DEVELOPMENT AND TESTING OF A TRACTOR DRAWN FIVE ROW FURROW OPENING DEVICE

3 authors:

Agidi Gbabo

68 PUBLICATIONS   **194** CITATIONS

SEE PROFILE

Andrew Ndudi Efomah

Tianjin University

6 PUBLICATIONS   **27** CITATIONS

SEE PROFILE

I. M. Gana

FEDERAL POLYTECHNIC BIDA

42 PUBLICATIONS   **43** CITATIONS

SEE PROFILE

Some of the authors of this publication are also working on these related projects:

Automation of grain drinks (soya milk, rice milk, kunu etc) processing plant View project

DEVELOPMENT AND TESTING OF A TRACTOR DRAWN FIVE ROW FURROW OPENING DEVICE

Agidi Gbabo[1], Andrew N. Efomah[2] and Gana Ibrahim Mohammed[3]*
[1]Department of Agricultural & Bioresources Engineering, Federal University of Technology, PMB 65, Minna, Nigeria
[2]Department of Agricultural & Biosystems Engineering, University of Ilorin, Kwara State, Nigeria
[3]Department of Agricultural & Bio-environmental Engineering, Federal Polytechnic, Bida, Niger State, Nigeria
*Corresponding author: ganaibro74@yahoo.com

Abstract: A tractor drawn five row furrow opening device having a capacity of 30 hectares per day was designed and fabricated as one of the tillage/planting device with which soil can be opened in order to facilitate the planting of seeds in an efficient and uniform manner that would save time and reduce drudgery. The fabricated device consists of a beam, transport wheels, bearing housing, spring bar furrow opener and the 3-point hitch to the tractor. The 3-point hitch which is standard on most tractors is the place of connection of the furrow opener to the tractor consisting of the upper link and two lower links. The 3-point hitch is very effective in lowering and lifting farm equipment and can also be used for semi-mounted implements such as the soil opener to give it stability and support when used on the farm. The device was fabricated with locally sourced materials that are not difficult to get. This makes maintenance and repairs on the device easy by local artisans since damaged parts can be easily repaired and if possible replaced with new parts. The results obtained from the trial tests of the fabricated device showed that the tractor drawn five row furrow opening device functioned properly as expected with a working capacity of 30 hectares/day. Visual inspection of the planted seeds after germination shows a uniform plant growth on a straight line indicating that soil nutrients abound and the depth of soil opening was uniform throughout the working operation of the fabricated device.

Keywords: Crop, furrow opener, tillage, soil

Introduction

As agriculture in the developing world is in the process of substantial change, there is still a scope for introduction of energy-efficient technologies that makes use of tillage implements. These tillage implements helps in the mechanical manipulation of the soil to achieve a desired purpose aimed at nurturing crops. Crop residues on the soil surface makes uniform seedling establishment difficult in conservation tillage systems. Additionally, high levels of crop residues stand present a constraint to the adoption of conservation tillage because residues mechanically interfere with seeding operations. Improved seeding equipment or residue removal may be necessary for successful direct drilling practices (Cater, 2002). There has been an increase in yield by 5 percent to 10 percent with zero- tillage technology over the conventional tillage and saving in sowing time by up to 70 percent as well as 60 percent savings in operating costs (Rautaray, 2004).

The continuous development of conservation tillage technologies has led to studies on the performance of no-till seeders. No-till sowing requires a seeder that will effectively penetrate untilled soil and place the seed at the optimum depth for rapid plant emergence. The furrow openers are the only components of any machine which actually break the soil surface. In no-tillage sowing, they are required to perform all of the functions necessary to physically prepare a seedbed and sow the seed.

