PERFORMANCE TEST ON CORN PLANTER OF ROLLING INJECTION TYPE

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Introduction

In Kenya's agriculture, maize is the main subsistence crop for small scale farming. The output of maize was 2,450 thousand tons during the period of two years from 1974 to 1976, but in 1983 decreased to 2,000 thousand tons.[3] On the other hand, the rate of growth of population in Kenya is about four percent in the last few years. So, it is necessary to increase crop production.[6)7)]

Therefore, a production improvement plan must be made immediately for increasing the yield of maize and the income of farmers.

So, we need to act the following ways as a basic solution;

1. To extend the cultivation area of maize
2. To carry out planting at the right time and to plant seeds at a constant space
3. To carry out improvement on production by agricultural mechanization.

This research is carried out to establish a base of the small scale agricultural mechanizatio on corn cultivation for small scale farmers in Kenya.

This research will reveal the performance of the corn planter with a view to improving on their reliability and to furnishing design data in developing the corn planter which has a higher performance.

Materials and Methods

1. The precise testing system indoors for small machines

The testing system is composed of a small trailer with an electric motor and a soil bin with rails.

(1) Soil bin

The soil bin which is shown in Fig. 1 and Table I was made at the workshop of the Department of Agricultultural Engineering, JKCAT. The merit of this soil bin is as follows;

1) To Keep the soil condition constant
2) To get precision datum
3) To be able to carry out research frequently
4) To be able to observe properly the mechanism of machine while the machine is working.

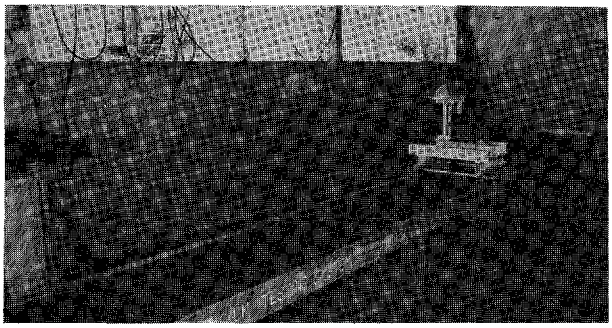


Fig. 1. Soil Bin

TABLE 1. SPECIFICATION OF SOIL BIN

Frame of Soil bin			Soil Bin			
Length (mm)	Width (mm)	Height (mm)	Length (mm)	Width (mm)	Depth (mm)	Kind of Soil
6000	600	500	5000	580	100	Nitosols

(2) Small trailer for pulling the experimental machine

The trailer shown Fig. 2 was for pulling the experimental machine. The power of the trailer is 0.75 kw. The small trailer can move forward and reverse by changing the switch and wiring. Table 2 shows the specification of the small trailer.

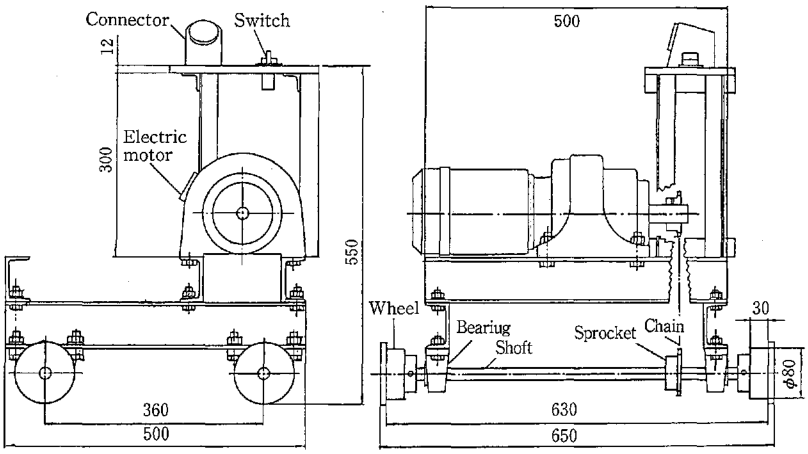


Fig. 2. Design of Small Trailer

2. Corn planter of rolling injection type used in the testing

Planting of maize on small scale farms in Kenya is done mostly by hand. So the demand of planting machines in Kenya is limited.[1)2)4)5)] In this case, there is only one machine for planting of maize in Kenya. It is the corn planter shown of rolling injection type

