering device was designed to be interchangeable to allow for the different varieties and types of seeds. The single-row manually operated multi-crop planter is very simple to use, the various adjustments are made with ease, and it is maintenance free, except for the bearings which needs to be lubricated from time to time to allow the planter's ground wheel to move freely.*
Key Words: *Farm mechanization, Planters, furrow opener, Seed metering device, chain drive system.*

I. Introduction

A developing country like India is expected to continue to rely more on hand tools for the foreseeable future for cultivation. The use of hand tools for land cultivation is still predominant in India because draft animals and tractors require resources that many Indian farmers do not have easy access to. The need for agricultural mechanization in India must therefore be assessed with a deeper understanding of the small holder farmer's activities and what values farm power generated for them [1].

As our population continues to increase, it is necessary that we must produce more food, but this can only be achieved through some level of mechanization. Manual method of seed planting, results in low seed placement, spacing efficiencies and serious back ache for the farmer which limits the size of field that can be planted. However, planting machine or planter that is normally required to produce more food is beyond the buying capacity of small holder farmers [1].

These small holder farmers still continue to plant manually, the result of which is low productivity of the crops. It is therefore necessary to develop a low cost planter that will reduce tedium and drudgery and enable small holder farmer to produce more foods and also environmental friendly[1,4,6].

In the past, various types of design have been developed with different design approaches which have their advantages and disadvantages and also operational limitations. Klocke (1979) described the building of two experimental planters, one using a smooth coulter and the other a ripple edged coulter. Both types of coulters were followed by hoe openers. The performance of the drills was satisfactory as long as the seed was placed into adequate soil moisture. Kumar et, at. (1986) developed a manually operated seeding attachment for an animal drawn cultivator. The seed rate was 43.2 kg/hr while the field capacity was 0.282 ha/hr. Tests showed minimal seed damage with good performance for wheat and barley. Adisa and Braide(2012) developed template row crop planter [2,7,9].

Bamgboye and Mofolasayo (2006) developed a manually operated two-row Okra planter. The field efficiency and field capacity were 71.75% and 0.36 ha/hr while seed rate was 0.36kg/hr with low average seed damage of 3.51%. Gupta and Herwanto (1992) designed and fabricate a direct paddy seeder to match a two-wheel tractor. The machine had a field capacity of about 0.5 ha/hr at a forward speed of 0.81mls, and there was no damage caused by the metering mechanism for soaked seeds; though 3% damage was recorded for pregerminated seeds. Molin and D' Agostin (1996) developed a rolling planter for stony conditions, using 12 spades radially arranged with cam activated doors and a plate seed meter. Performance evaluation showed important improvement in the planting operation with reduction in human effort, more accurate stands and high field capacity. Ladeinde and Verma (1994) compared the performance of three different models of Jab planters with the traditional method of planting. In terms of field capacity and labour requirement, there was not much difference between the traditional planting method and the Jab planters. However, backache and fatigue were substantially reduced while using the planters [2,5,8,10].

Hand-pushed and Transnational Journal of Science and Technology August 2012 edition volume2, No.728 tractor mounted row seeders (usually single and multiple row).Normally requires a well prepared seed-bed which may be ridged or flat bed [11].

The single and double row planters developed at the University of Southern Mindanao Agricultural Research Center (USMARC) can plant a hectare within 6-8 hours for single-row and half so much time for double-row. A disc type maize seeder developed which is simple in design and can be handily operated with ease and comfort [12]. This is a labor intensive and time consuming process. Lara-Lopez [13] developed a single-row direct planter for maize. The planter may be attached to a walking or riding type two-wheel tractor. Singh [3] designed and developed a two-row tractor drawn ridge planter for winter maize. Bamgboye and Mofolasayo [14] tested a manually operated two row okra planter developed from locally available materials. The planter had a field capacity of 0.36 ha/h with a field efficiency close to 72%.

In this paper we are designing of an advanced manual operated multi-crop seed planters, their utilization methods advantages, disadvantages and the process involving to design and fabrication of these planters for the purpose of utilization of poor farmers.