The types of furrow openers used vary with soil and operating conditions. The common types of furrow openers used for minimum and no tillage systems are single and double disc-type openers. Furrow openers for no-till seeding require an effective down-force to cut through surface residues and penetrate hard soil to a specific depth. This force typically ranges between 700 and 2300 N (Schaaf *et al.,* 1979) depending on the field conditions encountered. Maintaining a constant force on openers while seeding will help to achieve a uniform seeding depth under a uniform soil condition. Gratton *et al.* (2003) studied on the development of a mathematical optimization approach for the design of a no-till opener down force system. Two design alternatives, a spring-loaded single

linkage and spring-loaded parallel linkage, were considered for the replacement of a hydraulically loaded down force system. The prototype spring-loaded parallel linkage was tested in laboratory and in field conditions. Compared to the hydraulically loaded parallel linkage, the spring system resulted in approximately 50% smaller changes in down force. Tajudin and Balasubramanium (1995) evaluated hoe, shoe, wedge, single-disc and double-disc furrow openers used in bullock drawn seeders. Each furrow opener was tested with vertical forces of 0, 78.5, 157 and 245 N by adding dead weights. A performance index was developed to compare the furrow openers. Single-disc furrow openers gave the best performance index mainly due to lower unit draught, i.e. draught per unit area of furrow. Wedge-type openers required the maximum power. Double-disc openers had lower unit draught but the performance index of the opener was affected due to poor penetration.

Considering the specific requirements of sowing grain seedling in grain cropping system, the design of furrow opening configurations requirements by Zone disk tiller drill was carefully considered while developing and fabricating three different types of furrow openers (disk type, reverse hoe type and hoe type) in the Department of Farm Machinery and Power, University of Agriculture, Faisalabad:

The Single-disk-type furrow openers have gained popularity for use in conservation cropping systems over recent years, largely because the single disk- furrow penetrates soil with minimal disturbance of residue, enabling effective operation over a wide range of soil types and residue conditions without the need for a separate soil and residue cutting device (Desbiolles, 2004). Each disk- furrow opener had a 2.54 cm spherical curve in the centre in order to open a required width of furrow when mounted behind a wavy disk. The seed and fertilizer placement assembly was mounted on the concave side of each furrow opener. The standard was fabricated with mild steel and the disk with high carbon steel. In order to drop the seeds and fertilizer through separate tubes, a double boot type design was incorporated in the mechanism of disk-type furrow opener. The reverse hoe-type furrow opener with a curvilinear soil contact body was developed and fabricated

FUW Trends in Science & Technology Journal, www.ftstjournal.com
e-ISSN: 24085162; p-ISSN: 20485170; April, 2017: Vol. 2 No. 1B pp. 450 – 455

450

and named as reverse hoe-type furrow opener. The reverse hoe type furrow opener had a 51 cm adjustable height, 1.2 cm thickness, and 51 cm long mild steel standard which was sharpened and bent backward at the bottom. A 10.2 ×13 ×2.6 cm furrow opening assembly was fabricated and attached to the bottom of the standard on the opposite side. The reverse hoe-type furrow opener had a rounded soil contact edge to assist with a slender cut with minimal soil disturbance. The curvilinear shape helped to reduce soil resistance and the amount of soil thrown during operation. The reverse hoe type furrow opener was connected to two flexible plastic tubes coming from seed and fertilizer boxes. Each of the seed and fertilizer tube diameters was 2.5 cm and bent at 15° with the vertical. A partition wall in each furrow opener prevented mixing of seed with fertilizer. The level of fertilizer aperture was designed such that the fertilizer was applied at a greater depth than seeding depth in the soil.

The hoe-type furrow opener with a sharp soil contact edge furrow opener was developed such that seed and fertilizer were unrestricted through separate tubes. In order to drop the seeds and fertilizer through separate tubes, a double boot type design was adopted. A partition wall provided in each furrow opener eliminated seed and fertilizer mixing. The fertilizer tube was designed to apply fertilizer at a soil depth greater than the depth of seeding.

Bahri and Bansal (1992) evaluated the field performance of double disc opener, hoe-type furrow opener, and triple opener with two press wheel types on the basis of creating a favourable soil- seed environment for a good plant stand of wheat in no-till conditions. They found that in relatively moist and loose soils, double disc opener was the most suitable for use in a no-till grain drill, the hoe-type furrow opener was better suited for hard and dry soil conditions at sowing time because of its better penetration, and it also created the greatest amount of soil disturbance compared to other types of openers developed. They found the press wheel type had no significant effect in many of the observed parameters.

