PRINT ISSN 1119-8362
Electronic ISSN 2659-1502

Full-text Available Online at
https://www.ajol.info/index.php/jasem
http://www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 27 (3) 389-393 March 2023

Performance Evaluation of Home-developed Four-row Animal Drawn Precision Maize Planter using a Pair of Bull to Plant SAMMAZ 17 Maize Variety in Samaru-Zaria, Nigeria

[1]AHMED, K; *[2]SALEH, A; [3]KALU, G; [3]MUSA, AD; [4]AMONYE, MC

[1]Department of Agricultural and Bio-Environmental Engineering Technology, Samaru College of Agriculture, Division of Agricultural Colleges, Ahmadu Bello University, Zaria, Nigeria.
*[*2]Department of Agricultural and Bio-Resources Engineering, Ahmadu Bello University, Zaria, Nigeria.*
[3]Department of Agricultural Engineering and Irrigation, National Agricultural Extension and Research Liaison Services, Ahmadu Bello University, Zaria, Nigeria.
[4]National Board for Technology Incubation (NBTI), Federal Ministry of Science and Technology, Abuja.

Corresponding Author Email: salehaminu@gmail.com, Tel: +234 803 577 4780
Co-Authors email: kbahmd@yahoo.com; kaluntyg@yahoo.com; mosead@yahoo.com; mikeamanyo@yahoo.com

ABSTRACT: Realization of optimum yield per hectare in maize production has always been a challenge especially when using home-developed equipment. The objectives of this research was to evaluate the effect of ground speed, hopper seed quantity and planting depth on plant spacing, germination count, and seed delivery rate of a home-developed four-row animal drawn precision maize planter using a pair of bull to plant SAMMAZ 17 maize variety on a harrowed field. It was drawn by a pair of bull in a 3×3×2 randomized complete block experimental design. The treatment factors were three levels of hopper seed quantity (25%, 50% and 100%), three levels of ground speed (2.16, 2.88, and 3.6 km/h) and two levels of planting depth (15 and 25 mm). The results showed that the effects of planting speed, seed quantity and planting depth were highly significant on the planting performance of the machine. The optimum mean seed spacing, germination counts, field efficiency and seed delivery rate of 23.52 cm, 100 %, 86.9% and 20.3 kg/ha respectively were obtained. The study show that optimum seed stand could be achieved with home-developed planted for optimum yield when ground speed, hopper seed quantity and planting depth were varied appropriately.

DOI: **https://dx.doi.org/10.4314/jasem.v27i3.1**

Cite this paper as: AHMED, K; SALEH, A; KALU, G; MUSA, AD; AMONYE, M. C. (2023). Performance Evaluation of Home-developed Four-row Animal Drawn Precision Maize Planter using a Pair of Bull to Plant SAMMAZ 17 Maize Variety in Samaru-Zaria, Nigeria. *J. Appl. Sci. Environ. Manage.* 27 (3) 389-393

Dates: Received: 18 February 2023; Revised: 20 March 2023; Accepted: 22 March 2023
Published: 31 March 2023

Keywords: Evaluations; Ground Speed; Maize; Precision Planter; Seed Spacing

The increase in human population in most developing countries such as Nigeria has become the major reason prompting the demand of continuous food production, while the effects of climatic change continued to have adverse influence on agriculture (Akinseye *et al.*, 2013). The advancement in crop productivity can be realized through genetic improvement or by the use of an efficient technical know-how in production or even by the combination of both methods (Saleem *et al.*, 2013). Planting operation is one of the greatest operation associated with crop production. Adequate establishment of uniform crop stands would make subsequent operations more effective and thus increase yield could be ensured (Gambari *et al.*, 2017). Similarly, Behera *et al.*, (1995) reported that, one of the important factors that affect the germination of seeds is the uniformity in distribution pattern of seeds at proper planting depth and spacing for the realization of an appropriate crop stand there by increasing the crop yield. Planting operation in Nigeria is largely attributed with manual method resulting in high level of drudgery, non-uniformity of intra-row spacing and

Corresponding Author Email: salehaminu@gmail.com, Tel: +234 803 577 4780

depth of plant, low rate of seed emergence, (Upahi, 2017). This causes delay in planting operation which is detrimental to the yield of crop. Where locally developed planters are used, they are challenged with the inability to effectively meter seed in the right spacing and depth without damage to produce good seed rate (Ahmed *et al*., 2021). In addition, imported tractor-drawn planters are out of reach of the peasant farmers due to their exorbitant costs and lack of technicalities to operate and maintain them (Isiaka, *et al.*, 2001). In order to overcome these challenges, there is need to assess a locally developed planter that would efficiently perform such the appropriated stands per hectare could be realized that could aid high food production without minimum variability in climatic condition. This research intends to link these barriers. Hence, the objective of this research was to evaluate the effect of ground speed, hopper seed quantity and planting depth on plant spacing, germination count, and seed delivery rate of a home-developed four-row animal drawn precision maize planter using a pair of bull to plant SAMMAZ 17 maize variety on a harrowed field.

