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Designing of Small Powered Self Propelled Inclined Plate Planter

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A B S T R A C T

The project was taken to find out the designing parameters of the planter and the machine component for small power engine. In designing, engineering parameters like draft of the planter, working width, seed box capacity, number of furrow openers, power requirement and the engineering views were drawn. Based on the designing parameter and CAD component of the planter it is possible to develop the planter for the sowing of crops. The objective of the research papers is to design inclined plate planter and to draw the various engineering drawing views of the inclined plate planter.

Introduction

The planting operation is one of the most important cultivation practices associated with crop production. Increases in crop yield, cropping reliability, cropping frequency and crop returns all depend on the uniform and timely establishment of optimum plant populations. There are two broad areas in optimizing plant establishment. First, plant breeders, seed growers and seed merchants have a responsibility to provide quality seed. Second, farm managers must be aware of the agronomic requirements for optimum plant establishment and be able to interpret this information in a meaningful way so as to assist with the selection, setting and management of all farm machinery, especially planters. The multi seed drill/planter is the emerging concept which attributes in multi crop seed sowing with the fertilizer attachment. The establishment of crop in a soil is very important for the sustainable yield. The timeliness in precision sowing have greatly affect on yield and net income of the farmers.

Materials and Methods

Design of self-propelled inclined plate planter

This planter is used for intercultural operation on which planting mechanism is mounted. The planting mechanism consists of vertical plate with spoons, and receives drive motion from the ground wheel through chain and sprockets. The seed planter is sophisticated

sowing equipment which is normally used for those seeds which are larger in size and cannot be planted by usual seed drills. It maintains rows as well as hills distance during planting if the crops and thus the following function;

To open the furrow.

To mater the seed.

To deposit the seeds in group in the furrow.

To cover the seed and compact the soil over it.

Design procedure

Assumptions required for the design
Speed of operation
Type of seed grain
Seed rate
Row to row distance
Plant to plant distance
Bulk density of seed
Draft requirement
Angle of repose
Drawbar horsepower
Type of soil

We know that, drawbar horsepower (DBHP) is equal to 60% of BHP.

$$DBHP = \frac{Draft(kg) \times Speed(\frac{km}{hr})}{270}$$

$$Draft\ available\ for\ sowing = \frac{DBHP \times 270}{Speed\ of\ sowing}$$

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$$Draft\ available\ for\ sowing = \frac{DBHP \times 270}{Speed\ of\ sowing}$$

Draft requirement per meter width of planter is equal to 130 kg

$$Thereore, width\ of\ planter = \frac{Draft\ avilable\ for\ sowing}{Draft\ requrment\ width\ of\ palnter}$$

But designing 1.52meter wide planter will have buckling effect and we also create problem in transportation and handling. Therefore latest design a planter with 3 furrow openers having 22cm spacing between the furrow openers, as mostly the planter is used for sowing cereal crops.

Therefore, working width of planter = No. of furrow openers x spacing

Design of seed box

The seed box may be of MS sheet. The length of box is given by,

L_b = working width of planter – 2b

Where,

L_b = Length of box, cm

b = Distance between the side box and ground wheel.

Among the seeds used for sowing by the planter, maximum seed rate in kg and the planter may be designed for the seed application rate of 100 kg/ha.

Now,

$$Actual\left(\frac{km}{hr}\right) \times Working\ width\ of\ the\ planter = \frac{Speed\left(\frac{km}{hr}\right) \times Working\ width\ of\ the\ palnter \times Field\ effciency}{10}$$

Let's design the seed box for a such capacity, that it requires refilling of seeds after 1 hour.

Therefore,

Weight of seed to be used in 1 hr = $Seed\ rate\frac{kg}{hr} \times area\ cover\ per\ hour \times time(hr)$

$$Volume\ of\ seed\ box\ is\ given\ by\ Vs = \frac{(a+b)}{2}\ h \times L_b$$

Consider spillage losses of 10%.

Therefore,

Total volume of seed box of planter is = volume of seed box (v_s) + 10% of Volume of seed box (m^3)

Let, the seed box may be of trapezoidal section,

$$The\ Volume\ of\ seed\ box\ is\ given\ by\ V_s = \frac{(a+b)}{2} h \times L_b$$

Where,

Vs =volume of seed box having trapezoidal section (Vs), m^3

a = bottom width of the seed box, m

b = top width of seed box, m

l_b = length of seed box, m

Also, b = a + 2l

h = height of seed box

Putting the values of b in equation. We get,

$$V_s = \frac{(a+a+2l)}{2} \times h \times l_b$$

Also,

$$V_s \frac{(2a+2h\,cot\theta)}{2} \times h \times l_b$$

θ= angle of repose of seed

$$V_s = (a + hcot\,\theta) \times l_b$$

The angle of repose for wheat ranges from 23-28^o The design of seed box should be such that the θ is more than 28^o for easy flowing of seed. Therefore θ= 75^o.