II. Methodology

The basic objective of sowing operation is to put the seed and fertilizer in rows at desired depth and seed to seed spacing, cover the seeds with soil and provide proper compaction over the seed. The recommended seed to seed spacing and depth of seed placement vary from crop to crop and for different agro-climate conditions to achieve optimum yields [1].

But many mechanical factors, which affect seed germination and emergence, are [1, 15,16]:

a) Uniformity of depth of placement of seed.
b) Uniformity of distribution of seed along rows.
c) Transverse displacement of seed from the row.
d) Prevention of loose soil getting under the seed.
e) Uniformity of soil covers over the seed.
f) Mixing of fertilizer with seed during placement in the furrow.

Crop planting operations may involve placing seeds or tubers (such as potatoes) in the soil at a predetermined depth, random scattering or dropping of seeds on the surface (broadcasting), or setting plants in the soil (transplanting). Machines that place the seed in the soil and cover it in the same operation create definite rows. If the rows or planting beds are spaced far enough apart to permit operating ground-engaging tools or other machinery between them for inter tilling or other cultural operations, the resulting practice is called row-crop planting; otherwise, it is considered to be solid planting. Thus, grain drilled in rows 15 to 36 cm (6 to 14 in) apart is a solid planting, whereas sugar beets, with rows commonly 51 cm (20 in) apart, are grown as a row crop [16,17]. With appropriate planting equipment, seeds may be distributed according to any of the following methods or patterns:

a) Broadcasting (random scattering of seeds over the surface of the field);
b) Drill seeding (random dropping and covering of seeds in furrows to give definite rows);
c) Precision planting (accurate placing of single seeds at about equal intervals in rows);
d) Hill dropping (placing groups of seeds at about equal intervals in rows).
   Solid planting is generally done by one of the first two methods, whereas row-crop planting may involve any of the methods except broadcasting. With the exception of broadcasters, a seed planter is required to perform all of the following mechanical functions[1, 18,19];

a) Meter the seed;
b) Deposit the seed in an acceptable pattern;
c) Cover the seed and compact the soil around the seed to prevent rapid loss of moisture from the soil around the seed;
d) Should neither damage the seed nor affect germination, that is, the seed should be placed in the soil in such a manner that all the factors affecting germination and emergence will be as favorable as possible;

e) Since timeliness is of extrejne importance in the majority of planting operations, it is desirable that a planter be able to perform these functions accurately at fairly high rates of speed; and

f) Uniform soil penetration.

In addition to the above, a conservation tillage planter must meet the following requirements [1,20,34]:

a) Sufficient tilling of the seed zone to obtain good seed-soil contact;

b) Ability to follow the contour;

c) Ability to roll over obstacles without machine stoppage or damage; and

d) No clogging due to residue or soil.

III. Description, Design Analysis, And Material Selection

In this section we are going to discuss about the design and fabricate a manually operated multi crop planter sowing for different crop seed. Since most of our farmers especially in the rural areas and or small scale farmers use dibbler, matchet or sticks to sow different seeds. This dibbler, matchet or sticks is used to open the soil as the farmer drops the required numbers of seed (often times more than they require numbers are dropped) and then covers them up.

4.1 Description of the manually operated single row multicrop planter.

The developed a manually operated single row planter sowing for different crop seed consists of the adjustable handles, seed hopper, adjustable furrow opener, transport wheels, seed discharge tube, Furrow covering device, and seed metering wheel housing, adjustable row marker, chain and sprocket, idler sprocket and stand which are explain below:

