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DEPARTMENT OF AGRICULTURAL ENGINEERING

PERFORMANCE EVALUATION OF A PEANUT PLANTER

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BY

ACHAAB FRANCIS

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DECLARATION

I, ACHAAB FRANCIS, do hereby declare this thesis titled “Performance Evaluation of a Peanut Planter” that apart from the references of other people’s work which have been duly acknowledged, the research work presented in this thesis was done entirely by me as a result of my partial fulfillment of the requirements towards BSc. (Hon.) Agricultural Engineering and that it contains neither materials previously published by any other person nor one which has been accepted for award of any other degree in any university, except where due reference has been made in the text of this thesis.

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DEDICATION

This thesis is dedicated to my lovely parents Mr. and Mrs. Achaab who sacrificed much to bring me up to this level and to my lovely sister, brothers and every individual God used as a blessing unto me to make my life successful. I am because you are.

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My utmost gratitude goes to The All Wise God, whom in HIS own wisdom saw me safely through this four-year degree programme. I couldn't have made it without HIM because I am nothing without HIM.

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Lastly, I wish to express my sincere appreciation to the rural team of New Longoro for permitting me to evaluate the proto-type and the farmers for their cooperation in the performance evaluation of the peanut planter.

ABSTRACT

This study was undertaken to evaluate the performance of a prototype planter capable of planting peanut seeds at a predetermined seed rate and depths. Physical properties of seed used for the study were determined to evaluate the planter's components. The groundnut variety used and cultivated by the rural farmers was the ''Nkosuo'' type. The prototype planter, consisted of a frame, seed hopper, seed metering device, seed tube, furrow opener, and seed metering regulator.

This manually operated peanut planter was fabricated and evaluated in the New Longoro community situated near Wenchi, Brong Ahafo, Ghana. As sowing the seed is an important practice in crop production. There have been various ways of sowing the seeds, but precision planting has always been desirable. Precision planting is the placement of a specified number of seed in the soil at desired plant spacing in a row. Keeping this in mind, the performances were evaluated in terms of depth of planting, field capacity, field efficiency and seed damaged by the planter.

The sphericity and mean geometric diameter of the peanut seed were found to be 59.25% and 11.98 mm respectively, percentage of visible mechanically seed damaged by the planter was 11.76%, and the mean field capacity, field efficiency, and depth were 0.011 ha/hr, 37% and 4.2 cm respectively. Based on the performance evaluation results and observations, setting/adjusting the planter time during planting on the field increases from 635s to 863s at the fourth trial hence increasing the seed damage. In conclusion, higher efficiency and less seed damaged were attained initially during planting. The efficiency on the other hand would increase when a new and quality retention spring should be replaced periodically.

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LIST OF ABBREVIATIONS

Ce	effective field capacity
Dg	Geometric mean diameter
Ɛ	Field efficiency
hr	Hour
Kg/ha	Kilogram per hectare
L	Mean Length of seed
mm	millimetre
Pp	Plant population per hectare
Sm	Mean sphericity
s	Second
T	Mean thickness of seed
T_t	Total time
V	Mean volume
W	Mean width of seed