TABLE 2. SPECIFICATION OF SMALL TRAILER

Frame			Electric Motor			
Length	Width	Height	Output power	Volt	Amp.	Phase
80cm	70cm	50cm	0.75KW	415 V	2 A	3

Transmission to wheel	Gear Unit		Total Weight
	Output Torque	Revolution of Output shaft	
Sprocket & chain	13kg・m	56rpm	6.0kg

in Fig. 3. This planter are manufactured by Ndume Ltd., Gilgil, Kenya and an operator is needed for pushing the machine on planting. In this research, we reconstructed the planter to a pulling type shown in Fig. 4 and Fig. 5 for using the precise testing system which was made at our workshop. The specification of the corn planter is shown in Table 3.

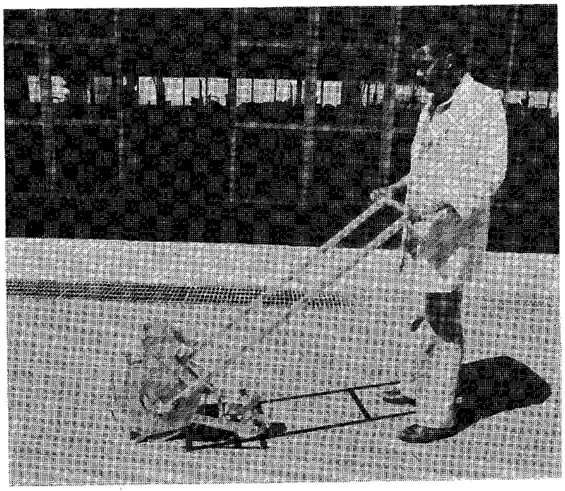


Fig. 3. Corn Planter of Rolling Injection Type in Kenya (Ndume Ltd.)