Table 1: Tools and materials used in the Fabrication

S. No.	Machine/Tool name	Purpose
1	**Stellram hard core drills machine**	Hole/Cell making
2	**Lathe machine**	Threading/Cutting/Finishing/Cutting/Shaping /Machining.
3	**Grinding machine**	Grinding/Cutting tool
4	**Cutting blade**	Cut flat bar
5	**Manual Facing Lathe Machine**	Making circular wheel
6	**Round file**	Smooth rough edges
7	**Electric welding machine**	Welding
8	**Steel scale**	Measurement of linear distance
9	**Steel tape**	Measurement of linear distance
10	**Vernier calipers**	Measurement of outer diameter and inner diameter
11	**Centre punch**	Hole Marking
12	**Choke**	Marking
13	**Hammer**	Used to strike an object
14	**Chisel**	Cutting
15	**Scissors**	Cutting sheet metal
16	**Vice**	Clamping or holding
17	**Spanner**	Tighting nut and bolt
18	**Screw driver**	Tighting screw
19	**Hand grinder**	Grinding metal sheet
20	**Flat file**	Smooth rough edges

a) Main Frame

The main frame is the skeletal structure of the seed planter on which all other components are mounted. The two design factors considered in the determination of the material required for the frame are the weight and strength. In this work, mild steel angle bar of 40 mm x 40 mm and 5mm thickness were used to give the required rigidity.

Table 2: Specification of manually operated precision planter for different seed metering wheel.[1]

Name of the component	No of items	Dimension (mm)	Material
Frame	1	Length- 844,Width-119	M.S.Flat bar
Adjustable handle	1	Length – 895, Pipe dia – 20	M.S.Flat bar & Circular pipe
Seed hopper	1	Height – 270,Width – 223	M.S.Sheet metal
Seed metering wheel shaft	1	Length- 207, Dia – 12.2	Medium carbon steel
Seed metering device (wheel type)	5	Dia-102	Nylone
Seed metering house	1	Dia-109, Length-118	Cast iron
Adjustable furrow opener	1	60× 5	M.S. Flat bar
Adjustable furrow closer	1	Length- 80, Width-70	M.S. Sheet metal
Adjustable row marker	1	Length- 400-900	M.S.Flat bar
Parking stand	1	Length – 245	M.S rod
Rear wheel	1	Dia- 275	Plastic & Sheet metal
Front wheel	1	Dia- 330	Plastic & Sheet metal
Lugs	12	Length-84, Height-28	M.S.Flat bar
Large sprocket	1	No of teeth-48 & Dia-190	Medium carbon steel
Small sprocket	1	No of teeth-18 & Dia-78	Medium carbon steel
Pintel chain	1	No of links-102	Malleable links
Seed tube	1	Length-300, Dia-75	Plastic
Ball bearing	2	Dia- 35	Bronze
Idler sprocket	1	No of teeth-18 & Dia-78	Medium carbon steel
Nut bolts	20		Low carbon steel
Total weight	Approximate 20 kg		

b) Adjustable handles

The adjustable handles consist of two mild steel flat bar each of 895 mm long fastened to the frame at two ends of the flat bar. One pipe of 20 mm external diameter attached at the end of mild steel flat bar.

c) Seed hopper

The seed hopper was made of mild steel having a frustration cross-section of a pyramid of 75mm square at the bottom, 214mm square at the top and 300mm height. The design capacity of the seep hopper is 1,750,000 mm3. The capacity is based on the volume of seeds required to plant a hectare of field.

d) Seed Metering Mechanism

Metering mechanism is the heart of sowing machine and its function is to distribute seeds uniformly at the desired application rates [6]. In planters it also controls seed spacing in a row. A seed planter may be required to drop the seeds at rates varying across wide range [6]. Proper design of the metering device is an essential element for satisfactory performance of the seed planter. The seed metering device was made by nylon and it have many cells on its periphery. The size and number of cells on the seed metering device depends on the size of seed and desired seed spacing. In this design, the seed metering wheel lifts the seeds from the hopper in the cells and drops these into the seed funnel which is conveyed to the open furrow through the seed tube. For varying the seed rate and sowing different seeds, four separate metering wheels were provided. The number of cells on the seed metering wheel may be obtained from the following expression [27,32]:

$$Number\ of\ cells = \frac{\pi \times Diameter\ \ of\ plante\ r'sground\ \ wheel}{Gear\ ratio\ \times Intra\ row\ spacing\ \ of\ seeds} \quad (1)$$