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CHAPTER 1

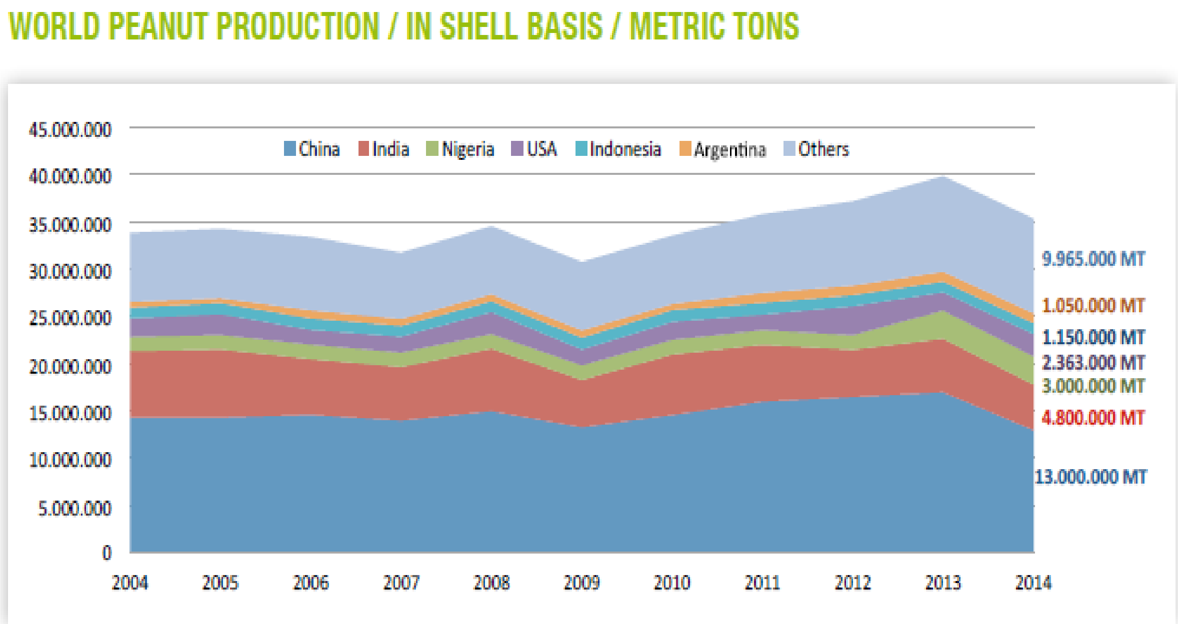
I. INTRODUCTION

i. Background Information

Peanuts, popularly known as groundnuts, monkey nuts, goober, etc. belong to the *Fabaceae* (bean) family. Peanuts, *Arachis hypogaea* is a legume species and also an oil crop, because of its high oil content. (*Arnaeson, 2014*). Peanut is grown for its nut, oil or its vegetative residue. It is an annual herbaceous plant that grows almost to ground level 30cm to 50 cm tall, with very slender stems, leaves been usually four leaflets (two opposite pairs; no terminal leaflet); each leaflet is 1 to 7 cm long and 1 to 3 cm wide, it has flowers that are pea-shaped, and fruits (legumes) that are basically seeds that sprout and mature underground. (*Putnam, et al., 1991*). Peanuts grow best in light, sandy loam soil with a pH of 5.9–7. Like most other legumes, peanuts harbour symbiotic nitrogen-fixing bacteria in their root nodules. Like many other legumes, the leaves are nyctinastic, that is, they have "sleep" movements, closing at night (http://www.botanical-online.com/english/peanuts.htm#, 14 Nov. 2016). Peanut has been found to be a very useful raw material for the production of oil, fuel, soap, medicine and food. It contains nutrients such as Protein, Calcium, Potassium, Magnesium, Phosphorous, Sodium, Folate, and Dietary Fibre. Peanut plays an important role in maintaining soil fertility in cereal-based cropping systems in sub-Saharan Africa because of their ability to fix nitrogen (*CSIR-SARI*). Most farmers are therefore gradually shifting from the small-scale subsistence farming because of the high demand for the crop (FAO, 1994).

Peanut is mainly produced in the tropical and subtropical regions of the world. Peanut is ranked 13th most important food crop of the world and the 4th most important source of edible oil (FAO, 1994). More than 35.6million of peanuts were produced in the year 2014 globally, China was the main producer country with 13million metric tons (36 percent of world production), followed by India with 5.8million metric tons (14 percent), Nigeria with 3million metric tons (8 percent), USA with 2.4million metric tons, Indonesia with 1.2million metric tons, Argentina with 1.1million metric tons and the other countries with 9.97million metric tons (*Global statistical review, 2014/2015*).

Table 1.1. world peanut production



Peanut is a native crop to South America, Mexico and Central America but was introduced to West-Africa (first the Senegambia area) by the Portuguese in the 16th century. Here it spread quickly, though faster in the interior of Africa than along the coast (*Putnam, et al., 1991*). Ghana has great agricultural potential because of its vast areas of fertile land, diverse climate, generally adequate rainfall, and large labour pool. According to the “Ghana statistical service review 2011”, Ghanaian farmers produced nearly 500,000 metric tons of groundnuts annually.

Farming in general is done in two ways either small scale or large scale depending on the method used, that is the traditional or mechanical method. There are two categories of implements, emphasizing on the peanut planter is the mechanical peanut planter and the manual peanut planter. Looking at the manual planter, there are also different models which are the *Jap planter, one-two-three-four-wheel planter* with the same focus. Peanut planters are used worldwide with most being use in the main producing countries like China, India, Nigeria, USA and the others. It is mostly used on ploughed farms where the nuts are usually grown in rows.