Chaudhry *et al.* (1991) studied the interactions between direct drilling opener design specification and seed groove micro-environments responsible for seed/seedling performance on a wet soil. The winged, hoe and triple disk openers were used. In the presence of crop residue, the winged furrow opener created inverted T-shaped groove and the hoe-type furrow opener created U-shaped groove that resulted in greater number of seedling emergence, oxygen diffusion rates and earthworms activity than V-shaped groove created by the triple-disk furrow opener. A compact zone adversely affects the seedling performance and earthworm activity around the groove profiles. Wilkin *et al.* (1983) conducted a field study and reported that the disk-type opening configuration forced some residues down into the seed trench and moved dry topsoil's into the seed zone rather than moved it laterally, thereby increased wheat emergence. Penetration of furrow openers in arable soils is a problem especially for disc-type openers when sowing under stubble mulch conditions, due to the tendency of the opener to push dry soil and stubble into the furrows. Also there is a tendency of failure in form of breakage to the furrow openers when they come in contact with obstacles such as stones and stumps this is because most furrow openers are not equipped with "spring" materials that can easily bounce back and roll over obstacles without breakage. Several factors, ranging from the lack of management decisions for handling crop residues to the inability of conventional planters to drill grains into soil and high costs of purchasing foreign made planters and furrow openers not adaptable to our local environment are contributing to the problem. In developing countries especially in the continent of Africa, the mechanization level of farming activities is very low such that almost 98% of

planting operations are carried out manually. In order to mechanize a fraction of the planting operation, the development of tractor draw five (5) row furrow opening equipment was conceived with a view to increase output of planting operations. The equipment was designed to open the soil, dropped seeds into the hole and covered manually. This is expected to increase agricultural productivity through a substantial increase in the total cultivated land area.

Materials and Methods
Machine description
The furrow opener is made up of the following components as described in Fig. 1.
Beam: This is the skeletal framework of the furrow opener on which all other components are mounted. It is made of 2 units of 3-inches mild steel angle iron welded together to form a rectangular hollow pipe to which a solid shaft is welded at both ends linking to the transport wheels.
Transport wheels: The wheels are located at both ends of the frame. They are circular in shape made from guage 14 mild steel plate containing 16 mm rods which serves as spokes. These spokes are used to support the centre hub (bearing housing). The spokes are arranged in such a way that it braced the wheels circular circumference and also gives it necessary radial support.
Tractor 3-point hitch: The hitch is the place of connection of implement or equipment to the tractor. Most farm operations involve hitching of some sort making forces transmitted through hitch or hitch point affect both tractor and implement. The three point hitch is standard on most tractors and consists of the upper link and two lower links. The 3-point hitch is very effective in lowering and lifting farm equipment and can also be used for semi-mounted implements such as the soil opener to give it stability and support when used on the farm. The entire 3-point hitch structure of the furrow was made of welded U-channels brazed at the sides to increase strength and rigidity.
Spring bar furrow opener: This is made of two parts: The upper part which comprises of a bolted spring bar and the lower section which does the actual soil opening comprising of a V-notched 3-inches angle iron. The spring bar is a specially treated mild steel flat bar of 10mm thickness fastened to the beam with the aid of bolts and nuts. The spring works in such a way that it swings upwards/backward when obstacles such as roots, stumps and stones are encountered and allows the lower section/soil opener to ride over the obstruction, thus preventing damage. The angle between the flat spring bar and the soil opener is 120°. This helps in ensuring better penetration into the soil and also helps perfect the springy action of the soil opener against damage when in contact with obstacles. Thus the "springing action" makes it possible for the soil opener to work effectively in soils that contains stones and stumps. The lower section (soil opener) is spaced 50 cm apart from each other so as to enhance uniform spacing on the farm.
Bearing/bearing housing: The bearings are selected based on their load carrying capacity, life expectancy and reliability. Ball bearings are fixed in the hub (bearing housing) provided at the two ends of the frame in other to support the solid 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. Each of the bearing housing contains two bearings through which a shaft welded to the beam is allowed to pass through the bearings and locked at both threaded ends with an interlocking nut. The whole bearing and shaft assembly permits the free movement of the wheels but disallows the turning of the beam.

