DESIGN AND EVALUATIONOF A MANUALLY OPERATED PLANTER

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ABSTRACT

This work was focused on design and evaluation of a manually operated single row planter for different field crop seeds, easy to use, easy to maintain, light in weight, requires less labour and costs. Thesingle row planter consists of the main frame, seed hopper, seed metering device, drive wheels, seed tube,furrow opener, furrowcloser and push handle. Most of these were fabricated from steel metals, except metering device which was made from good quality nylon, all machine componentswere designed to achieve good performance and long operation life span. Laboratory and field tests were conducted to evaluate the single row planter which were included: field capacity, field efficiency, amount of seed per feddan, and costs.Results revealed that the designedmachinehad highly performancein field capacity reachedto7.6 and 10.2 times for maize sowing at 1.89 and 2.61 km/h forward speeds,and about 8.9 and 11.9 times for faba beanat 1.83 and2.58 km/h forward speedsand the amount of seeds per feddan were decreased by 40 and 11.5 % for maize and faba bean respectively. comparing with manual planting.The total cost of feddan cultivate by the single row planter was less than the manual plantingby 95.92 & 96.63 % and 89.35 & 89.84 % for maize and faba bean respectively under the two possible speeds.Moreover, it was relieved thatthe designed machine cultivates at straight line and same depth and reduce hardship on labours compared with the manual planting.

Keywords*: Farm mechanization, Planter, Seed metering device, manuallyoperated planter*.

INTRODUCTION

The planting operation is one of the most important practices process associated with the crop production. Increases in crop yield, cropping reliability, all depend on the uniform and timely establishment of optimumplant populations.

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Traditional method of planting result very low production, not the proper seed rate or seed spacing and consume more time. To achieve the best performance from the seed planter, the proper design and good selection of the components required on the machine is needed to suit the crop needs. **Adisa and Braide. 2012** reported thatthe basic requirements for small scale cropping machines were: should be suitable for small farms, simple in design, improve planting efficiency and reduce drudgery involved in manual planting method.They developeda row planter; its plantation rate was 0.20ha/h.with a field efficiency 88%.The basic functions of the planters are opening the seed furrow specific to proper depth, metering the seeds, depositionof the seeds in the furrow and cover the seeds to proper degree for the type of crop involved. The main component of the planterare: hopper; metering system; furrow opener. **(Ani,et al., 2016).**Metering mechanism is the heart of sowing machine and there is many types of metering system for seeding.The function ofthe metering system is dropping the seeds at the proper rate and helps produce the precise spacing necessary for high yieldsand do not allow skipping, doubling and damagingthe seeds during the process of planting. **(Khan, et al. 2015; and Rabbani, et al.2016).**Seed tubes, is a channel that seed transfer from seed hopper into the opened furrow. **(Bashiri et al.2013).** Furrow openers open the soil where seeds metered out and falling through the seed tube will be dropped and covered. Angle of attack and planting depth should be considered in designing furrow openers. **(Ani,et al., 2016).Rabbani, et al.2016 and Kyada&Patel,2014** designed, developed and tested a low cost manually operated push type maize planter,used for drilling seeds. The metering device is attached to a delivery system (vertical shaft) that conveys the seed for placement. The photographic view of a plate type seed metering device for the seeder is shown in fig.1.In the laboratory test the effective field capacity was 0.128 ha/hr., with field efficiency76.5%.

In another design, the seed-metering device is the wooden roller type with cells on its periphery. The size and number of cells on the roller depends on the size of seed and desired seed rate. The wooden roller lifts the seeds in the cells and drops these into the seed funnel, which is conveyed to the open furrow through the seed tube as shown in fig.2.

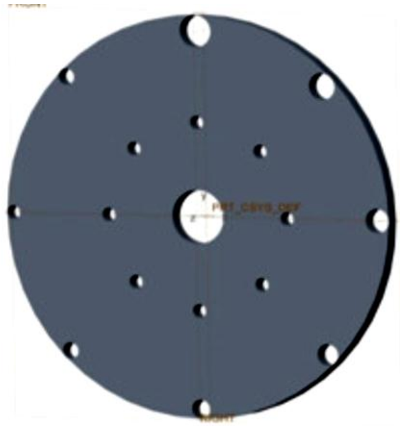


Fig. 1. View of a plate type seed-metering device for the planter

Fig. 2. Photograph of seed-metering of maize planter

Ikechukwu, et al. 2014.designed and fabricated a manually operated single row maize planter capable of delivering seeds precisely in a straight line with uniform depth in the furrow, and with uniform spacing between the seeds, the results showed that the planter capacity was 0.0486 hectare/h. with a field efficiency 88%, Visual inspection of the seeds released from the planter's metering mechanism showed no visible signs of damage to the seeds. **Khalil et al. 2015** reported that the maize planted at 65-70 cm between rows, 20-25 cm distance between seeds on row and placed at a depth of 5 cm and covered with soil, while faba been planted at 40 cm between rows, 15-20cm distance between seeds on row. Furthermore, maize and faba bean are the most important grain crops in Egypt, they are used in human and animals feeding, and they enter in the dry feed industry of poultry.Egyptian agriculture in old lands is characterized by small landholdings and is classified by the Ministry of Agriculture into four categories: extra small (less than one feddan), small (one to three feddan), medium (three to less than five feddan) and large (five feddan and above). The distribution of farms by size of landholdings differs significantly for Lower (north) and Upper (south) Egypt, as indicated in Table (1) (**M.O.A.G.S.,2016**). From this statistical survey, there is high percentage from small farm spread in Egypt, so that it is very important to design and manufactured small scale agricultural equipment to suit the small holding.