MATERIALS AND METHODS

Experimental site: The study was conducted in the Experimental Farm of the Institute for Agricultural Research (IAR), Ahmadu Bello University, Samaru-Zaria, Nigeria. It is located at Samaru on Latitude 11.7° 30° to 11° 120¨ N, Longitude 07° 36¨ E to 07° 42" and an altitude of 686 m above sea level (Figure 1). The climatic condition of this region is characterized by an annual mean rainfall of 1000 mm, atmospheric humidity as low as 15% during the dry season and above 60% during the wet season, minimum temperature of 22˚C in January and attaining the maximum 28˚C in April (Adeyemi *et al.*, 2019). Mean wind velocity was 13 km/h while the soil in the site is sandy loam.

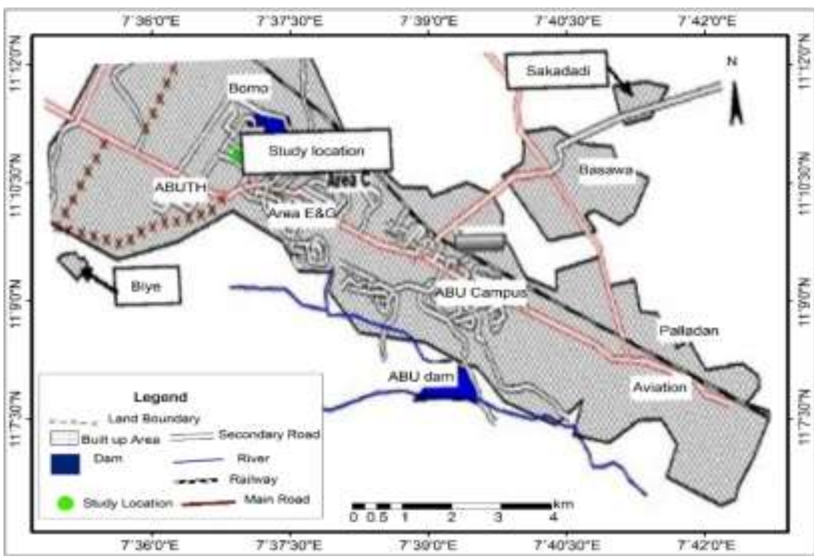

Fig 1: Map of Samaru-Zaria Showing the Study Area (Saleh *et al.*, 2022)

The assessment of the planter (Plates 1 and 2; Orthographic view – Appendix I) was done on a harrowed wet field during the 2021 cropping season with a total of 54 treatments as shown in plate 2. Each treatment was run along 5000 mm length, maintaining the width of the planter which was 2250 mm to serve as a single treatment (Badua 2021). The plot was divided into three portions with each serving as a replicate across slope, and each replicate contains 18 treatments. The planting is aimed at discharging seed at intra row spacing of 250 mm with each unit of the planter spaced at 750 mm to achieve at least 80 plant stand in each treatment plot.

Experimental Design and Statistical Analysis: Randomized Complete Block Design (RCBD) in a $3 \times 3 \times 2$ experimental design was adopted in evaluating the planter while the slope of the field is the blocking factor. The experiment comprised of three levels of planting speed (V1 = 2.16 km/h, V2 = 2.88 km/h, and V3 = 3.6 km/h), three levels of seed quantity (Q1 = 25%, Q2 = 50%, Q3 = 100%) and two levels of planting depth (T1 = 1.5cm and T2 = 2.5 cm). Data obtained from the experiment was subjected to analysis of variance ANOVA using Statistical Analysis System (SAS) software. Mean differences were tested using Duncan Multiple Range Test (DMRT) to determine the significance of variables.

The orthographic view of the four-row animal-drawn precision planter is presented in Plate 3

Plate 1: The Developed planter

Plate 2: Planter in operation

Data Collection: Data collection and performance evaluation of the planter was carried out on the field by adopting the procedures prescribed by FAO (2000) as shown below.