e) Adjustable type furrow opener

The design of furrow openers of seed planters varies to suit the soil conditions of particular region. Most seed planters are provided with pointed tool to form a narrow slit in the soil for seed deposition. The adjustable furrow opener permits planting at each variety's ideal ground depth. The type used for this work is the pointed bar type. These types of furrow openers are used for forming narrow slit under heavy soils for placement of seeds at medium depths. The Furrow opener is a thin mild steel (angle bar). The angle bar iron was fabricated to shoe type like structure to facilitate an easy cut through the soil. Nut and both were used to fasten the device to the frame through a hole drilled on the frame for adjusting sowing depth according to crop.

f) Adjustable Furrow Closer

The furrow closer was also designed to be adjustable. The type used for this design is the shoe type furrow closer. It was designed to allow for proper covering and compaction of the soil over the seeds in the furrows.

g) Transport wheels

Two transport wheels are made of mild steel. The front wheels have many numbers of lugs on its periphery which increase traction and reduction slip. The front wheel have small sprocket transfer the power to seed metering wheel shaft sprocket with the help of chain, in such a way seed metering wheel rotate, seed was singulated into the cell and dropped into the planting shoe/ground opener with the help of seed discharge tube that deposits the seed in the soil. The wheels are located at both ends of the frame. They are circular in shape containing periphery width 75mm which reduce side thrust and 1 inch square pipes which serves as spokes. These spokes are used to support the centre bushing or hub. The spokes are arranged in such a way that it braced the wheels circular circumference and also gives it necessary radial support. Material used for the design was a combination of both 1 inch mild steel square pipes and 3.5mm thick mild steel flat bars.

h) Seed tube

The seed tube is made of rubber hose pipe 30mm diameter and 300 mm long. Two holes of 75mm diameter each were made at the metering housing at the lower and upper part of the metering housing. Seeds picked from the hoppers pass through the upper hole at the slide of the castellated metering mechanism to the lower hole. Into the discharge tube which deposits the seeds at desired uniform spacing into the opened furrow.

i) Bearing Selection

Bearings are selected based on their load carrying capacity, life expectancy and reliability. Ball bearings are fixed in the bushing provided at the two ends of the frame in other to support the eccentric shaft on which the wheels are attached. They allow the carrying of an impressive load without wear and tear and with reduced friction. This device ensures the smooth operation of the wheels. The material for the bearing is high speed steel.

j) Furrow covering device

The Furrow covering device is made of rectangular mild steel plate of dimension 80mm $\times$120mm. It was fastened with nut and bolt to the frame through a hole drilled on the frame. The Furrow covering device is perpendicular to the direction of travel of the machine to facilitate proper covering of the soil.

k) Seed metering wheel house

The seed metering house was constructed from mild steel of 102mm internal diameter and 118mm long. Two slots of 75mm were made at the upper and lower portions on the metering housing. Seeds from the hoppers pass through the lower slot to the castellated metering mechanism to the lower hole, into the discharge tube.

l) Row marker

The function of the planter row marker is help to the operator maintain a more accurate or constant accurate row spacing. A constant crop row spacing will make for simpler and more effective cultivation especially when cultivating between row. Before planting of any type crop, consideration should be given to the subsequent cultivation operation. It was made of plated steel 33.5" long.

m) Chain and sprocket

Power transmission is done by the gear sprocket and pintel chain. When push the planter front wheel rotate then small sprocket of front wheel rotate and transfer the power to seed metering wheel shaft sprocket with the help of chain, in such a way seed metering wheel rotate, seed was singulated into the cell and dropped into the planting shoe/ground opener with the help of seed discharge tube that deposits the seed in the soil. The number of teeth in small gear sprocket and large gear sprocket was 18 and 48 respectively.

n) Idler gear sprocket

Idler sprockets should not rotate at greater speeds than are allowable for drive sprockets of the same size. They should be mounted in contact with the "slack" span of chain, whenever possible. Mount them on the outside of the chain when the arc of chain wrap on the smaller sprocket would otherwise be less than 120°. It is advisable that idler sprockets have at least three teeth in mesh with the chain. Inside mounted idlers usually account for quieter operation, especially if centers are short and speed is moderately high.