Table 1. Percentage Distribution of Farms by Size of Landholding in Egypt

Holding / Regions	The percent of sizelandholding (feddan)				
	<1	1 to <3	3 to <5	≥ 5	Total area, fedd.
Lower Egypt	29.28	32	11.76	26.96	5916546.1
Upper Egypt	42.31	35.89	10.95	10.85	3085823.6

The aim of this study is to design and evaluate a manually operated single row planter machine thought the following steps:

1- Designing the main parts of the planter.

2- Fabricating the manually operated planter.

3- Testing the designed planter and the feeding device in the laboratory.

4- Evaluation ofthe designed planter and the feeding device in the field.

MATERIAL AND METHODS

The experiments were carried out in a clay loam soil at the Experimental Station Farm., Faculty of Agric., Cairo Univ., during summer seasons of 2017 - 2018 in an area which was prepared using a chisel plough two orthogonalways and a disc harrow. Then divided into two areas, the first planted maize (*Zea mays L.)*and Fababean (*Viciafaba L.)*using the designed machine, the second was manually cultivated at the same spaces.

It is designed to plant maize and faba beans because they are planted at close distances on the row.

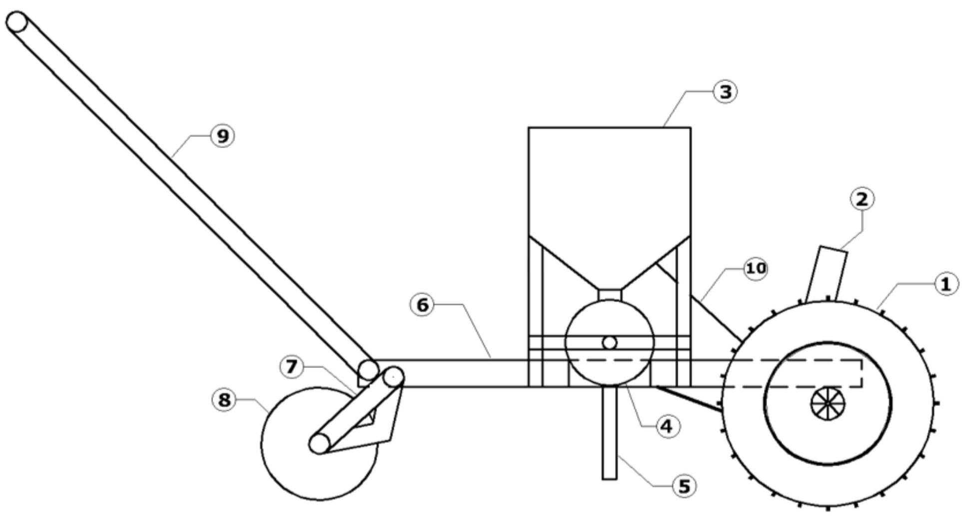
The design plantermachine was based on the following considerations:

1. Ease of fabrication using local materials forthe most component.
2. Simplicity of the machine operation for smallholding farmers.
3. Manufactured with the lowest possible costs.

MachineDescription:

The planter machine was designed and made up from the following major parts as shown in figs.3&4.

Fig (3): Photo of the designed manually operated single row planter



1.Drive wheels	2. Furrow opener	3.Seed box
4.Housing of seed metering device	5. Seed Tube	6. Main frame
7.Strips for install the path	8. Rear wheel	9. Push handle
10. Transmission belt		

Fig. (4): Front view of the designed manually operated single row planter

a. **Main Frame:**This is the skeleton of the planter machine in which all other components are mounted. It is made of mild steel U beam 100 x 50 x 6mm with 90 cmlength, it has a rectangle-shaped slot (5 x 8 cm) to facilitate changing the seed metering when needed.

b. **Push Handle:** The handle helps the operator to push the planter, it was designed to be articulated to adjustable for the different height of labours in order to reduce drudgery.It was made of combination of 1.5inches steel pipe with length of 90 cm, and 1.5 inches mild steel pipe with length of 30 cm welted perpendicular to the handle pipe.

c. **Seed box (hopper):** A cuboidal boxmad from steel sheet 2mm thickness attached with a three-dimensional trapezoidal, with a small base with a circular opening of 2.5 cm diameter has side slope is higher than the average angle of repose of the seeds to ensure free flow of seeds, the theoretical hopper capacity is 9000 cm^3.