FUW Trends in Science & Technology Journal, www.ftstjournal.com
e-ISSN: 24085162; p-ISSN: 20485170; April, 2017: Vol. 2 No. 1B pp. 450 – 455
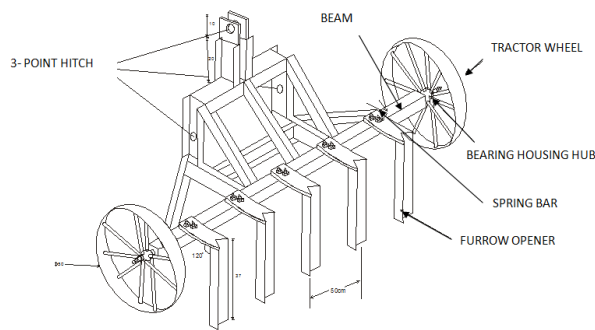
451

Fig. 1: Isometric projection of the tractor drawn five row opening device

Design analysis
The design analysis was carried out with a view to evaluating the necessary design parameters, strength and size of materials for consideration in the selection of the various machine parts in order to avoid failure by excessive yielding and fatigue during the required working life of the machine.

Selection of bearing
In the selection of bearing for the bearing housing/hub, careful consideration was given to the bearing life. Khurmi and Gupta (2005) defined the life of a bearing as the number of revolutions or hours at some given constant speed which the bearing runs before the first evidence of fatigue develops.
Considered fatigue developing in the bearing due to high operating number of hours a deep groove ball bearing was used. In this type of bearing fatigue rarely develops.

Design of the major parts of the machine
In order to get the desired job done, the following components of the furrow opener were constructed according to the designed specification based on the selected materials.

Determination of weight of the beam
The weight of the beam was determined in order to know the amount of load being exerted on the beam by other components of the furrow opener. Therefore, the weight of the beam is expressed as:

$$W = \rho v g \qquad 1$$

Where: W-weight of the beam, ρ - density of the beam, g-acceleration due to gravity, v - volume of the beam

Determination of the bearing shaft diameter
The bearing shaft diameter is needed in order to determine the load carrying capacity of the shaft. For a solid shaft with little or no axial load, the diameter of the shaft is determined as reported by Khurmi and Gupta (2005)

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

Where, d-is the diameter of the shaft, S_s- is the allowable stress
K_b-is the combine shock and fatigue factor applied to bending moment
M_b- is the bending moment,
K_t-is the combine shock and fatigue factor applied to torsional moment

Determination of the power required to create the furrow
The power required to create the furrow was determined as reported by Khurmi and Gupta (2005)

$$P = Tv \qquad 3$$

Where, P -power required to create the furrow, T - torque of the tractor engine
v – forward speed of the tractor

Determination of the total length of the beam
The beam carries five furrow openers spaced uniformly from each other with the same distance away from the edges of the beam.

$$L = 4s + 2f \qquad 4$$

Where, L= Total length of the beam, S= Uniform distance between furrows
F= Distance from the edge of the beam to the first furrow opener