The planters are mostly made up of components such as; the hopper, seed tube, furrow opener, soil cover, seed meter regulator and many more depending on the planter.

ii. **Problem Statement**

In Ghana, development and adoption of improved agricultural technologies including farm implements and machinery has been a long term concern of agricultural experts, policy makers, and agricultural researchers and many others linked to the sector. The adoption of agricultural innovation in developing countries attracts considerable attention because it can provide the basis for increasing production and income. Small scale farmers' decisions to adopt or reject agricultural technologies depend on their objectives and constraints as well as cost and benefit accruing to it (*Ashebir*, 2015). Therefore, farmers will adopt only to technologies that would suit their needs.

Over the years, our farmers (the rural farmers who account for the greater production of groundnut/peanut in Ghana) depend on indigenous experiences gained through oral tradition and practice over many generations (*Norem, et al., 1988*). It is very difficult for these farmers to own and operate costly agricultural machinery and equipment that can establish the optimum plant population. Inefficiency and losses in crop establishment have always been the problem with the famers since traditional mode of crop establishment is the practice engaged in their cultivation. In areas where agriculture continues to depend on human power, significant improvements in production can be obtained by the introduction of improved small farm implements, adoption and efficient utilization of farm machines.

iii. Justification

The most efficient mode of planting is the use of a planter. Precision planting has always been desirable i.e. the placement of a specified number of seed in the soil at desired depth and plant spacing in a row. To determine the planting depth, field efficiency and field capacity, there is the need to carry out performance evaluation of the peanut planter.

iv. Objectives of Study

i. General Objective

i. The main objective of this study is to evaluate the performance of a groundnut planter.

ii. Specific Objectives

i. To study the physical properties of experimental peanut and generate data that will be used to evaluate the performance of the planter;

ii. To test the performance of developed planting implement on the basis of;

    i. planting depth,

    ii. seed damage by the planter,

    iii. field efficiency, and

    iv. field capacity.

CHAPTER 2

II. LITERETURE REVIEW

i. Crop establishment

Crop establishment is the sequence of events that includes seed germination, seedling, emergence and development to the stage where the seedlings could be expected to grow to maturity. Establishment depends on the complex interaction over time of seed, soil, climatic, biotic, machinery and management factors (Wood, 1987).

The environment is modified by many management activities such as irrigation, fertilizer application, pesticide application, etc. The seed properties is as well modified by the harvest techniques, seed storage method, pre-plant seed treatments, etc. The selection, setting and operation of planting machines directly influence seedbed conditions and may cause mechanical seed damage (Gramshaw et al., 1993).

ii. Agronomic Requirement for Germination

The major agronomic requirements for germination can be grouped as either seed factors or as environmental factors influencing water and oxygen availability and temperature. Seed quality and pre-sowing seed treatments are the major seed factors influencing germination. Purity, viability, vigour and health are the four factors determining seed quality for planting (Brocklehurst, 1985).

iii. Plant Spacing

As sowing the seed is an important practice in crop production. There have been various ways of sowing the seeds, but precision planting has always been desirable. Precision seeders place seeds at the required spacing and provide a better growing area per seed (Karayel 2009). It is necessary for seeds to be placed at equal intervals within rows with uniform spacing so the roots can grow uniformly (Karayel & Ozmerzi, 2001). For different plants, both seed population and seed spacing at planting time have effects on harvested yield and size of stalks (Robinson et al., 1981).

iv. Land Preparation

Field is usually prepared after the land has been cleared, by first ploughing followed by harrowing. Peanut could be planted on the flat, on ridges or on beds.

Traditionally, peanut is grown on flat bed without proper gradation and slope and the problem of water logging becomes severe. To overcome this, a broad bed and furrow system is suggested. The raised beds should be 1.2 m wide and 15 cm high and two furrows of 30 cm width on either side to drain out excess of water. This width of the raised bed will accommodate 4 rows of peanut at 30 cm distance between rows. (www.ikisan.com/tn-groundnut-land-preparation.html).