The hopper was supported with the machine frame by two steel strips 0.4 cm thickness and 2.5 cm width was formed as u channel with 13 cm width and 28.5 cm depth.

d. **Seed Metering Mechanism:**It was made by good quality nylon wheel 14.5 cm diameter and 4.5 cm thickness used to distribute seeds uniformly at the desired rates, it lifts the seeds from the hopper and drops these into the open furrow through the seed tube. Two steel strips of 40 cm length, 2 cm width and 0.4 cm thickness, were used to fix the meteringseed rotational axis with screw bolts and wing nuts to facilitate removing the seed metering housing cover and replace the feeder wheel if necessary.The cells on the circumferenceof the seed metering wheelwere elliptical shape with 2and 1.5 cm diameters and 1.4 cm depth,the cells were designed to pick two maize seeds or one seed of faba bean and drop them at intra row, the number of seed cells on the circumference of the seed metering wheel was determined using the following equation (**Kepner et al 1978)**:

$$N_C = \frac{\pi * D}{I * ds} \qquad \ldots\ldots(1)$$

Nc = No. of cells on the circumference of metering device;

D = The diameter of the driver ground wheel (cm);
I = Speed ratio (from drive wheel shaft to metering shaft);
ds = The intra distance between seeds in the row (cm) = 20 cm, (**Khalil, N. A. et al, 2015)**

Speed ratio (I) = $\frac{Dg}{Dm}$……………………………………(2)

Dg = Diameter of the drive pulley on the ground wheel shaft, (cm)

Dm = Diameter of the driven pulley on the metering shaft, (cm)

$I = \frac{Dg}{Dm} = \frac{16}{9.5} = 1.68$

$N_C = \frac{\pi * 39}{1.68*20} = 3.65$

No. of cells on the circumference of metering device was taken = 4

Distance between cell to cell(ds)= $\frac{\pi * D}{I*NC} = \frac{\pi * 39}{1.68*4} = 18.23 \; cm$

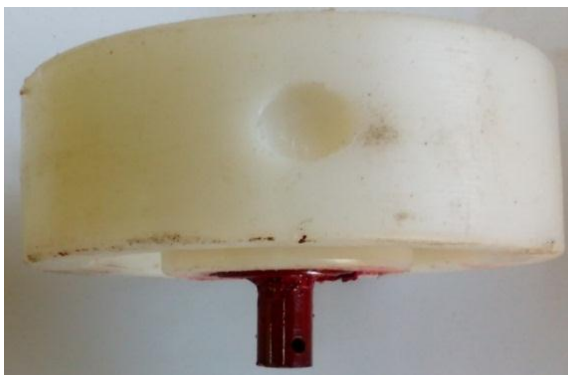


Fig. (5):Seed Metering Device

e. Belt and pulley transmission:

The belt and pulley drive mechanism consist of three pulleys the first one (16 cm diameter) is attached to the front drive shaft, the second is driven pulley (9.5cm diameter) attached to the metering shaft, in the middle very small pully (2.5 cm diameter)for tight and for easy removal and installation the belt. The V-belt circumference was determined by run a tape close enough around the three pulleys, belt length is 140 cm.

f. **Furrow Opener:** Installed by two strips of steel with 25cm length, 2cm width and 0.4 cm thicknesswhich perforated each 1 cm, while the opener perforated every 1.5 cm to permits planting each variety's at suitable depth. It has knife edge to form narrow slit under the soils for placement of seeds. It is an iron steel flat bar 0.5cm thickness (Fig.6). Furrow Opener coulters a backward slant to reduce the soilresistance facing the opener, the sowing depth was controlled by raising or lowering the furrow opener.

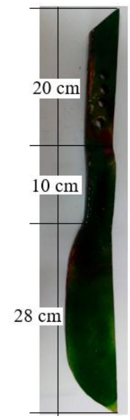


Fig. 6

g. **Drive Wheels:** These were located at first of the main frame (Garden Tire 400-8 R1 Pattern pneumatic Rubber Wheel) with trads to reduce slippage, the tiresize is 9× 3×4 inches

h. **Seed Tube:** This was the channel to conveyed seeds from the metering system to the furrow. It is made from steel tube with diameter of 1.5 inchand 17cm length.

i. **Furrow Closer:** The rear wheel usedfor proper covering and compact the soil over the seeds. It is made from compact rubber with 21 cm diameter and 6 cm thickness. Connected with the machine frame by ball bearingsto facilitate rotation during movement and equipped with two strips of steel with 23 cm length, 2 cm width and 0.3 cm thickness to install the path during planting, it is fixed with a screw bolt and wings nut to facilitate the connection and manually unplug.

measurements:

a. Design Analysis:

The following design analysis were carried out in order to select the various machine parts:

1. Seeds length, width, thickness and bulk density:

A caliper was used to measure length, width, and thickness of 100 randomly selected bean and maize seeds (table 2), seed dimensions used to site the dimensions of feeding drum cells، while the bulk density used to calculate the weight of seeds in hopper.

2. Friction angle:

Friction angle between seeds and hopper surface was measured using a rectangle galvanized steel20 x 10 cm filled with seeds, it was raised slightly just seeds started to slide down the angle was read from a graduated scale (F), five replicates for friction angle were carried out, Angle of the hopper sides should be greater than the angle of friction.