Determination of the thickness of the spring flat bar
The thickness of the spring flat bar was determined by applying the formula:

$$\partial = \frac{WL^3}{48EI} \qquad 5$$

Where, W= weight of the spring flat bar, l= Length of the bar, E=Young modulus
I= Moment of inertia, ∂= Deflection during operation, But moment of inertia is given as:

$$I = \frac{bh^3}{12} \qquad 6$$

Where b = width of bar, h= Thickness, from equations 5 and 6

$$\partial = \frac{WL^3}{48E(bh^3/12)} \qquad 7$$

Therefore,

$$h = \sqrt{12WL^3/48E\partial b} \qquad 8$$

Determination of the maximum shear stress of the shaft
The shaft is under a combined load of bending moment and torque and was determined as reported by Khurmi and Gupta (2005)

$$\tau_{max} = \frac{16}{\pi d^3}\sqrt{(M^2 + T^2)} \qquad 9$$

Where, τ_{max} = Maximum shear stress (N/m), T= Torque (Nm)
M= Bending moment of shaft (Nm), d= shaft diameter (m)
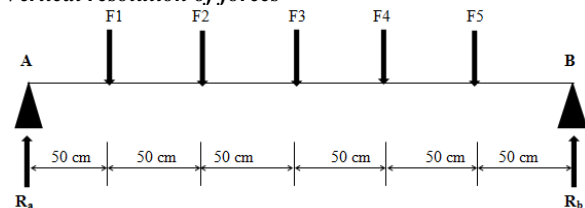
Vertical resolution of forces

Fig. 2: Free-body diagram of the beam and wheel system
Where: R_a and R_b = vertical soil reactions acting on the transport wheels
F1 to F5= vertical forces acting on the individual (Flat spring bar) furrow openers
Resolving forces acting on the beam/furrow opener assembly vertically, using the relationship below;

$$F_v = Wcos\theta \qquad 10$$

Where, F_v-is vertical force
W- is the weight of beam with the furrow opener
θ-is the angle of inclination of the furrow opener
For this design θ is taken to be 120^0.
From the figure 1.0, the summation of vertical forces is equal to zero(0)
$+\uparrow \sum V = 0, \ R_a + R_b - F_1 - F_2 - F_3 - F_4 - F_5 = 0$
$\therefore R_a = F_1 + F_2 + F_3 + F_4 + F_5 - R_b \qquad 11$
Taking moment about point$A$
$+\uparrow \sum M_A = 0, \qquad 50F1 + 100F2 + 150F3 + 200F4 + 250F5 - 300R_b = 0$

$$R_b = \frac{50F1+100F2+150F3+200F4+250F5}{300} \qquad 12$$

Determination of angle of twist
The angle of twist helps to know whether the diameter of the shaft is safe to carry the applied load. According to Hall *et al.*, 1980 the amount of twist permissible depends on particular application and varies about 0.3 degree per meter for a machine tool shaft and about 3 degree per meter for line shafting.
Therefore, angle of twist (θ); for solid shaft is given as follow:

FUW Trends in Science & Technology Journal, www.ftstjournal.com
e-ISSN: 24085162; p-ISSN: 20485170; April, 2017: Vol. 2 No. 1B pp. 450 – 455

452

$$\theta = \frac{584 M_t L}{G d^4} \qquad \qquad 13$$

Where, L- is the length of shaft, M_t-is the torsional moment G-is the torsional modulus, d-is the diameter of the shaft

Hitching and weight transfer

Hitching affects both the vertical and horizontal relationship between the tractor and the furrow opener. The vertical component of forces on the tractor affects the tractive performance of the tractor. Force imposed on the tractor by hitched implement could be transmitted by the drawbar or semi mounted and the 3-point hitch.

Weight transfer is the changes that occur in the front and rear wheel reactions that occur when a tractor pulls a load behind either via the drawbar, 3-hitch point or P.T.O.
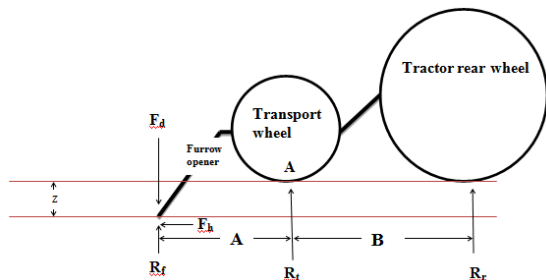

Fig. 3: Working diagram of the furrow opener hitch to the rear of the tractor during operation

Taking moment about point A

$$+\uparrow \sum M_A = 0$$
$$R_f.A + F_h.Z - F_d.A - R_r.B = 0 \qquad 14$$

Where: R_f = Vertical soil reaction on the furrow opening device

R_t = Vertical soil reaction on the transport wheel of the furrow opener

R_r = Vertical soil reaction on the rear wheel of the tractor

F_d = Downward force acting on the furrow opener

F_h = Horizontal component of the resistance force acting on the furrow opener in the X-direction.