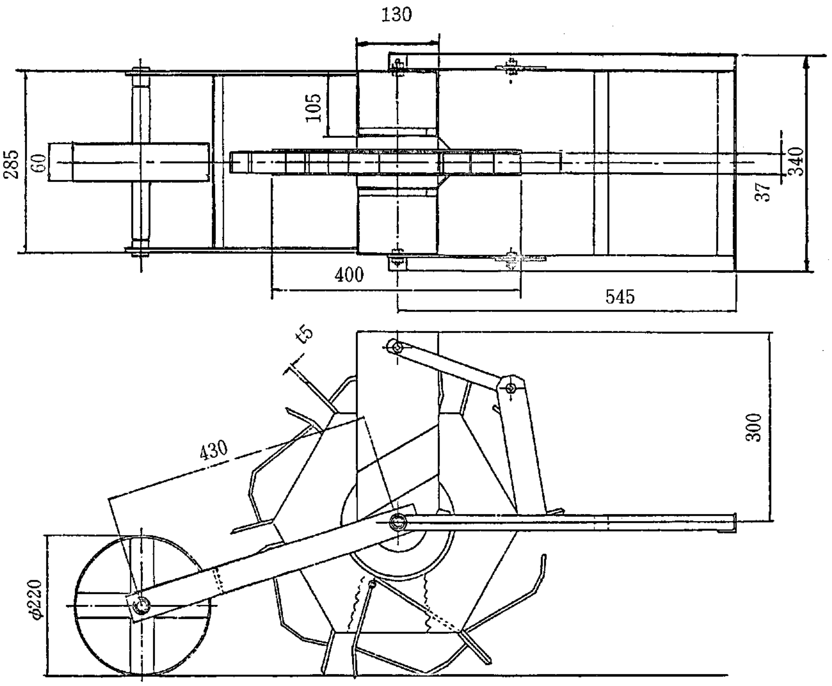


Fig. 4. Reconstructed Corn Planter of Rolling Injection Type for Testing

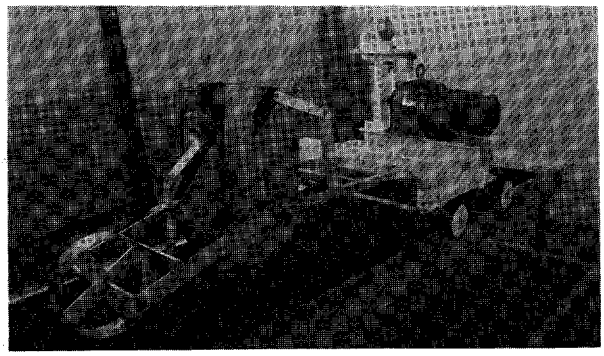


Fig. 5. Tested Corn Planter of Rolling Injection Type and Small Trailer

TABLE 3. SPECIFICATION OF CORN PLANTER OF ROLLING INJECTION TYPE

Model Power & Company	Dimension of planter				Mechanism Metering Planting	Theoretical Planting Distance
	L mm	W mm	H mm	Wt kg		
Ndume	500	650	550	27	Roll* Injection Type	24cm

*Dimension of cell=14.5mm, Depth=6.2mm.

3. Methods

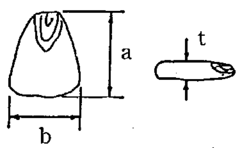
(1) Experimental condition

1) Corn (maize) seeds for testing

Corn (maize) seeds which were used for this research were of five varieties as shown in Table 4.

TABLE 4. DIMENSION OF SEED

Variety	a (mm)		b (mm)		t (mm)		Weight at 1,000 (g)
	AV	SD	AV	SD	AV	SD	
511	12.3	0.8	11.5	0.6	5.3	0.7	499
5012	13.9	1.5	11.0	1.1	5.2	1.3	517
613	11.6	1.3	10.3	1.1	6.4	1.0	477
614	11.2	1.6	10.8	1.1	7.2	1.8	498
625	11.8	1.2	10.6	0.9	5.4	1.2	437



2) Working speed

The working speed was kept constant by the small trailer at 0.24 m/s. If other speed are needed in other testing, a change of the speed is possible by changing the sprocket of the motor side or the diameter of wheels since the revolution of the motor is constant.

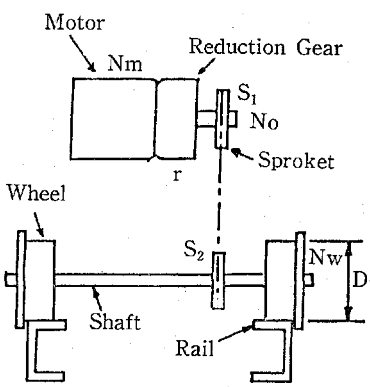


Fig. 6. Mechanism of Running

In Fig. 6, general calculations for getting working speed on the transmission of this trailer is as follows.

S_1: number of sprocket teeth on the shaft of motor

S_2: number of sprocket teeth on the shaft of wheel

Nm: revolution of motor (rpm)
No: revolution of shaft of motor (rpm)
Nw: revolution of wheel (rpm)
r: reduction gear ratio
D: diameter of wheel (m)

Where, $No = Nm \cdot r$

$$Nw = No \frac{S_1}{S_2}$$

$$V = \frac{\pi D Nw}{60} \text{ (m/s)}$$

From these formulas, the theoretical speed in this testing is calculated as follows:

$$S_1 = S_2 = 17,\ r = 1/23.8,\ Nm = 1380 \text{(rpm)},\ D = 0.08 \text{(m)}$$

$$No = 1380 \times \frac{1}{23.8} = 57.98 \div 58$$

$$Nw = 58 \times \frac{17}{17} = 58$$

$$V = \frac{3.14 \times 0.08 \times 58}{60} = 0.243 \div 0.24 \text{ (m/s)}$$

From the measuring results, the working speed was shown in Table 5. The slip was considered negligible in this testing.

TABLE 5. MEASURING RESULT OF SPEED

Without Planter		With Planter	
Time per 3 m	Speed	Time per 3 m	Speed
12.3sec.	0.244m/s	12.6sec.	0.238m/s

3) Soil condition

The soil was collected from the farm of JKCAT. Table 6 shows the soil condition at testing. The soil preparation for mixing soil and water was done before testing for keeping the soil moisture constant.