Table (2) Properties of the seeds used to evaluate the manually operated single row planter

Properties	**Maize(SC-Giza 10) 10% w.b.**	**Faba bean(Sakha 2) 11% w.b.**
Length، mm	11.7 - 12.35	18.49 - 19.1
Width, mm	8.2- 9.5	13.26-13.9
Thickness, mm	4.43- 4.47	7.51-8.2
Bulk Density (kg/m^3)	652.3	875.17
Friction angle (degrees)	24	15
Mass of 1000 grains (g)	256	769

3. Total theoretical weight of seeds:

Total theoretical weight of seeds = (theoretical hopper capacity, cm^3) × (seeds bulk density, kg/cm^3) ……, kg

The actual mass of seeds = Total theoretical Weight of seeds × 0.75 =……, kg

Where:

- 75 % will be used to fill the seeds hopper,
- Weight of seeds will be calculated according to bean seeds because their bulk density is greater.

The actual Weight of seeds = $9000 \times 10^{-6} \times 875.17 \times 0.75 \times 9.81 = 57.9$ N

4. Weight of the Main Frame:

The weight of the longitudinal meter of the using channel beams 100 x 50 x 6 mm = 10.6 kg/m (**MAIAK-M company. 2019)**

The weight of the main frame= $10.6 \times 0.9 \times 9.81 = 93.59$ N

5. Weight of seed box (hopper):

The weight of the square meter of steel sheet 2 mm thickness is 15.56 kg. (E**-Village Forum**. 2019)

Weight of seed box = Total surface areaof the seed box, (m^2)

× weight of the square meter of the used material,(kg/m^2)

= 0.236 ×15.56 × 9.81= 36.0 N

Total weight of seed box and seeds = 57.9 + 36 = 93.9 N

6. Check the suitability of the main frame thickness:

The vertical load diagram is shown in Fig. (7). Let R_A and R_B represent the reactions at A and B respectively for vertical loading.

By taking the moments about A,

∴ RA = 55.92 N ∴RB = 71.48 N

Fig. (5) shows the bending moment diagram for vertical loading.It is obvious that C is the point of maximum bending moment (MC) = 25.16 N.m.

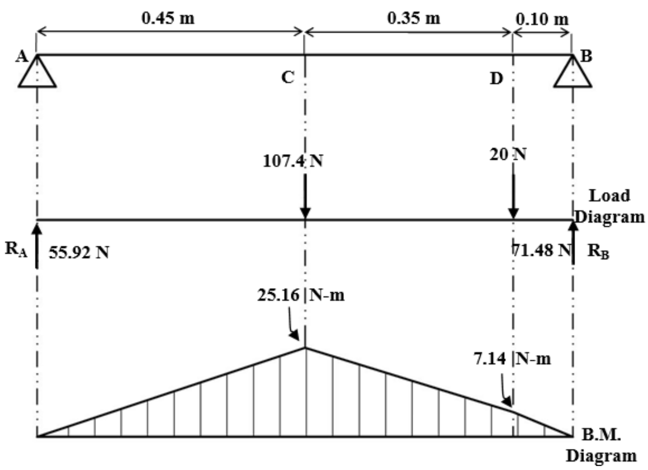


Fig. (7): The bending moment diagrams of the main frame beam

The following equation calculate the bending stress(σ) on the main frame:

$$\sigma = \frac{M}{I} \times Y \quad = \text{MPa} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

Where:

M = Bending moment acting at the given section.

I = Moment of inertia of the cross-section about the neutral axis = 207.01 cm^4.

y = Distance from the neutral axis, m.

The calculating bending stress on the main frame was 3.04 MPa, which is very low value, so the beam is safe

7. Determination of the shaft diameter:

The shaft diameter was determined to ensure satisfactory strength and rigidity when the shaft transmite power under various operating and loading conditions. For a shaft having little or no axial loading, the diameter may be obtained using the ASME code equation (***Khurmi and Gupta, 2005***) given as

$$d^3 = \frac{16}{\pi S_s}\sqrt{[K_b M_b]^2 + [K_t M_t]^2} \qquad (4)$$

Where

d : Diameter of shaft, m.

M_b : Resultant bending moment, N.m.

M_t : Torsional moment, N.m.

K_b : Combined shock and fatigue factor applied to bending moment.

K_t : Combined shock and fatigue factor applied to torsional moment.

Ss : Allowable shear stress of the shaft material, $MN.m^{-2}$.

Allowable shear stress (Ss) For rotating shafts when load is suddenly applied, and for shaft

without key way, allowable stress is $55\ MN / m^2$ (**Khurmi and Gupta, 2005**)

Fig. 8 shown the maximum bending in the front and rear axis, by applying the equation (4), shaft diameter of the front and rear axis (d) should be equal to or more than **12** mm and **10** mm respectively.