Design of seed metering mechanism

Let the seed metering mechanism may be of inclined plate type using the following formula,

$$V_{plate} \frac{pD_G R_w S_r \times 10^5}{\rho g r}$$

Where,

V_{plate} = Volume of seed drop per rotation of feed roller, m^3

D_g= Diameter of ground wheel, m

R_w = Inter row width, cm

S_r = Seed rate.kg/ha

ρ =Bulk density, kg/m^3

$$G_r = \frac{Number\ of\ teeth\ on\ metering\ shaft}{Number\ of\ teeth\ on\ ground\ wheel}$$

Now, number of flutes on the rollers periphery can be decided from given formula

$$N_f = \frac{\pi . D_g}{x . gr}$$

Where,

N_f= number of slots or flutes per roller

D_g=diameter of ground wheel, cm

x= linear spacing of seed on ground, cm

g_r= gear ratio

Results and Discussion

The Designing of planter for inclined plate involved the identification of various parameters. The design parameters have been

identified for considering the power tool of 6.5 hp to operate the planter. The details regarding the calculation of various parameters are given as below;

Planter designing parameters

In this section the design of self-propelled inclined plate planter is suitable for 6.5 hp power engine are as below;

Brake horse power (BHP) =6.5 hp
Speed of operation = 2.5 km/hr
Type of seed grain = wheat
Seed rate = 100 kg/ha
Row to row distance = 20 cm
Plant to plant distance = 10 cm
Bulk density of wheat = 700 kg/m^3
Draft requirement = 130 kg/row
Angle of repose of wheat = 26^o
DBHP = 60% of BHP
Type of soil = heavy clay

We know that, DBHP = 6.5 × 0.60 = 3.9 hp

We know that, drawbar horsepower (DBHP) is equal to 60% of BHP.

$$DBHP = \frac{Draft(kg) \times Speed\ (\frac{km}{hr})}{270}$$

$$\frac{130 \times 2.5}{270} = 1.20 \text{ hp}$$

$$Draft\ available\ for\ sowing = \frac{DBHP \times 270}{Speed\ of\ sowing}$$

$$\frac{3.5 \times 270}{2.5} = 378 \text{ kg}$$

Draft requirement per meter width of planter is equal to 130 kg

$$Therefore, width\ of\ planter = \frac{Draft\ availble\ for\ sowing}{Draft\ requirement/m\ width\ of\ planter}$$

$$= \frac{378}{130} = 2.90\ m$$

But designing 1.52meter wide planter will have buckling effect and we also create problem in transportation and handling. Therefore latest design a planter with 3 furrow openers having 22 cm spacing between the furrow openers, as mostly the planter is used for sowing cereal crops.

Therefore,

Working width of planter = No. of furrow openers × spacing

= 3 ×30 =90 cm

Where, L_b =length of seed box which will be 4.5 cm

Design of seed box

The seed box may be of MS sheet. The length of box is given by,

L_b = working width of planter – 2b

Where, L_b = Length of box, cm = 3×3 =90 cm

Where, L_b =length of seed box which will be 4.5 cm

b = Distance between the side box and ground wheel.

Among the seeds used for sowing by the planter, maximum seed rate in kg and the planter may be designed for the seed application rate of 100 kg/ha.

Now,

$$Actual\ field\ capacity\ of\ planter = \frac{Speed\ (\frac{km}{hr}) \times working\ width\ of\ planter \times field\ efficiency}{10}$$