TABLE 6. SOIL CONDITION

Kinds	Moisture %	Dimension (mm)			
		Under9.5	9.52-19.1	19.1-25	25over
Nitosols	30-35	90.4%	7.9%	1.7%	0 %

(2) Item and methods of measurement

After planting, the covered soil was removed and the following measurement was taken.

1) Number of seeds planted

Seeds were counted on each spot after planting.

2) Planting distance

The distance from one seed to another was measured by a steel ruler.

3) Depth of planting

The depth of planting was measured from the soil surface to the positon of seeds after removing the covered soil in seeds.

(3) Analysis of planting mechanism

The planting operation was taken by a video camera. The planting mechanism was observed from a display window at each rotation of the wheel of the planter.

(4) Calculations of average(AV) and standard deviation(SD)

The average and the standard deviation on the dimension of seeds, the number of seeds planted, the space between seeds, the depth of planting were calculated by a coumputer as follows;

$$AV=\frac{\sum X}{n}$$

$$SD=\sqrt{\frac{1}{n}\left(\sum X^2-\frac{(\sum X)^2}{n}\right)}$$

n = number of samples

X = datum

Results and Discussion

1. Number of seeds planted

The results of the average number of seeds planted per spot, the ratio of planting and the distribution frequency of metering seeds were shown in Table 7, Fig. 7 and Fig. 8 respectively.

TABLE 7. AVERAGE NUMBER OF SEED

Variety	Number	
	AV	SD
511	0.9	0.8
5012	0.6	0.7
613	1.1	0.8
614	0.9	0.6
625	0.8	0.7

This result was influenced by the dimension of seeds. The varieties of 511 and 5012 were not good for this planter because the dimension (size) of seeds was larger than the dimension of the cell in the metering device. The average number of seed, except for variety 613 was below 1.0. This means that there were many spots where the planter failed to drop seeds.

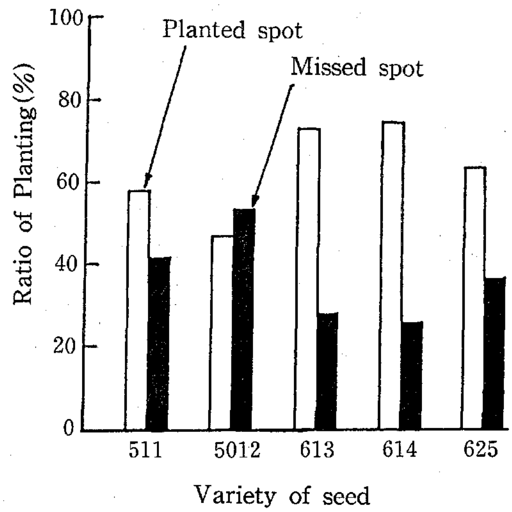


Fig. 7. Ratio of Planting

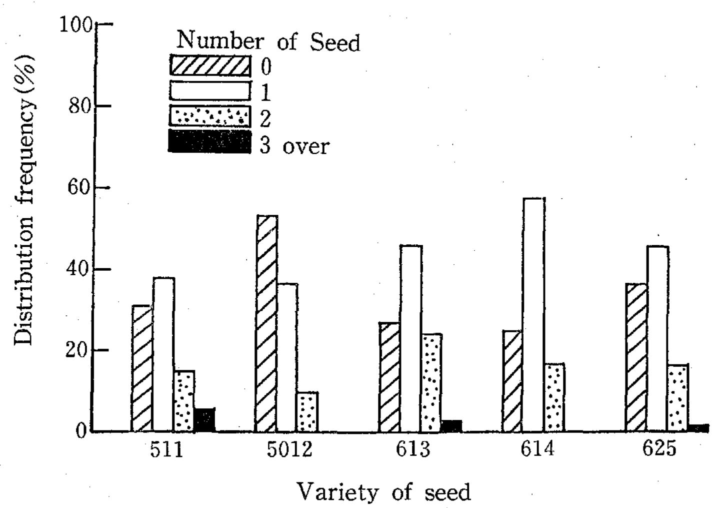


Fig 8. Distribution Frequency of Metering Seed

2. Planting distance

The result of the average and the distribution frequency on the planting distance are shown in Table 8 and Fig. 9. The average planting distance (space) was 25 cm and the standard deviation was about 2.0cm. This mechanism of the planter shows a good performance for seed spacing.