8. length of the furrow opener:

The minimal length of the furrow opener L (fig. 9) is given by:

$$L = \frac{d + c + s + b + h}{\sin\beta}, m \qquad (5)$$

where:

d = The appropriate depth for seeds planting= 5 cm;

c = Addition to attaching or wearing = 3 cm;

s = The distance between the bottom of the main frame and ground surface = 19 cm;

b= The height side of the main frame = 5 cm;

h= The distance up to the first fixed point over the main frame = 7 cm;

β = Angle of furrow opener is 60º.

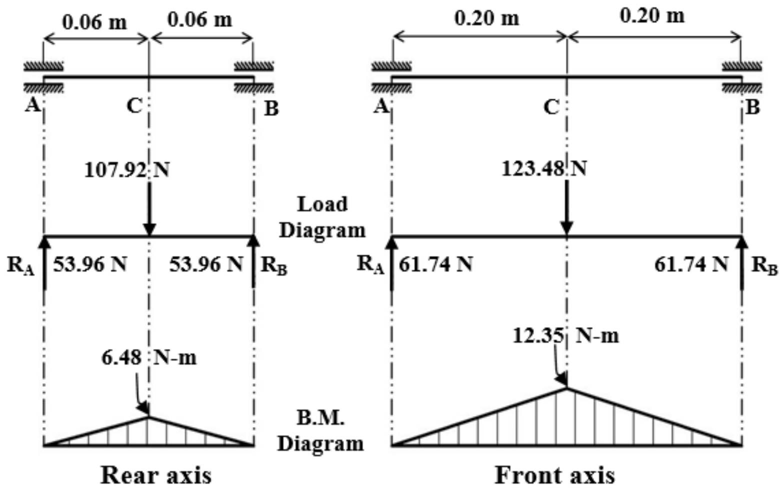


Fig. (8): The bending moment diagrams of the front and rear axis

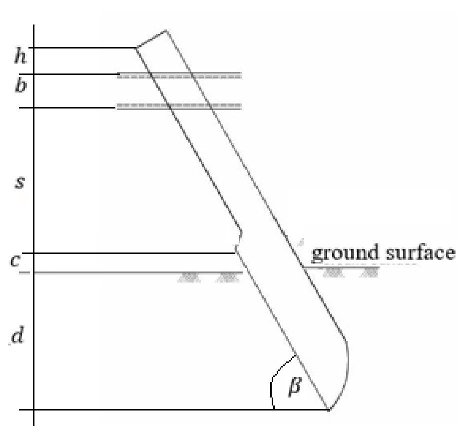


Figure 9. The main dimensions of the furrow opener

The minimum length of the furrow opener = 45.03 cm

8. Determination of the Force Required to Push the Planter:

Figure 10 gives the free body diagram showing all the forces acting on the planter. The force required to push the planter may be obtained from the following formulas:

$\sum F_X = F_P \cos\theta - R_S \cos\varphi - F_R = 0.0$ .... (6)
$\sum F_Y = R_S \sin\varphi - F_P \sin\theta - W_P = 0.0$ .... (7)

Where,

F_P= Planter push force, N

F_R= Horizontal soil resistance force, N

R_S= soil friction resistance =10 - 20 N/m^2 for Clay Loam soil **(Dragan L. 2018)**

φ = Soil friction angle = 18 - 32° for Clay Loam (according to **Dragan L. 2018)**

θ = Angle between planter handle and the horizontal plane= 55º(by measuring)

Suitable for the average height of men labours during age of 15 - 25 years in EgyptWhich ranged from 169 – 177cm the majority were 166.7 cm(**Amer D. 2016**)

W_P = Weight of planter = 3333.54+ 57.9 = 391.44 N

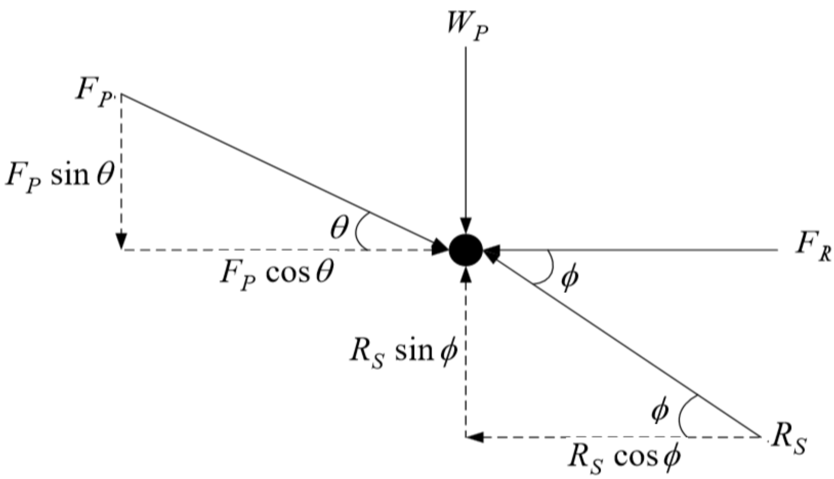


Fig. 10: Free body diagram showing all the forces acting on the single row planter

- Horizontal soil resistance force (F_R):