Seed discharge rate R_s (kg/ha): The seed discharge rate was determined from the formula given in equation 1.

$$R_s = \frac{Q_p}{A} \qquad (1)$$

Where: Q_p = Quantity of planted seed (kg); A = Area of planted field (ha)

Field efficiency ε (%): The field efficiency was calculated from the equation 2;

$$\varepsilon = \frac{Te}{Tt} \times 100 \qquad (2)$$

Where: ε = Field efficiency (%); T_e = Effective time (min); T_t = Total time

Plant population P_p (%): The plant population was obtained from the expression given in equation 3

$$P_P = \frac{S_g}{S} \times 100 \qquad (3)$$

Where S_g = Germinated seed; S = Total seed planted

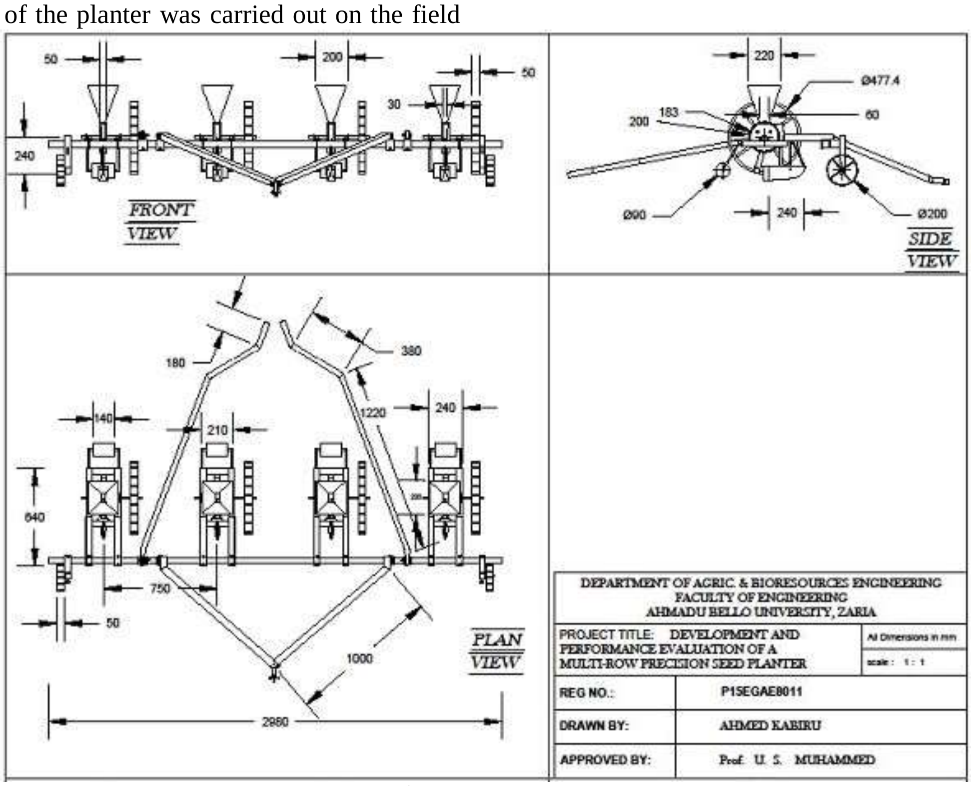

Plate 3. Orthographic View of the Four-Row Animal-Drawn Precision Planter

RESULTS AND DISCUSSION

Seed spacing: Results obtained from the study (Table 1) shows that the interactive effect of planting speed and planting depth on the seed spacing. Generally, the 15 mm planting depth at 2.88 km/h and 25 mm planting depth at both planting speed of 2.16 km/h and 2.88 km/h recorded the highest mean seed spacing and are significantly the same, but significantly different at 2.16 km/h and 3.6 km/h. Highest mean seed spacing of 23.52 cm for 15 mm planting depth at 2.88 km/h and least mean seed spacing of 21.24 cm for 25 mm planting depth at 3.6 km/h were recorded. This shows that the machine could operate with a better seed spacing at a moderate forward speed regardless of whether the penetration of the furrow opener in the soil was increased or decreased. This agrees with Mandal *et al* (2013) and Ahmed *et al* (2021) who obtained the highest field result with 2.88 km/h.