Beds *Flat*

Figure 1: Various landforms used for planting peanut.

i. Seeding Rate and Plant Populations

Seeding rate or planting rate refers to the number of seeds planted per area to attain a certain plant population. Plant population refers to the number of plants per area. The difference between the seeding rate and the plant population is called the mortality rate. Mortality rates differ significantly and depend on planter type, planter adjustment, planting depth and speed, seedbed conditions, soil type and drainage, seeding rate, and row spacing. Seed quality and germination rates, weather, pathogens, and insects will also influence plant population (Ashebir, 2015). In practice, the needs of the individual plants have to be balanced against the requirement to maximize crop yield (Wollin et al., 1987).

The optimum plant population per hectare can be calculated from recommended plant spacing (row spacing and distance between plants) for a given crop, as follows:

$$P_p = \frac{10{,}000\ \mathrm{m}^2}{P_s{}^2}$$

Where: - Pp = Plant population per hectare. Ps = Area per plant (m^2)

v. Physical Properties of Seeds

The physical properties of seeds are essential in the design and development of specific planting machine components. Seed metering devices, which are moving or stationary members have indents, i.e. holes or cells and the metering performance highly dependent on the compatibility between cells/holes and seeds size and shape (Ashebir, 2015). Hence, knowledge of the shapes and sizes of seeds, in terms of seed length, seed width and seed thickness, and mean diameter and sphericity, are essential in the design of metering devices and sizing of cell (Konak et.al, 2002).

vi. Seed Metering Devices

Metering mechanism is the core component of planting machines and its function is to distribute seeds uniformly at the desired application rates. Proper selection and/or design of the metering device is an essential element for satisfactory performance of the seed planter (Ikechukwu et al., 2014).

A large range of seed metering devices exist, but most can be classified as either 'mass flow' or 'precision' depending on their principle of operation and the resulting planting pattern. Mass flow meters attempt to meter a consistent volume of seed per unit of time to give average seed spacing equal to the desired spacing, i.e. a drill planting pattern. Unlike mass flow seed meters, precision type seed meters attempt to select single seeds from the seed lot and deliver them at a pre-set time interval. Crops usually planted using precision seed metering devices include peanut, maize, sorghum, sunflower and cowpea. The selection of metering devices solely depends on the type of crop and pattern of planting and the purpose for which the crop is grown (Murray et al., 2006).

vii. Furrow Opener

A furrow opener cuts the soil to a depth and allows the seeds or seedlings to be deposited before being partially covered by soil. The types of furrow openers used vary with soil and operating conditions. (Chaudhuri, 2001). Furrow openers may be: runners, shovel, or shoes openers.

The aim of furrow opener design and selection must be to ensure desired modifications, rather than impair conditions for emergence (Murray et al., 2006).

viii. Seed Delivery Tube

Seed delivery tube includes those devices that convey the seed from the meter to the device that deposits the seed on the soil surface or in the furrow. Improper design of seed tubes leads to unsteady flow of seeds, and result in irregular seed spacing along the row. Seed delivery tube should be smooth, narrow, straight, and short. However, its outlet should be close enough to the furrow bottom and the friction between seed and tube wall should be minimized (Ibrahim et al., 2008)

ix. Traditional method of planting peanut

Traditionally peanuts are planted in different method with different materials, most traditional methods make use of the hoe, cutlass or the dibber.

The figure below shows two different manual peanut planting methods; one with the help of a cutlass and the other using dibber.

Figure 2. planting with the help of cutlass and a dibber

Figure 3. the various manual planters

CHAPTER 3

III. MATERIALS AND METHODS

i. The Experimental site

Fabrication and the performance evaluation of the peanut planter was done at New Longoro. This place is situated near Wenchi, Brong Ahafo, Ghana, its geographical coordinates are 8° 9' 0" North, 2° 1' 0" West.