F_R =Soil Resistivity ×d ×t_0

= 10×0.5×5= 25N

- The frictional resistance of the contact surface must satisfy the **Coulomb's** equation:

$R_S = Ca\, A + P \tan\varphi$…………………………………………..(8)

R_S = (24000 × .05 ×0.005) + (19.62 × tan 32)
= 6 + 12.26 = 18.26 N

where,

R_S = frictional resistance (N)

Ca = soil-material adhesion = 12000 - 24000 Pa for cohesive soil with medium consistency (GEO5, 2019)

φ= angle of soil/material friction = 32^0

P = normal force on surface = 19.62 N

A = the surface area of the furrow opener in contact with soil, m^2 was estimated Using: $A_S = dt \times t_o$

where :

dt =The recommended depth for seeds planting = 0.05 m

t_0 = The thickness of the furrow opener = 0.005 m

- The Required force to push the designed Planter (F_P)was calculated using the Following equation (referred to fig 8):

$$F_P \cos \theta - R_S \cos \varphi - F_R = 0.0$$

$$(F_P \times \cos 55) = (18.26 \times \cos 32)+25$$

$$F_P = 40.48 \text{ N}$$

On an average, a farm labour develops nearly 0.1 horse power (***Jain*, S. C. 2003**) at the maximum manually sowing speed (3.41km/h.) the labour cane produce force equal to79.18 N, which greater than the required force for operated the designed machine

b. Determination of the Performance parameters of the manually Planter:

1. **The effective diameter of ground wheel under load (D)**: was determined according to ***(RNAM,1995)*** by measuring the distance of the machine traveled in 15 revolutions of ground wheel by using formula (7):

$$D = d/ (\pi * n), \text{ cm} \quad \ldots\ldots (9)$$

Where:

d = distance in (n) revolution, cm

n = revolution numbers of ground wheel.

From formula (7) the effective ground diameter of the driver wheel was 37.62cm.

2. **The feeding rate (Q**) was calculated from the delivery in 30 revolutions of ground wheel in the laboratory by using the following formula:

$Q = (q * 4200) / (\pi * D * n * w)$, kg/fed. …………..……(10)

Where:

Q = delivered seeds in a given number of revolution (n) of ground wheel, kg.

D = the effective diameter of ground wheel, m

n = number of ground wheel revolutions.

W= nominal working width (distance between planting rows), m.

- The field requirement feeding rate = Q × 1.2, kg/fed.

3. **Seeds weight required per feddan** (W_f) was calculated from following formula:

$W_f = \frac{Hn \times Sn}{1000} \times Ws \times \frac{1}{GR}$, kg/fed. …………………..…(11)

Where:

Hn = hills number per feddan.

Sn = sprouts number required per one hill.

GR = germination ratio, (decimal).

Ws = weight of 1000 seeds, gm.

4. **Theoretical field capacity (TFC)** was calculated using the following formula:

TFC = (w × s × 1000) / 4200 = 0.238 × w× s, fed/h …….. (12)

Where:

w = Nominal working width (distance between planting rows), m

s = Average working forward speed, km/h.

5. **Actual field capacity (AFC)** taking into consideration the non-productive time

as turning at the ends of the field and stopping to check machine performance was calculated from the following formula (13):

AFC = 1/AT, fed./h ……………………………...….(13)

Where:

AT = actual total time,h/fed.

6. **The field efficiency (η_f)** was calculated by using the following formula (14):

η_f = (AFC × 100) / TFC, % ……………………………..(14)

All experiments were carried out to evaluate the designed single row planter, all laboratory tests and field experiments were replicated three times, to give more reliable averages
The obtained data was subjected to statistical analysis. (T)test and analysis of variance (ANOVA) were calculated.

RESULTS AND DISCUSSIONS

For testing the designed planter, the following criteria were considered:

1- Effect of forward speed on Seeds distribution:

In laboratory tests, the designed planter was operated on light plastic sheet at speeds range from 1.90 to 3.41 km/h. with maize and faba bean seeds. For all pushing speeds there was no significant difference in seeds distribution and seeds quantities per feddan, this might be due to the adjust of the seed metering device (fig 11).

Fig.11: Seeds distribution form during laboratory test

2.Seed Damage Rate:

The seed damage rate was very minimal with the lowest speeds 1.90 and 2.60 km/h which was 0.00%, and the highest rate was 0.03 % at 3.4km/h speed recording for maize seeds while the highest rate of damage faba bean seeds was 0.01% recorded at speed of 3.41 km/h, the damage percentage of faba bean seeds were lower than maize seeds may be due to the hardness of faba bean seeds and also the regular shape of faba bean seeds.

3. Effect of forward speed on field capacity and field efficiency:

From figs (12&13) it is clear that the increasing of pushing speed resulted on increase in the actual field capacity and decrease in the field efficiency all over the field pushing speeds.