TABLE 8. AVERAGE & STANDARD DEVIATION OF PLANTING DISTANCE

Variety	Planting distance (cm)	
	AV	SD
511	25.8	2.1
5012	25.3	1.6
613	25.5	3.6
614	25.2	1.9
625	24.6	1.7

TABLE 9. AVERAGE AND STANDARD DIVIATION OF DEPTH OF PLANTING

Variety	Depth (cm)	
	AV	SD
511	3.8	0.7
5012	4.2	1.1
613	4.2	1.3
614	3.9	0.9
625	4.2	0.9

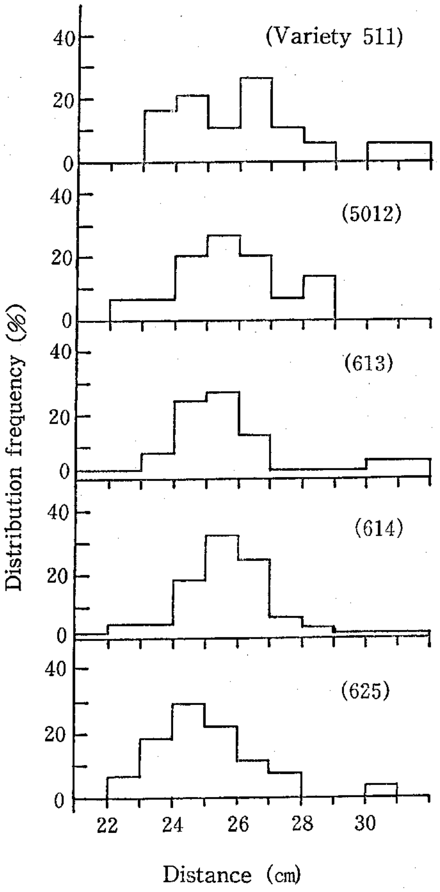


Fig 9. Planting Distance

3. Depth of planting

The result of the average and the distribution frequency of the depth of planting are shown in Table 9 and Fig. 10. The depth of seed by this planter was about 4 cm and the standard deviation was below 1.0cm. The performace of the depth of planting on all tests was good because the mechanism for the depth of planting is the injection type.

TABLE 10. NUMBER OF SEED AND PLANTING DISTANCE ON PLANTER OF INCLINED-PLATE SEED METERING TYPE.

Variety	Number		Distance(cm)	
	AV	SD	AV	SD
511	1.6	0.6	24.0	3.5
5012	0.9	0.6	24.8	3.8
613	1.2	0.4	24.2	3.9
614	1.2	0.4	24.7	2.4
625	1.4	0.5	24.8	1.9

*Dimension of cell=14mm

This planter shows that the performance for seed spacing and depth of planting are good, but the mechanism for metering seeds is not good.

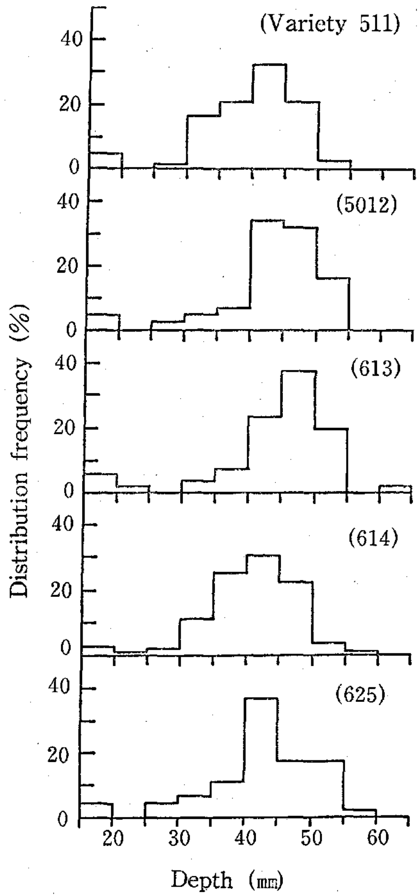


Fig 10. Depth of Planting

4. Comparision of the corn planter of rolling injection type and inclined-plate type

Tested the corn planter of inclined-plate type was produced by Taki Co. Ltd. in Japan. This planter has the same planting conditions with the rolling injection type in Kenya. The operation of this planter is the same as that of rolling injection type except the seed-metering device is different.