Z = Sinkage; Distance from the level ground to the depth of the furrow opener in the soil

A = Distance from the centre of the transport wheel to the point of action of the furrow opener

B = Distance from the centre of the rear wheel of the tractor to the centre of the transport wheel of the furrow opener

Hence, $R_r = \frac{R_f.A + F_h.Z - F_d.A}{B} \qquad 15$

When there is no pull, $F_h = 0$ and the rear wheel reactions becomes

$$R_{r0} = \frac{R_f.A - F_d.A}{B} \qquad 16$$

That is the force, R_r = Dynamic rear wheel reaction

R_{r0} = Static rear wheel reaction

The weight transfer therefore (ΔR_r) is the difference between the static rear wheel reaction (R_{r0}) and the dynamic rear wheel reaction (R_r).

$$\Delta R_r = R_{r0} - R_r$$
$$\Delta R_r = \frac{F_h.Z}{B} \qquad 17$$

Determination of the capacity of the furrow opener

The capacity of the furrow opener was evaluated in terms of the total land area covered per day expressed in hectares per day. This was done to evaluate the efficiency of the device as compared to the manual method of soil opening and planting. The result obtained would be an important engineering data that would be used in comparing different soil opening devices. The capacity of the furrow opener was obtained from the following expression:

$$C_F = \frac{A_T (m^2/day)}{10,000 \ (m^2/hectare)} \qquad 18$$

Where: C_F = Capacity of the furrow opener in hectares/day

A_T = Total area covered per day in m^2/day

But $A_T = S \times W \qquad 19$

Where: S = Forward speed of the tractor during the operation in km/h.

W = Total width of the furrow opener in metres

Working operation and testing of the furrow opener

The furrow opener works effectively under conservation tillage where the soil has not been worked upon by tillage equipment (i.e. soft un-tilled soil) as well as under soils that have undergone secondary tillage using plough and harrow to churn up the soil.

The various aforementioned parts of the furrow opener were assembled, after which the two wheels were set in place using a lock nut to position them so as to ensure the wheels are well set and does not pull out during farm operations. Since welding the flat spring bar to the beam would reduce its strength leading to breakage, the flat spring bars (five in number) were therefore bolted to the beam with bolts of size "22". After all the parts have been assembled, the 3-point hitch of the furrow opener was connected to the three point linkage of the tractor comprising of an upper link arm and two lower link arms located at the rear of the tractor. The control lever at the driver's side which enhances the lowering, lifting, trailing and transportation of the furrow opener was engaged. The depth of penetration of the furrow opener into the soil was also controlled from the adjustment of the tractor's three point linkage controlled by the hydraulic control lever.

The furrow opener can be effectively used where minimum costs of cultivating farm lands are required. The furrow opener works effectively in the absence of a ridger and planter thus minimising money spent on mechanised ridging and planting.

After the land has been cleared of bushes and shrubs, the land was ploughed and immediately followed by harrowing so as to scatter soil clods and also helps pulverise the soil. Instead of ridging, the furrow opener spaced at 50 cm apart was introduced into the farm so as to open up the soil for planting operations. With the furrow opener hitched behind the tractor and with the tractor operating at a speed of 12.5 km/h the hydraulic control lever was engaged so as to make the furrow opener sink into the soil. As such about 5 cm of the furrow opener enters into the ground and as the tractor moves a five furrow was created. The continuous forward motion of the tractor makes the creation of a continuous furrow spaced at 50 cm apart. As the furrows were created, five persons with seeds in a seed container follows behind the furrow opener and drops the seeds into the furrow created while another five persons followed behind and immediately covers the furrow containing the dropped seeds. With this, a uniform planting was ensured spaced at 50 cm apart thus conserving the money that would have been spent on an entirely mechanised ridging and planting operation as well as reducing the drudgery that would have been associated with an entirely manual planting process. As the crops springs up, the entire plant population was observed to be evenly spaced at 50 cm apart on a straight line.