Adjustable idler sprockets are used to:

- Obtain proper chain tension when neither driving nor driven shaft is adjustable.
- Guide chain around an obstruction.
- Prevent whipping action in the slack span of chain transmitting an uneven load.
- Bring about greater chain wrap around a small sprocket, particularly if it is the lower sprocket in a vertical drive.
- Take up slack chain caused by normal chain wear.
- Provide for reversed direction of rotation of a sprocket in contact with the outside of the chain.

O) Stand

When any farmer completes the work in the field or he tired then that time stand is necessary for stand the planter for taking rest. It made by mild steel solid rod 250 mm in length and 10mm diameter.

4.2 Design Considerations

The design of manually operated planter for sowing different seed crop is based on the following considerations [28,29].

- The ease of fabrication of component parts.
- The safety of the operator
- The operation of the machine should be simple for small scale or rural farmers.
- The materials available locally were used in the fabrication of the components.
- Availability and cost of the materials for construction.

4.3 Power developed by the operator of machine

According to Campbell (1990), power of useful work done by an average human on the drive machine is given by [35]:

$$HP = 0.35 - 0.092\, log\, t \qquad (2)$$

Where, t is the operation time in minutes.

Now, on average a human can work on the field 2-4 hour continuous. So power developed by the operator is 0.13 – 0.16 hp. Now if we take working time three hours then the power developed by a human is 0.14 hp.

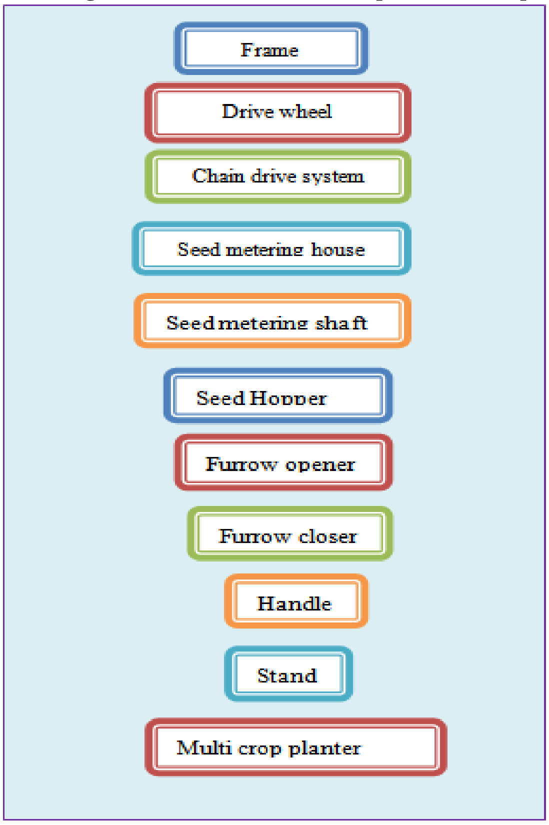

Figure 1: Flow chart of design process of single row manually operated multicrop planter

Now we know that developed power by a chain drive is [35]:

$$HP = \frac{Push\ force\ (kgf) \times Speedof\ machine\ (m/s)}{75} \qquad (3)$$

The operating speed of the machine is 2.5 km/h (0.7 m/s)

SoPush force from equation (3) 15 kgf.

From other equation of drive machine as given below [35]

$$HP = \frac{2 \times \pi \times N_w \times T_w}{4500} \qquad (4)$$

Where N_w is the speed of ground wheel in RPM while T_w is the torque on the wheel. Since the speed of the machine is 2.5 km/h.

$$N_w = \frac{speed\ of\ machine\ in\ m/s \times 100}{\pi \times 60} \qquad (5)$$

And torque on the each wheel is

$$T_w = K_w \times W_t \times R_w \qquad (6)$$

Where Kw is the coefficient of rolling resistance (0.3 for the metallic wheel) and Wt is the active weight of the machine (20 Kg approx) and Rw is the radius of ground wheel (16.5 cm).