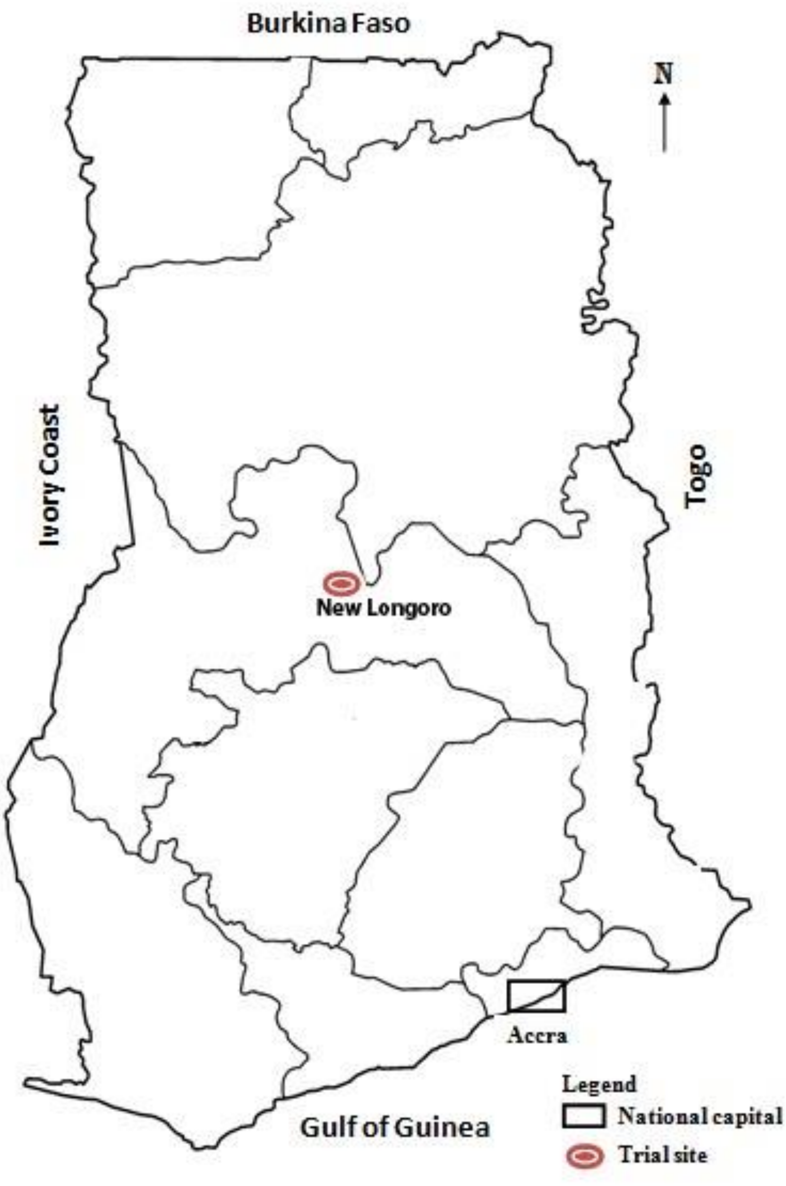


Figure 4. Fabrication and Evaluation of the prototype site.

ii. Materials and their uses

Table 2. materials and their uses

Material	Uses
Tape measure	For taking the dimension of the planter.
A pair of calliper	For measuring the diameter of circular parts
Peanut seed	This is a strayed seed that is to be used for the performance evaluation.
Peanut planter	The prototype evaluated
Stop watch	For checking time taken for seed to be delivered
Cutlass	For clearing and establishing of seed manually.
Soil moisture meter	For testing the soil moisture content
Plastic bowls	For keeping the groundnut seeds.

iii. Experimental crop

Groundnut seeds were used to fabricate the prototype at New Longoro. The crop, peanut was selected for the study because of its dominance among commercial valued crops and row planted crops in the study areas. Hence, the prototype planting implement was designed to plant this seed. The groundnut seeds used were cultivated by the farmers at New Longoro. This site was selected based on its potential for relatively higher groundnut production and consumption.

Figure 5. the experimental peanut crop

iv. Description of the Prototype planting implement.

The developed planter consists of the handle, seed hopper, furrow opener, seed discharge tube, main body (frame) and metering disc housing.