For a furrow opener, the ability to open the soil at a given sowing depth is an important factor in evaluating its performance. For the furrow opener operation, the capacity was calculated by multiplying the forward speed of the tractor in km/day by the total span width of the furrow opener all divided by 10,000. This gives us the capacity of the furrow opener in hectares per day.

FUW Trends in Science & Technology Journal, www.ftstjournal.com
e-ISSN: 24085162; p-ISSN: 20485170; April, 2017: Vol. 2 No. 1B pp. 450 – 455

453

Furrow opener- testing

The six row tractor drawn furrow opener was tested for its capacity, furrow opening efficiency and seed germination.

One hectare of flat land was ploughed and harrowed properly at Essa village in Niger state, Nigeria in October, 2015 which is the rainy and planting season. The furrow opener was fastened to a 75 horse power Massey Ferguson 375 tractor. It was then lowered and adjusted to a depth of 5 cm which is the recommended depth for planting soybeans with the aid of the upper and two lower links of the tractor and pulled along at four different speeds to open the soil. The four speeds were 8, 12, 16 and 20 km/h. Soybeans was drilled in the furrows and left to germinate. The germination rate was then assessed after 3 weeks from date of planting. The actual depth of soil opened by the equipment, its efficiency in opening the soil relative to the adjusted depth and seed germination were assessed as follows:

I) Depth of furrow: This was assessed by measuring the depth with a measuring tape. A flat bar was laid horizontally across the furrows at random points and the metric tape was used to measure the vertical height.

II) Furrow Opening efficiency: The furrow opening efficiency of the implement was computed as the ratio of the actual depth of the furrows created by the implement to the adjusted furrow depth before commencing operation expressed in percent :

$$F_O = \frac{F_{ad}}{F_{id}} \qquad 20$$

Where F_O is furrow opening efficiency (%)
F_{ad} is actual furrow depth (cm)
F_{id} is initial adjusted depth before commencement of operation (cm)

III) Germination rate: The germination rate was determined by marking out and counting the number of seeds drilled within a given area at different points. The number of seeds that germinated after three weeks was also counted and was expressed as percentage relative to the seeds number of seeds drilled originally at each point as follows:

$$G_r = \frac{S_g}{S_d} \times 100 \qquad 21$$

Where G_r is Germination rate (%)
S_g is Number of germinated seeds (number)
S_d is Number of drilled seeds (number)

Results and Discussion

The results of testing of the furrow opener is shown in Table 1, the furrow opener performed better at tractor and implement speeds of 8, 12 and 12 km/h by opening up the soil up to depths of 4.0 cm at 8 km/h to 4.7 cm at 16 km/h. The furrow depth obtained ranged from 2.7 cm to 4.7 cm. The highest value of 4.7 cm was obtained from speed 16 km/h while the lowest furrow depth of 2.7 cm was recorded for the highest speed of 20 km/h. This could be due to the imperfectly level soil condition which makes the implement to skip some portions of land. Also, the germination rate of the soybean seeds was 94%, the highest for tractor/implement speed of 16 km/h and lowest, 54% at the highest speed of 20 km/h. The low germination rate for the highest tractor speed corresponding to poor furrow opener is attributable to the shallow furrow which enabled rodents, beds and pests to pick them up. The best and optimum speed for desirable performance of the implement is therefore recommended to be 16 km/h.