Fig.1 Planter top view

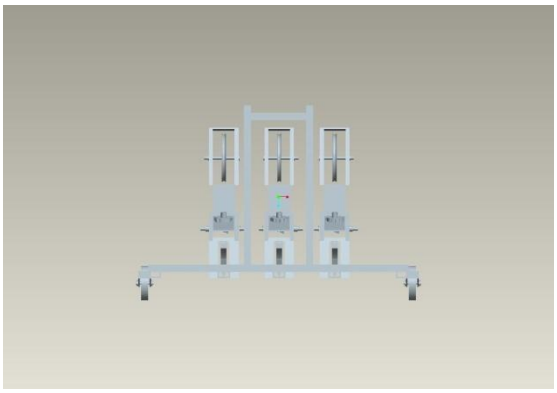


Fig.2 Planter isometric view in first angle

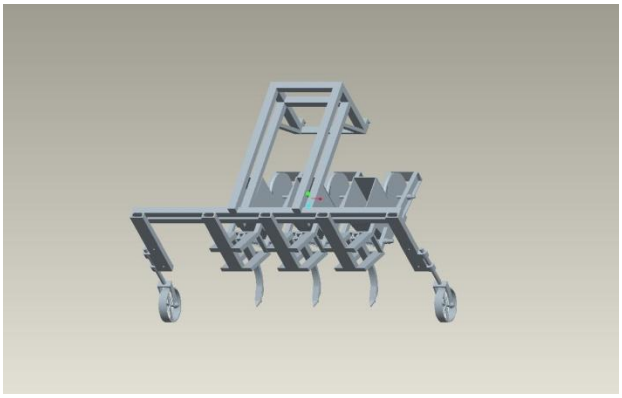


Fig.3 Top view of the planter

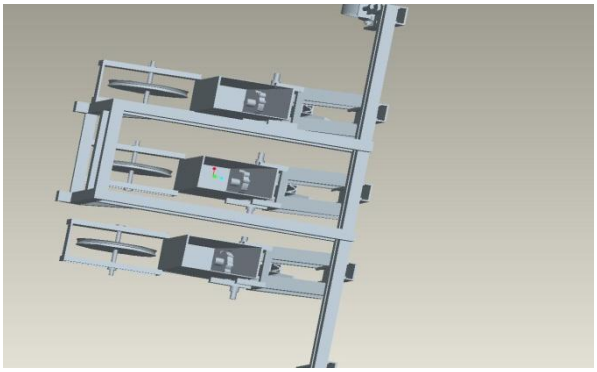
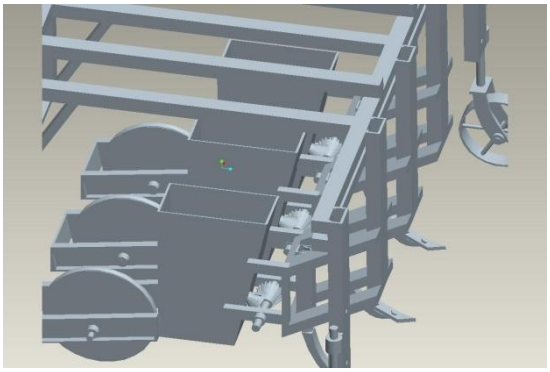


Fig.4 Gear to deliver power to plate



Let field efficiency assume to be 70%

$$\frac{2.5 \times 0.90 \times 0.70}{10} = 0.157 \text{ ha/hr}$$

Let's design the seed box for a capacity that it requires refilling's of seeds after 1 hour.

Therefore,

Weight of seed to be used in 1 hr = Seed rate kg/ha × area cover per hours × time (hours)

= 100 × 0.157 × 2 = 15.7 × 2 = 31.4 kg = 32 kg

$$Volume\ of\ seed\ box = \frac{Weigth\ of\ seed\ (kg)}{Bulk\ density|(\frac{kg}{m^3})}$$

= 32/100 = 0.0457 m^3

Consider spillage losses of 10%.

Therefore,

Total volume of seed box of planter is = volume of seed box (v_s) + 10% of Volume of seed box (m^3)

Vs = 0.0457 + 0.00457 = 0.0502 m^3

Let, the seed box may be of trapezoidal section

$$The\ volume\ of\ the\ seed\ box\ is\ given\ by\ V =_s \frac{(a+b)}{2} \times h \times L_b$$

$$Draft\ of\ each\ row = \frac{HP \times 75}{Speed\ (\frac{m}{s})}$$

$$= \frac{6.5 \times 75}{0.8} = 609.375 \text{ kgf}$$

$$Size\ of\ planter = \frac{D}{d} = \frac{609.375}{203.125}$$

= 3 No. of furrow openers

Width (w) of planter (cm) W= s × a

= 3 × 30 to 35 = 90 or 105 cm = 1m

CAD views of planter

The designed planter engineering views are given in figure 1 to 4. The three row inclined plate planter for sowing the crop is proposed for the small powered engine (6.5 hp capacity). This machine can effectively save the energy and cost of operation.

The Project designing of inclined planter which operated on the 6.5 hp power tool bar have designed and estimated the designing parameters. The draft power, size of seed box, length of furrow openers and the width of planter have been calculated. Based on the parameters identified to design the planter, CAD view of the planter is prepared. It is concluded that by considering the by the identified parameters it is possible to development the inclined plate planter. This proposed planter can effectively save the energy and cost of operation.

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