Table 1: Effect of Interaction between Planting Speed and Planting Depth on Seed Spacing

Mean Seed spacing (cm)			
Treatment	**Planting speed (km/h)**		
	2.16	2.88	3.6
Planting depth (mm)			
15	22.26b	23.52a	22.29b
25	23.37a	23.47a	21.24c
SE+		0.174	

Means followed by same letter(s) in the same column and row are not different significantly at P=0.05 using DMRT.

Plant population: The DMRT on the second level of interaction between planting speed, seed quantity and planting depth on germination count was presented on Table 2. At 2.16 km/h planting speed with seed quantity of 100% and planting depth of 15 mm, the highest plant population of 100% which was significantly different from others was recorded. The least germination counts of 73.0% at 3.6 km/h speed, 100% seed quantity, 15 and 25 mm planting depth was recorded. This may be attributed to the good plant population at a low speed, high hopper seed quantity and shallow furrow opening of the soil. This may also be as a result of consistent seed metering due to low speed, stable operation due to the increase in hopper weight and shallow opening of soil. Nwachukwu *et al* (2000) constructed a single row planter and obtained the highest germination count of 58 % at 2.16 m/s forward speed. The result also agrees with Ahmed (2021) who developed a planter having a better germination count at lower speed, planting depth and high seed hopper quantity.

Field efficiency: The DMRT on the second level of interaction between planting speed, seed quantity and planting depth on field efficiency and field capacity was presented on Table 3. At 2.88 km/h planting speed with seed quantity of 50% and planting depth of 25 mm, the highest field efficiency of 86.9 % which was significantly different from others was recorded. The 2.88 km/h, 25 %, 15 mm and 2.88 km/h, 50 %, 15 mm are the same, as well as 2.88 km/h, 100 %, 25 mm and 3.6 km/h, 25 %, 15 and 25 mm are also the same. The best result obtained was as a result of intermediate forward speed and seed hopper quantity used and high planting depth. This agrees with Isiaka *et al.* (2000) and the high mean field efficiency obtained was as a result of more number of rows (i.e. 4 rows). The least field efficiency of 56 % for 3.6 km/h, 100% and 15 mm was recorded.

Table 2: Effect of Interaction between Planting Speed, Seed Quantity and Planting Depth on Seed Germination Count.

Mean Germination count (%)			
Planting speed (km/h)	Seed quantity (%)	Planting depth (mm)	Plant population (%)
	25	15	87.7c
		25	81.7ef
2.16	50	15	92.0b
		25	79.0fg
	100	15	100.0a
		25	86.3cd
	25	15	80.7ef
		25	81.7ef
2.88	50	15	81.0ef
		25	79.7efg
	100	15	83.3de
		25	79.3efg
	25	15	78.0fg
		25	75.7gh
3.6	50	15	73.3h
		25	75.7gh
	100	15	73.0h
		25	73.0h
SE+			1.270

Means followed by same letter(s) in the same column are not different significantly at P=0.05using DMRT.

Table 3: Effect of Interaction between Planting Speed, Seed Quantity and Planting Depth on Field Efficiency.

Planting speed (km/h)	Seed quantity (%)	Planting depth (mm)	Field efficiency (%)
	25	15	67.9f
		25	78.2bc
2.16	50	15	72.7de
		25	79.6b
	100	15	57.6hi
		25	69.3ef
	25	15	75.1cd
		25	60.7gh
2.88	50	15	74.6cd
		25	86.9a
	100	15	62.2g
		25	73.6de
	25	15	72.8de
		25	73.3de
3.6	50	15	68.3f
		25	70.0ef
	100	15	56.0i
		25	62.1g
SE+			1.365

Means followed by same letter(s) in the same column are not different significantly at P=0.05 using DMRT.

Seed Discharge Rate: Table 4 below shows the effect of seed quantity/planting depth interaction on the seed rate. The 15 mm planting depth at 100% seed quantity recorded the highest mean seed discharge rate and is significantly different, but significantly the same at 25 and 50% seed quantity. The 25 mm planting depth was also the same at 25, 50 and 100 % seed quantity. Highest mean seed rate of 20.3 kg/ha for 15 mm planting depth at 100 % and least mean seed rate of 18.3 kg/ha for 25 mm planting depth at 50 % were recorded. Here there is uniform consumption of plant nutrients. This may be due to high seed quantity in the hopper and low planting depth causing quick and effective emergence as seeds are not sowed deeply into the soil. This conforms to the finding of Virk *et al.* (2019).

Table 4: Effect of Interaction between Seed Quantity and Planting Depth on Seeding Rate.