Table 1: Performance of furrow opener

S/N	Tractor/ Implement speed (km/hr)	Replications	Furrow depth (cm)	Germination (%)	Average Furrow Depth(cm)	Average germination (%)	Furrow opening efficiency (%)
1	8.0	1	4.0	80.0	4.3	74.0	86.0
		2	4.0	74.0			
		3	5.0	68.0			
2	12.0	1	3.0	82.0	4.0	79.0	80.0
		2	4.0	75.0			
		3	5.0	80.0			
3	16.0	1	5.0	81.0	4.7	81.0	94.0
		2	4.0	79.0			
		3	5.0	83.0			
4	20.0	1	3.0	75.0	2.7	66.7	54.0
		2	3.0	68.0			
		3	2.0	57.0			

Conclusion

A tractor drawn five row furrow opening device for the opening of soils in order to facilitate planting process was designed, fabricated and tested for uniformity of depth, crop emergence and working capacity. From the test results on the fabrication and testing of the device, the following conclusions are made;

i. The device was able to effectively open the soil at a uniform depth of 5 cm on a straight line for the facilitation of planting seeds in order to save time and reduce drudgery associated with manual planting.

ii. Visual inspection of the planted seeds after germination showed a uniform plant growth on a straight line indicating that the depth of soil opening was uniform throughout the working operation of the fabricated device.

iii. The device was found to have a capacity of 30 hectares per day which an entirely manual method of planting would require large labour force to accomplish.

iv. The fabricated device would help alleviate the drudgeries encountered during an entirely manual planting operation and it would also help correct the abnormalities and problems encountered from other seed opening devices. Thus increasing

FUW Trends in Science & Technology Journal, www.ftstjournal.com
e-ISSN: 24085162; p-ISSN: 20485170; April, 2017: Vol. 2 No. 1B pp. 450 – 455

454

agricultural productivity in the country by an increase in the total number of cultivated land, the simple design and use of local materials makes it easy for local artisans to maintain and repair.

References

Bahri A & Bansal RK 1992. Evaluation of different combinations of openers and press wheels for no-till seeding. *Hommes Terre & Eaux.,* 22: 55-66.

Carter MR 2002. Soil quality for sustainable land management: organic matter and aggregation interactions that maintain soil functions; US Department of Agriculture. *Agricultural Research Service. Agron. J.* 94: 10-18.

Chaudhry AD, Baker JC & Springett JA 1991. Direct drilling (no tillage) influence on barley seedling establishment in a wet soil. *Pak. J. Agri. Sci.,* 28: 21-27.

Desbiolles J 2004. Mechanics and features of coulters openers in zero tillage application, institute of sustainable systems and technologies. *Soil & Till. Res.,* 100: 1-19.

Gupta JK, & Khurmi RS 2005. *Machine design (14thed.).*S .Chand & Company Ltd., Ram Nagar, New Delhi-110055, pp. 434-960.

Gratton J, Chen Y & Tessier S 2003. Design of a spring-loaded downforce system for a no-till seed opener. *Can. Biosyst. Eng.,* 49: 29-35.

Hall AS, Hollwen KOA & Laughum H 1980. *Schaum's Outline of Theory and Problem of Machine Design.* Metricselection. McGrac-Hill Books Company. NewYork, USA.

Rautaray SK 2004. Demonstration of zero-till seed cum fertilizer and strip-till drill. Progress report of CIAE, Bhopal center under All India ICAR coordinated research project presented during the xxv workshop held at PAU, Ludhiana, pp. 6-8.

Schaaf DE, Hann S & Rogers B 1979. The development of performance data on seed drill furrow openers. ASSAE Paper No. 791016. St. Joseph, MI.

Tajuddin A & Balasubramanium M 1995. Comparative performance of different types of furrow openers. *AMA.* 26: 18-20.

Wilkin HA, Simpson AJG & Dhali IS 1983. Evaluation of power driven for residue management. *Asian J. Agri. Res.*, 1522-1624.

FUW Trends in Science & Technology Journal, www.ftstjournal.com
e-ISSN: 24085162; p-ISSN: 20485170; April, 2017: Vol. 2 No. 1B pp. 450 – 455

455