DEVELOPMENT OF A PUSH TYPE SEED DRILL FOR SOWING MAIZE IN RWANDA

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Abstract
Farmers in Rwanda perform agriculture mostly with manual operation. The pain involved in doing each and every operation has to be reduced by the way of introducing simple technology. The aim of the present study is to develop a seed drill to suit the varied topographic condition of Rwanda. The specific objective of the study is to develop a seed drill and test the performance of the seed drill. It is also compared with manual seeding for its benefit cost analysis. The study reveals the following vital points in the development and testing of seed drill.

1) A manually drawn single row seed drill is developed to sow the maize seeds at the spacing of 30 cm from plant to plant and 70 cm between row to row.
2) The seed drill is tested on 25 m² area in concrete floor, actual field and it is compared with the manual sowing of same area. The sowing efficiency of seed drill in ideal concrete floor is 98% because the concrete floor does not have slippage for wheels.
3) Sowing efficiency of the seed drill on actual field condition evaluated by germination test is 88%. Sowing efficiency of manual method on actual field condition is 96%.
4) The actual field capacity of seed drill is found to be 60 hours / hectare whereas the field capacity by manual method is 247 hours / hectare.
5) The ergonomic study gives the conclusion that the human drudgery can be saved by 10 times by using seed drill than by working manually in sowing the seeds. It is found that ratio of body movement of using seed drill and manual method is estimated to be 1 : 10.
6) The benefit cost study reveals the fact that the cost of sowing of land by seed drill is 3900 Frw /hectare and the manual sowing gives 12350 Frw /hectare. Hence, it is advantageous to go in for using seed drill for sowing. Sowing by seed drill gives 3 times saving in cost.

INTRODUCTION
Rwanda is a developing country in agricultural technology and its adoption. According to a study made by ISAE, it is found that hoes, pangas, axes and shovels are the main farm tools used by the farmers in Rwanda. These tools are conventional, time immemorial and no improvement in agricultural practice is adopted. Hence, it caused us to develop drudgery reduction and easy to use hand tools to help the farming community in Rwanda.
Sowing is one of the basic operations needed to get better revenue from agriculture. Manual sowing has the problem of not giving adequate spacing between row to row and plant to plant leading to less population of crops than recommended by the agronomists. Also there is the problem of placing the seeds at correct depth and correct soil coverage. Manual sowing is time consuming and costly. Hence, there is a need for appropriate seed drill for sowing. This paper deals the development and testing of an appropriate seed drill for sowing cereal crops like maize, beans and sorghum.
REVIEW OF LITERATURE
Seymour's sowing machine [1], which was successfully introduced among the farmers of Western New York. It sows correctly all kinds of grain and seed, from peas to grass seed. With this machine, any body who can drive a horse with common accuracy, may ride in an easy seat and sow much better than is usually done by hand, or than most people can sow by hand.
Sahay [2] stated that seed drills or seed cum fertilizer drills (Bullock drawn tractor drawn or manual push type seeders) facilitate line sowing and proper application of seed and fertilizer in the field. Thus there is saving of 10-15% inputs. About 30% saving of fertilizer is estimated if properly applied. The animal drawn two row and three row sowing devices have been adopted as these cover more area at less cost.
Jain [3] stated that seed drill is developed to save time, fuel and irrigation expenses. These machines are used for sowing all types of seeds like wheat, maize, soya etc in fully tilled field. The mechanism of a seed drill, which distributes and delivers the seeds from the hopper at selected rates, is called seed metering mechanism.

MATERIALS AND METHODS
Main frame of seed drill consists of a mild steel tube of 40 mm diameter so that it can withstand all types of load during operation. It has holes at both ends so that the ground wheel can be fitted. The ground wheel can be applied with lubrication for efficient movement. The main frame carries a seed box (hopper). The seed metering disk is fitted in the mainframe. The seed disk is covered by a cover. The main frame consists of a handle for pushing seed drill. Seed hopper is made of mild steel sheet. It is made of trapezoidal shape of dimension 17 x 14 cm on top side and 6 x 4 cm on bottom side. The height is 18 cm. A seed regulator is provided to control the flow of seeds. The regulator can be closed while the seed drill is not in working condition. It can be opened to the desired level as per the wish of the operator. The hopper has the seed holding capacity of 1.5 Kg of dried seed.

Seed metering mechanism
Seed metering mechanism is fitted at the bottom of the seed box to allow the desired quantity of seed. It consists of seed disk, cover of seed disk, seed tube and seed holes.

Seed metering disk
It consists of flat rod of 3 cm wide and 0.5 cm thickness. It is bent and welded to circular shape having the diameter of 16 cm. It has 8 holes around the circumference of the circle at equally spaced distance and it is used for sowing beans. The same circular rod having 5 holes equally spaced in its circumference can be used for sowing maize. The distance between centres of hole to next centre of hole is 10 cm. The seed disk is fixed on the shaft of the ground wheel so that the motion of ground wheel provides the motive force for rolling of the seed disk.