4.4 Determination of maximum bending moment on the shaft

We know that the power is transfer to the machine by the chain drive system so for the measurement of the bending moment of the shaft or machine is measured by the theorem of the chain drive system. So load on the chain or chain load (Q) is[36]:

$$Q = K_l \times P_t\ kgf \qquad (7)$$

Where K_l is the coefficient of chain (1.15 for the mild steel) and P_t is the push force of the chain.

Now chain drive is working at an angle φ (35^0) with the horizontal

Therefore equivalent chain load on the machine is

$$Q_v = Q\ sin\varphi \qquad (8)$$

Now Maximum bending moment on the shaft given by the chain drive system

$$Mb = (Weight\ on\ wheel \times overhung) + (Qv \times overhung) \qquad (9)$$

Assume that overhung of wheel = 15 cm and so that the Overhung of sprocket = 5 cm.

Hence;

Equivalent bending moment $= \sqrt{(M_{b^2} + M_{t^2})}$ (10)

Where

$$M_t = T_W \qquad (11)$$

Allowable shear stress = (τ_s) = in shaft is 600 kg/cm^2

$$M_{eq} = \frac{\pi}{16} d^3\, \tau_s \qquad (12)$$

So from the equation (12) the diameter of the shaft of the machine is:

$$d^3 = \frac{16}{\pi \tau_s}\, M_{eq} \qquad (13)$$

Where

d = diameter of shaft in cm.

4.5 Design of the size of the planter

For the design of the planter, first of all we design the number of furrow opener for the sowing of the seeds. So Number of furrow opener in the planter [23,24]

$$(Z) = \frac{draft\ of\ planter\ (D) kgf}{draft\ of\ each\ row\ (d_r)} \qquad (14)$$

Now the working width of the machine (W) = Z × row to row distance (depend on types of crop (15)

4.6 Design of seed hopper

Volume of seed hopper $V_b = 1.1 \times V_s$ (16)

Volume of seed $V_s = \frac{\text{Weight of seed in the box } (W_s)g}{\text{Bulk density of the seed } (\gamma_s)g/cm^3}$ (17)

Now from the structure of seed hopper
$(V_b) = V_a + V_b$ (18)

4.7 Design of seed metering device
For the design of the seed metering device the most important thing is that how many cells would be developed for desired crop; so that the requirement of the plant to plant spacing is achieved. So
Number of cell on the seed metering device is
$Ns = \frac{\pi \times \text{diameter of drive wheel } (d_w)}{\text{drive ratio } (N) \times \text{plant spacing } (X)}$ (19)
Now the second thing is that what would be the diameter of the seed metering device. So the diameter of the seed metering device is:
$D_m(cm) = \frac{V_r}{\pi N_r}$ (20)
$V_r =$ Peripheral velocity of seed metering device in m/min
$N_r =$ rpm of seed metering device.

4.8 Design of power transmission system
Since a power (HP) transmitted in manual seed planter is very low. So, for the amplification of the power for desired power requirement of seed metering device, we apply a chain sprocket system which have two chain sprockets (small sprocket have 18 teeth and large sprockets have 48 teeth). The chain length is calculated by the following equation[2]
$m = \frac{2C}{p} + (\frac{Z_1+Z_2}{2}) + \frac{(Z_2-Z_1)^2}{2\pi p}$ (21)
Where m is the number of chain links and C is the centre to centre distance between two sprocket in millimeter, p is the chain pitch in mm and Z1 an Z2 are the number of teeth in the driver sprocket and driven sprocket respectively.

4.9 Design of handle of the planter
The adjustable handles of the planter was designed to be adjustable for the different height of person male/female which can adjust according to own height which reduced drudgery. The adjustable handle helps the operator to push the planter at the time of operation [2]. The materials was used for adjustable handle was a combination of two mild steel flat bar fastened to the frame and mild steel circular pipe.
Length of the handle is calculated based on average standing elbow height of female operator. So, the average standing elbow height of women workers is the 100cm.
Distance of wheel centre from the operator (for operator height of 95-105 cm) in operating condition is the 115 cm. therefore angle of inclination.
So, the angle of inclination (θ_h) with the horizontal is
$\tan\theta_h = \frac{a_1}{a_2}$ (22)
Where a_1 is the height of centre of wheel to the elbow and a_2 is the horizontal distance between the normal to the centre of wheel and normal to the elbow line.