Mean Seed rate (Kgha^{-1})			
Treatment	**Seed quantity (%)**		
	25	50	100
Planting depth (mm)			
15	19.1b	19.2b	20.3a
25	18.7bc	18.3c	18.5c
SE±		0.194	

Means followed by same letter(s) in the same column and row are not different significantly at *P=0.05* using DMRT.

Conclusion: The performance evaluation of the home-developed four-row animal drawn precision seed planter was conducted. The selected planting speeds, hopper seed quantity and planting depths has influence the field performance of the planter. Seed discharge rate increased with decreasing planting speed, planting depth and increasing seed hopper quantity. Planting at 2.16 and 2.88 km/h, with 50 and 100 % seed hopper capacity and 15 mm planting depth result in maximum planting performance giving optimum plant population where optimum field efficiency could be obtained.

REFERENCE

Abubakar LG (1994). A Multicrop Rotary Jab Planter for Sandy Loam Soils. A MSc. Thesis Submitted to the Department of Agricultural Engineering, Ahmadu Bello University; Unpublished: 168 Pp.

Adeyemi, FI; Saleh, A; Ramalan, AA; Othman, MK; Aminu, HG; Adeyemi, AS (2019). Effects of Irrigation Deficit and Mulching on the Yield and Water Use Efficiency of Soybean (*Glycine Max*) in Samaru, Nigeria. *Nig. J. Sci. Res.*18 (3)*:* 254 – 260.

Ahmed, K., Mohammed, US; Saleh, A; Zakariyah A; Abubakar, I; Ali, HK (2021). Development of a Four-row Animal Drawn Precision Maize Planter, *FUDMA J. Sci*. 5(4): Pp 118-123.

Akinseye, FM; Ajayi, VO; Oladitan TO (2013). Assessing the impacts of climate variability on crop yield over Sudano- Sahelian zone in Nigeria. *Access Inter. J. Agric. Sci*. l1 (7), 91- 98

Badua, SA; Sharda, A; Strasser R; Ciampitti, I (2021). Ground Speed and Planter downforce influence on corn seed spacing and depth. Transaction of the ASABE. http://doi.org/10.1007/s11119-020-09775-7

Behera, BK; Swain, S; Sahoo, PK; Behera, D (1995). Evaluation of seeding device for dry land Paddy. AMA, 26(4), 17-21.

FAO (2000). Draught Animal power, An over view. AGSE Report Agriculture 21 spotlight. www.fao./ag/ags/chapter1- e.htm

Gambari, AB; Bello, KI; Soyemi, YW (2017) Development and performance evaluation of a manually operated two-row maize planter, *International Conference of Science, Engineering and Environmental Technology,* 2(11): 78-86

Isiaka, M; El-Okene AMI; Suleiman, ML (2001) Comparative Study of Three Planting Methods for Small and Medium Scale Farm. *Savanna J. Agric. Mechanize*. 3 (1) 49-53

Isiaka, M; Suleiman, ML; El-Okene, AMI; Muhammad, US (2000) Development of two-row animal drawn seed planter. *Savanna J. Agric. Mechanize.* 2 (1): 29-32

Mandal, SK; Sutar, SM; Sensharma, S; Shamrao, P (2013) Development of Animal Drawn Planting Equipment, *J. Mech. Eng*. 2451-8372

Nwachuukwu, CE; Kuye. JS (2000) Development of Seed Planting Machine for Rural Communities in Nigeria. *J. Educ. Res.* Assoc. 14 (2) 221 – 227

Saleem, A; Abbas, K; Asad, K; Anjum, MS (2013). Best statistical model estimation for mustard yield in Azad Kashmir, Pakistan. *Pak. J. Sci.* 65(1), 77-82

Saleh, A; Takalafia, SM; Suleiman, ML (2022). Determination of Selected Soil Properties for Selecting Appropriate Land Preparation Equipment in Samaru – Zaria, Nigeria. *UNIOSUN J. Engineer. Environ. Sci.* 4 (1). 57 – 63

Upahi, EJ (2017). Development and Performance Optimization of a Two – Row Engine – Propelled Seed Ridge Planter; A Phd Thesis submitted to the Department of Agric and Bio – Resources Engineering, Ahmadu Bello University; Unpublished; 209 Pp

Virk, SS; Fulton, JP; Porter, WM; Pate, GL (2019). Row-crop planter performance to support variable-rate seeding of maize. Precision Agriculture, 21, 603–619.