Seed holes on the metering disk
The holes are drilled on the circumference of the disk. The function of the hole is to collect the seeds from the hopper and transport it to seed tube. The distance between two successive holes is 10 cm for maize. The holes are in the shape of a cup having 2.3 cm diameter and 1.5 cm depth.

Fig 1: Seed drill
Cover of Seed disk
It is made of metal sheet cut in to two separate circular shapes. The two parts are
welded with a rectangular sheet of length equal to the circumference of the circular sheet, which is 63 cm length and width of 5 cm. This cover has plastic grooves which control the quantity of seed taken from the hopper. The cover also helps in preventing the damage of seeds and it guides the seeds to go to the seed tubes.

**Seed tube**
It is made of mild steel having 4 cm diameter circular cross section. It received the seeds from the seed disk and transfers them to the furrow opened by the furrow opener. It assures the free flow of seeds to the furrow. The height of the seed tube is 13 cm. The seed tube carries a furrow opener to make the furrow for placing seed. The back side of the seed tube has furrow closer to cover the seed with soil.

**Furrow Opener and Closer**
Furrow opener and closer are provided at the bottom of the seed tube to facilitate the correct amount and placement of seed at desired uniform depth. It also helps to close the furrow and compact the soil after placement of seeds.

**Furrow Opener**
It is made of metal sheet. It is cut into triangular and curved shape. It is provided with a sharp cutting edge to cut the soil. The concave curved portion of the plough is forward and the convex part is backward. It is a two way plough like opener. The angle between two wings of the openers is 135º. This furrow opener has total length of 20 cm for both the wings and the depth is 15 cm. It makes an angle of 45º with horizontal which facilitates the easy penetration into the soil. It cut the soil, lift up the soil above the wings of the opener and pulverise the soil and thorough the soil on both sides of the two way wings. It makes a furrow of 5 cm deep, which is the best depth for placing the seeds. The furrow opener is kept 15 cm in front of the seed tube to avoid clogging of seeds and soils.

**Furrow Closer**
It is made of mild steel sheet. It is cut into the form of crescent shape. It is curved. The concave part is backside. The angle between wings is 135º. It facilitates the soil to cover the seed. The furrow closer has total length of 30 cm for both the wings and the depth is 10 cm. The furrow closer is kept 15 cm at the backside of the seed tube to avoid clogging of seeds. It makes an angle of 60º with the horizontal so that it can take all soils in to the furrow.

**Ground wheel**
The rim of the wheel is made from a flat metal rod of 3 cm wide and 0.5 cm thickness. It is bent and welded to form a circular form of 49 cm diameter. The periphery is fitted with 15 numbers of lugs at equal spacing. The lugs are of square form of 3 cm side. It reduces the slippage while moving in the field. The distance between the holes in the seed metering disk depends upon the diameter of the ground wheel.

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**Performance testing of seed drill in actual field condition**
The field testing of the seed drill is done on a well prepared and leveled land. The testing of seed drill is done with medium moisture content. These testing are compared to the field sown manually.

**Germination of seeds after sowing**
After preparing seed bed of 50 cm of depth, maize grains have been sown at a depth of 3 cm using the seed drill. The seed to seed distance was 25 cm and the row to row distance was adopted as 30 cm. Two grains are placed in a hill.

\[
\text{Number of grains sown} = \frac{\text{min min} \times 100}{\text{min min}}
\]
**Ger ation Percent = Number of grains ger ated**

**Benefit cost analysis**
The cost sowing in 25 m² areas by the manual method and also using seed drill was calculated and compared. The time saving between the two methods are also worked.

**RESULTS AND DISCUSSIONS**

**Calibration of seed drill**
Before the seed drill is taken to field, it is calibrated in the laboratory condition. It is calibrated to regularize the quantity to be sown. Calibration is done as follows:

**Table 1: Details of calibration of seed drill:**

- Circumference of ground wheel \( \pi D = 3.14 \times 49 = 153.86 \text{ cm} = 1.54 \text{ m} \)
- Number to turns the ground wheel make in running 100 m
  
  \[ \frac{100 \text{ m}}{1.54 \text{ m}} = 64.9 = 65 \text{ turns} \]
- Width of seed drill
  
  \[ 1 \times 0.7 \text{ m} = 0.7 \text{ m} \]
- Area covered for one revolution
  
  \[ \text{Circumference of ground wheel} \times \text{Width of seed drill} = 1.54 \text{ m} \times 0.7 \text{ m} = 1.078 \text{ m}^2 \]
- Number of turns needed/ha
  
  \[ \frac{10000 \text{ m}^2}{1.078 \text{ m}^2} = 9276 \text{ turns} \]
- Number of grains dropped assuming the seed hole capacity is 2 seeds
  
  \[ 2 \text{ grains/hole} \times 5 \text{ holes/revolution} = 10 \text{ grains} \]
  
  Therefore for 9276 turns, the number of grains to be dropped
  
  \[ 10 \times 9276 = 92760 \text{ grains/hectare} \]
- No. of grains needed for 25 m² is worked out to 232 grains.