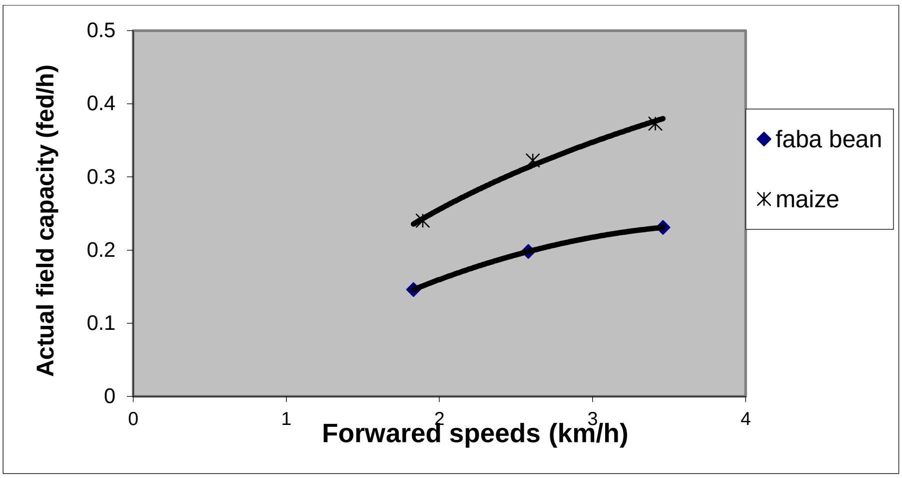


Fig. (12): Effect of different forward speeds on actual field capacity.

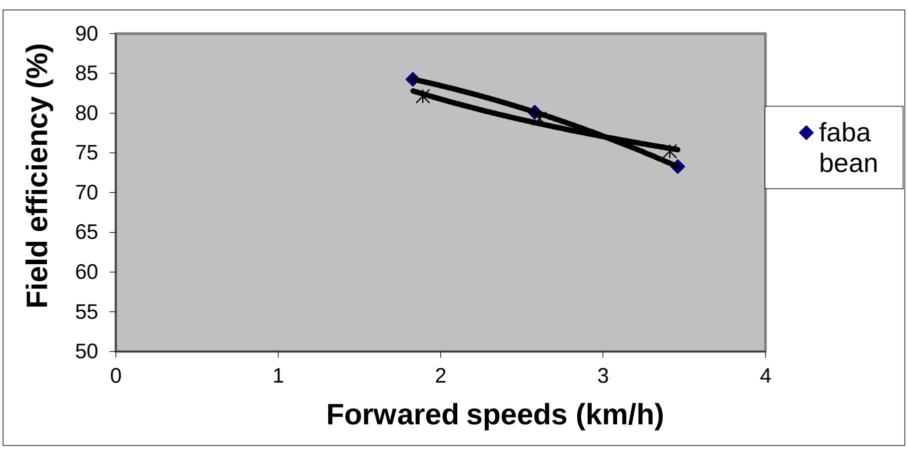


Fig. (13): Effect of different forward speeds on field efficiency.

The actual field capacity of maize plantingincrease from 0.24 to 0.373fedd./h. when the forward speed increased from 1.89 to 3.41 km/h. while the field efficiency decreased from 82.12 to 75.21%,in faba bean sowing the actual field capacity increased from 0.146 to 0.231fedd./h. when forward speed increased from 1.83 to 3.46 km/h., while the field efficiency decreased from 84.25 to 73.25 %, while increasing the forward speed from 1.83 to 3.46 km/h.

4- Comparison between designed machine and manual sowing:

Manual planting required 14 kg /fedd. of maize and 55 kg/fedd. faba beanwith planting speed of 0.21 km/h, and field capacitywere 0.19and 0.10 fed./day (working day=6h) for maize and faba bean respectively. Results of the manual sowing were compared to those obtained by the use of the designed machine under the two pushing speeds without seeds breaking which were 1.89 and 2.61km/h. in maize plantation and were 1.83 and 2.58 km/h. in faba bean plantation.

This comparison showed high significant different which was clear in the following:

A- **Field capacity**: highly significantly increased by the use of the designed machine under the two used speeds compared to manual plantingto about 7.6 and 10.2 times for maize, which were increased by 8.9 and 11.9 times for faba bean

B-**Seed quantity:** was significantly reduced by 40 and 11.5% for maize and faba bean

respectively. As well as regular seeding and appropriate coverage.

C-Table (3) shows that the total cost of sowing feddan by the designedplanterwas less than the manual sowing by 95.92&96.63 % and 89.35&89.84%for maize and faba bean under the two possible speeds respectively.