4.10 Design of the furrow opener
Considering lower push/pull available and easy operation of the planter is selected for the planter. The furrow opener includes:

- Selection of standard (tyne)
- Furrow opening portion

For the selection of standard (tyne) the draft force on furrow opener is F kgf/tyne and acting at a height of h/3 from the bottom of the furrow opener where the h is a total length of furrow opener and tyne.[2]
Moment arm length= (h-a) (23)
Where a=h/3 (24)
Bending moment in tyne = D (h-a) (25)
Therefore maximum bending moment in tyne= B.M.×F.O.S. (26)
Where B.M.=bending moment and FOS= factor of safety(=2)
Section modulus of tyne $f_b = 56\ N/mm^2$ for mild steel
$Z_t = \frac{M_b}{f_b}$ (27)

$Z_t = (1/6)tb^2$ (28)

4.11 Determination of Planter Capacity

The capacity of the planter may be determined in terms of the area of land covered per time during planting or the number of seeds planted per time of planting. The capacity of the planter in terms of the area of land covered per time may be obtained from the following expression:

$C_{PA} = \frac{\text{Area covered by planter}}{1000}$ (hectare/time) (29)

C_{PA} = Capacity of planter in hectare/time

The capacity of the planter in terms of number of seeds planted per time may be obtained from the following expression:

$C_{NP} = \frac{\text{Distance covered by planter per time}}{\text{Intera row spacing}} \times \text{No.of seeds per hole}$ (seeds/time)

(30)

4.12 Time required cultivate a hectare of land

The time required to cultivate of one hectare of land is therefore obtain from following equation:

Time required =1/C_{PA} (31)

4.13 Number of days required to plant on a hectare of land

Assuming 8hrs is used per day for planting, the number of days required to plant on 1 hectare of land is obtained as follows

Number of days required =time required to cultivate of one hectare of land (hrs) /no. of hours worked per day (32)

IV. Fabrication Of The Machine

As shown in Figure 3, all the parts of the multi-crop planter were fabricated in Farm Machinery and Power Engineering laboratory, SHIATS Allahabad. All the parts of the multi-crop planter were fabricated from mild steel material, the seed funnel which was made from rubber material, and the seed tube which was also made from rubber material. The choice of rubber material for the seed funnel and seed tube was because the coefficient of restitution for rubber material is lower than that of a mild steel sheet of the same thickness. The rubber material will go a long way in minimizing seed bouncing, thereby protecting the seeds from damage due to impact. The hopper was fabricated using 2mm thick mild steel metal sheet. The metering mechanism was fabricated from good quality nylon and fiber.

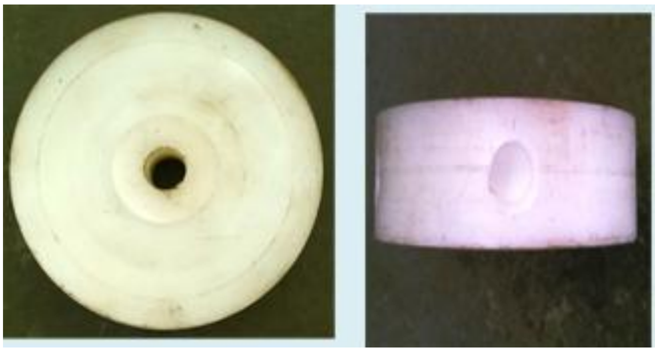

Figure 3: Manually operated multicrop planter

The main frame which supports every other component of the multi-crop planter was fabricated using mild steel flat bar of length of 84.4cm and width of 12cm. The adjustable handle for the planter was fabricated using a combination of 1 inch mild steel circular pipe, and 1 inch mild steel angle bar. The adjustable furrow opener and furrow closer were both fabricated using a 60mm x 5mm mild steel flat bar. The planter's ground wheels were fabricated using a combination of both 1 inch mild steel square pipes and 3mm thick mild steel flat bars. Furrow opener and closer were designed to be interchangeable. For this design, the drive shaft directly controls the seed metering mechanism which eliminates completely attachments with chain drive system which increase cost, and increasing efficiency at a highly reduced cost.
Figure 4 shows the diagram of the seed planter indicating necessary dimensions