**Testing the performance of seed drill**
The seed drill is tested on 25 m² area in concrete floor, actual field and it is compared with the manual sowing of same area. The field is divided into 6 rows of 15 columns so that desired plant population is maintained. There are 90 grid points. The total number of seeds from each place of dropping is counted. Row total and column total seeds are recorded. It is found that total number of seeds dropped in concrete floor, actual field and in manual sowing is 193,159 and 166. The number of grid points does not have seeds in concrete floor, actual field and in manual sowing are 2, 11 and 4 respectively.

**Sowing efficiency** is computed by the formula:

\[
\text{Sowing efficiency} = \frac{\text{Number of grid po having seeds placed}}{\text{Total grid po}} \times 100\%
\]

Using the above formula, the sowing efficiency as computed and is shown in Fig 2.

**Fig 2: Sowing efficiency of seed drill and manual method**
The reason for having 98% sowing efficiency in the concrete floor is due to no slippage for wheels and the resistance for the ground wheel to move on the floor is very minimum. This caused better performance of the seed drill on ideal condition. Sowing efficiency of seed drill in actual field conditions is 88% because of the resistance offered...
by the soil to the ground wheel, slippage of wheel due to undulating conditions in the field, damaged seeds may be selected for sowing and seeds may be damaged due to friction between the seed hole and seed cover. The manual sowing gives the sowing efficiency of 96% in the field. There is only 4% loss of performance. The reason for high performance is due to the fact that manual operation is highly selective, it is accurate placement of seeds at correct depth, seeds are very well covered with soil and gentle compaction is done on the soil.

**Computation of field capacity of different methods of sowing**

Sowing is carried out simultaneously by seed drill and manual method in the fields having 25 m² areas. The time taken for sowing by seed drill is found to be 9 minutes and for the manual method was found to be 37 minutes. Extrapolation was carried out to find out the field capacity (time to sow seed for one hectare land). Actual field capacity for the seed drill was found 60 hours/ha and for the manual method it was 247 hours/ha. This shows that the time of sowing is saved with the ratio of 1:4 between seed drill and manual method.

**Ergonomics as applied to seed drill and manual operation**

Ergonomics is the study of computing human drudgery and finding the solution by manipulating the operational parameters of the machine used for sowing. The number of body movements made in manual sowing and in the seed drill method is assessed for a comparative study. The number of body movements in manual sowing for 25 m² plot was estimated to be 1561 and for the type seed drill it is 154 only. The ratio of body pain and drudgery for manual and seed drill sowing can be worked out to be 10:1. The ergonomic study gives the conclusion that the human drudgery can be saved by 10 times by using seed drill than by working manually in sowing the seeds.

**Benefit cost analysis**

Initial cost of the seed drill = 30000 Frw  
Life of machine = 15 years  
Taxes, shelter etc = 1.5% of cost of machine = 450 Frw  
Repair and maintenance = 2.5% of cost of machine = 750 Frw  
Operating charge = 400 Frw / day of 8 hours (50 Frw / hour).  
(It was found that the actual field capacity of using seed drill for sowing is 60 hours / hectare whereas it is found that manual sowing needs 247 hours / hectare). Therefore, in using seed drill for operating 60 hours to complete one hectare area.  
Operating cost = 60 hour x 50 Frw = 3000 Frw  
Total cost of sowing by seed drill for one hectare = Cost of taxes, shelter etc + Cost
of repair and maintenance + Operating cost
Total cost of sowing by seed drill/ha = 450 + 750 + 3000 = 4200 Frw / hectare.
Cost of sowing by manual method / ha
= 247 hours x cost/hour = 247 hours x 50 Frw/hour = 12350 Frw / hectare
The cost of sowing one hectare of land by seed drill is 4200 Frw /ha and the same
operation can be done by manual sowing with 12350 Frw / ha. Hence, it is advantageous
to go in for using seed drill for sowing the seeds.

SUMMARY AND CONCLUSIONS
The following is the main conclusions of the development and performance
evaluation of a single row push type seed drill. A push type single row seed drill is
developed to sow the maize seeds at the spacing of 30 cm from plant to plant and 70 cm
between row to row. The seed drill is tested on the flat concrete floor, actual field and it
was compared with the manual sowing of same area. It was found that the sowing
efficiency on concrete floor, actual field and in manual sowing are 98%, 88% and 96%
respectively. Though the seed drill has 8% lesser performance than manual sowing it can
be adopted because of the advantage of time saving and reduction of human drudgery. It is
found that the time saving between seed drill and the manual sowing is 1:4. The ergonomic
study gives the conclusion that the human drudgery can be saved by 10 times by using
seed drill than by working manually in sowing the seeds. The benefit cost study reveals
the fact that the cost of sowing of land by seed drill is 3900 Frw /hectare and the manual
sowing gives 12350 Frw /hectare. Hence, it is advantageous to go in for using seed drill
for sowing. Sowing by seed drill gives 3 times saving in cost.

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