Table (3): Total costs of manual sowing and sowing by the designed machine, according to 2018 Prices (to the nearest EGP)

Components of sowing cost	**Costs of using the designed machine under two selection speeds**				**Costs of manual planting, LE**	
	Maize		Faba bean		maize	bean
Operating speed (km/h.)	1.89	2.61	1.83	2.58	0.21	0.20
Actual field capacity (fedd. /h)	0.242	0.323	0.146	0.198	0.021	0.012
Planting time (h./ fedd.)	4.13	3.1	6.84	5.05	47.62	83.33
Planting costs (L.E./fedd.)	119	89	196	145	5238	9166
Price of used seeds (L.E./fedd.)	100	100	897	897	140	1100
Planting total costs (L.E/fedd.)	219	189	1093	1042	5378	10266

*- *total costs of operating the designed machine = 28.7 L.E./h.*

*- *Daily wage of sowing labour = 110 L.E./ working day.*

*- *Maize seeds price = 10 L.E./kg.*

*-*Faba bean seeds price = 20 L.E./kg.*

CONCLUSIONS:

This work focused on the design and evaluation of a manually operated single-row planter machine that easy to use, easy to maintain, light in weight, requires less labour and costs

From the information and design values obtained in this study; it is been found that the designed planter gives:

1. high significantly increased in field capacity by the use of the designed machine compared to manual planting.
2. Seed quantity per feddanwas significantly decreased, regular seeding compared to manual sowing and appropriate coverage.
3. Reduce the effort exerted by the labour.
4. The designed planter work effectively in planting other maize and faba bean. It can used in planting other grains by switch seed metering device by another suitable for the cultivated crop.
5. It is simple, cheap and does not require any special skills to operate.
6. The second speed 2.61 km/h for maize and 2.58 for faba bean was recommended to

Increase the productivity and decrease operating costs.

The finally recommended to maximize the utilization of the design planter all over the year and to reduce the operating costs a similar feeding device must be fabricated to be more suitable for other field crops.

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الملخـص العـربي

تصميم وتقييم آله زراعة تدفع باليد

د. محمد سيد عمران *

أجري هذا البحث لتصميم وتقيم أداء آله زراعة تدفع يدوياً تناسب زراعة معظم بذور المحاصيل الحقلية التى تزرع على خطوط مثل الذرة والفول البلدى على أنتكون سهلة الاستخدام ، سهلة الصيانة ، خفيفة الوزن ، لا تتطلب الكثير من المهارة وقليلة التكلفة مقارنة بالزراعة اليدوية. أجريت اختبارات معملية وحقلية لتقدير ومقارنة أداء الآلة المصممة خلال موسمي ٢٠١٧- ٢٠١٨ بمحطة التجارب الزراعية بكلية الزراعة- جامعة القاهرة، وتم تصنيع معظم مكونات هذه الآلة من خامات محلية من الحديد الصلب ، بإستثناء جهاز التلقيم الذي صنع من بكرة من النايلون المضغوط عالى الجودة.

تم تصميم وتقييم آلة الزراعة صف واحد بزراعة بذور الذرة والفول البلدى تبعا للخطوات التالية:

١. تحديد أهم الخصائص الطبيعية لحبوب الذرة والفول البلدى (الطول- العرض – زاوية التدحرج - وزن الألف حبة) والتي استخدمت في تصميم مكونات جهاز التلقيم وصندوق البذور.

٢. إستخدام المعادلات التصميمية لتصميم والتأكد من صلاحية أجزاء الآلة لأداء مهامها.

تم إجراء الإختبارات المعملية و الحقلية لتقييم الآلة عن طريق حساب كمية التقاوى المستخدمة ، مدى تشتت البذور عن محور الزراعة ، معدل الأداء، تكاليف التشغيل، ثم قورنت النتائج المتحصل عليها بالزراعة اليدوية .

و كانت أهم النتائج :

أوضحت النتائج المتحصل عليها تفوقا معنوياً باستخدام الآلة المصممة مقارنة بالزراعة اليدوية وذلك عند استخدام الآلة بالسرعات فى حدود إمكانية دفع العامل للآلة و كانت النتائج كما يلى:

- إستخدام الآلة المصممة أدى إلي تقليل كمية البذور المستخدمة للفدان مقارنة بالزراعة اليدوية بنسبة ٤٠ % في حالة زراعة الذرة ، بنسبة ١١,٥ % في حالة زراعة الفول.
- زيادة معنوية في السعة الحقلية للآلة مقارنة بالزراعة اليدوية حيث حققت الآلة سعة حقلية تعادل ٧,٦ و ١٠,٢ أضعاف عند زراعة الذرة ، وحوالي ٨,٩ و ١١,٩ ضعف عند زراعة الذرة و الفول البلدى مقارنة مع الزراعة اليدوية.

*** أستاذ مساعد بقسم الهندسة الزراعية – كلية الزراعة – جامعة القاهرة.**

- تقليل تكلفة زراعة الفدان مقارنة بالزراعة اليدوية بنسبة بنسبة ٩٥,٩٢ ، ٩٦,٦٣ % بتشغيل الآلة بسرعة ١,٨٩، ٢,٦١ كم/ساعة عند زراعة الذرة ، وبنسبة ٨٩,٣٥ ، ٨٩,٨٤ % عند سرعات تشغيل ١,٨٣، ٢,٥٨ كم/ساعة عند زراعة الفول البلدى.
- بالإضافة إلى توفير الجهد والمشقة علي العامل مقارنة بطريق الزراعة اليدوية.
- توصى الدراسة بعمل نماذج متكررة من جهاز التلقيم يناسب محاصيل حقلية أخرى لتعظيم الإستفادة من الآلة على مدار العام بما يساهم فى خفض تكاليف التشغيل.