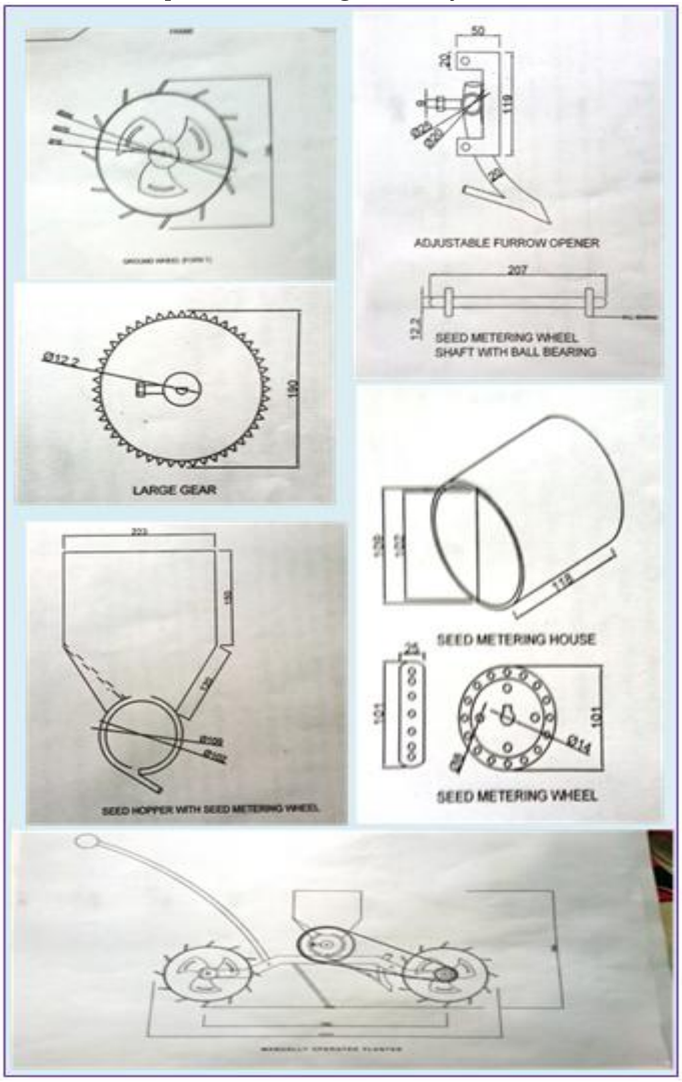

Figure 4: Diagram of the seed planter indicating necessary dimensions

V. Conclusions

The need of a poor and small land farmer has fulfilled by the manual operated seed planter and they can easily and effectively plants their seed in the field by these planters. But due to different crops have different requirement for the seed planting in the field. So the usefulness of the single crop planter is limited. Hence the requirement of the manually operated multi-crop planter is very high.

This work focused on the design and fabrication of a manually operated single-row multi-crop planter that is cheap, easily affordable, easy to maintain and less laborious to use. The planter will go a long way in making farming more attractive and increasing agricultural output. All parts of the planter were fabricated from mild steel material, except for the metering mechanism which was made from good quality nylon and the seed funnel and tube, which were made from rubber material. The seed metering mechanism used for this work was the nylon wheel type with cells on its periphery. For this design, the drive shaft directly controls the seed metering mechanism which eliminates completely attachments power transmission system thereby eliminating complexities which increase cost, and increasing efficiency at a highly reduced cost.

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