The performance under the same testing condition are shown in Table 10, Fig. 11. and Fig 12. As compared with their performance, missed spots in the ratio of planting for the corn planter of inclined-plate type was 0%, but the corn planter of rolling injection type was 30~40 %. On the other hand, the distribution frequency of metering seeds was 70~80% for the corn planter of inclined-plate type, and 40~50% for the corn planter of rolling injection type. From the results obtained, the corn planter of inclined-plate type was better than that of the corn planter of rolling injection type synthetically. This is because the inclined-plate seed-metering device fits maize seeds well.

So, improvements for getting higher performance by the corn planter of rolling injection type in Kenya must be made on points of a seed-metering device.

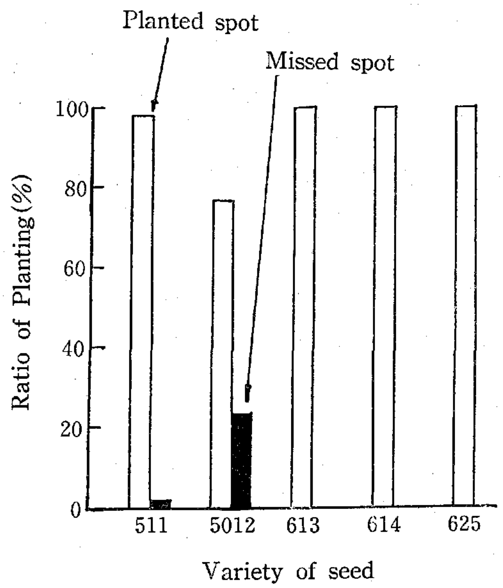


Fig 11. Ratio of Planting on Corn Planter of Inclined-Plate Type

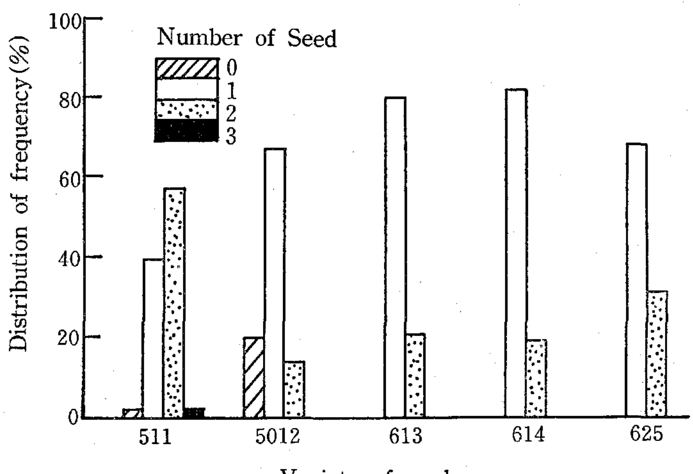


Fig 12. Distribution Frequency of Metering Seed on Corn Planter of Inclined-Plate Type

Summary

1. This research is carried out to establish a base for the small scale agricultural mechanization on the corn cultivation for small scale farmers in Kenya.
2. The testing system for the corn planter was made by authors. The testing system is composed of a small trailer with an electric motor and a soil bin with rails. The small trailer can move forward and reverse by changing a switch.

3. The tested corn planter is manufactured by Ndume Ltd., Gilgil, Kenya.
4. Item and methods on the measurement were the number of seeds planted, the planting distance and the depth of planting on the corn planter.
5. The average number of seed except for the variety 613 was under 1.0. This means that there were many spots where the planter failed to drop seeds. The result of the average and the distribution frequency on the planting distance are 25.3 cm and 2.2 cm respectively. The depth of seed by this planter was about 4 cm and the standard deviation was below 1.0 cm.

Acknowledgements

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