Figure 6. the prototype

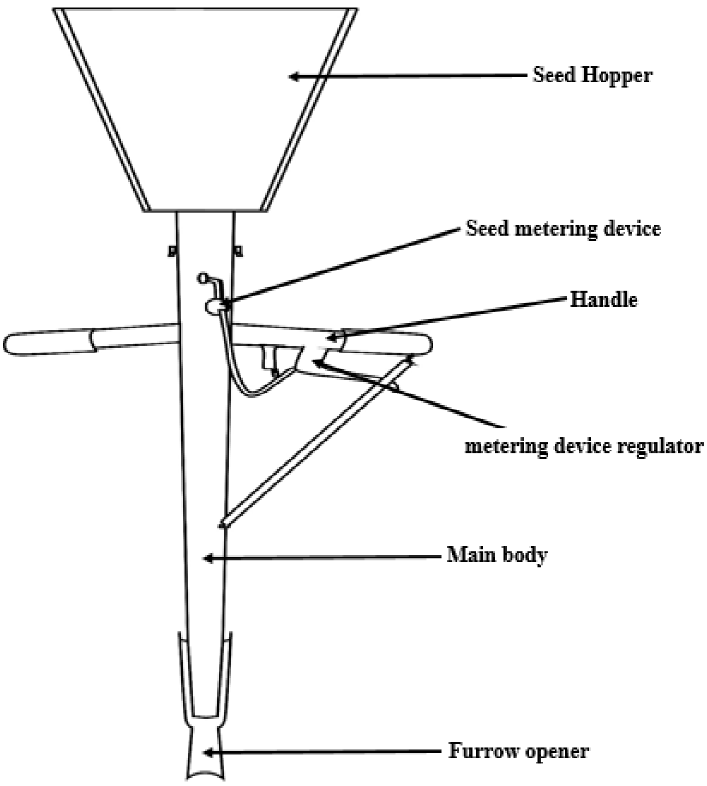
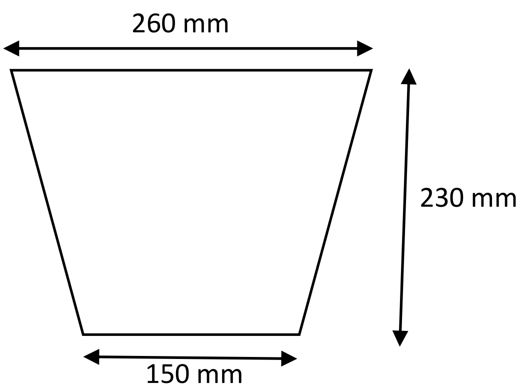


Figure 7. A sketch diagram of the prototype

i. **Seed hopper:** the seed hopper was made of plywood of thickness 13mm having a frustration cross-section of a pyramid of 150mm square at the bottom, 260mm square at the top and 230mm height. The design capacity of the seed hopper is 9.90x^{6}mm^3 (volume = $\frac{1}{3}(150^2 + (150 \times 260) + 260^2) \times 230$).



ii. **Handle:** The handle consist of two mild steel pipes of 35mm external diameter (surface area = $\pi\times(\frac{35}{2})^2$mm = 306.25mm^2), each of 230mm long fastened to the frame at two opposite side of the implement.

iii. **Furrow opener:** The Furrow opener is a 150mm mild steel (angle bar wide) with a length of 350mm. The angle bar iron was fabricated to cave type like structure to facilitate an easy cut through the soil. Nut and both were used to fasten the device to the frame through a hole drilled on the frame.

iv. **The seed tube** is made of wood hollow 40mm square from the hopper to the seed meter and 25mm diameter and 9700mm long. The 25mm diameter begins immediately after the metering housing of the planter. Seeds picked from the hopper pass through the upper hole at the open and close castellated metering mechanism to the lower hole into the discharge tube which deposits the seeds into the opened furrow.

v. **Metering disc:** the metering mechanism was constructed from the principle of bicycle braking system where the seed metering component is linked to the regulator handle. Applying the regulator handle causes the seed meter to open for a seed from the hopper to pass through the lower slot tube, into the opened furrow.

vi. **Main body (frame):** this is square made of wood with a hollow in it which is the seed tube and houses the metering housing. It is 970mm long and 60mm square wide.

v. Determination of Effective field capacity

The effective field capacity was determined by measuring the effective width of the implements used, using a measuring tape and the forward constant traveling speed of planting operation; that is, the time taken to cover a specified distance using stop watch. the formula used for the effective field capacity was propound by kepner et al, (1978).

$C_e = \frac{WS}{1000}\varepsilon$,

where C_e = effective field capacity (ha/hr)

W = effective width (m)

S = forward speed (km/hr)

$\mathcal{E}$ = field efficiency (%)

vi. **Determination of Field Efficiency**

To determine the field efficiency, the planting operation was performed in multiple times however the traditional way of planting with the help of a cutlass and dibber was used in checking the field efficiency before the peanut planter was also used. Planting of the peanut was done in the direction of the specified length of the bed measured with the help of a measuring tape. The length distance travelled with the corresponding time to complete was achieved with the help of a stop watch. The effective operating time and the time spent to remove stumps, time spent on adjusting or setting the planter, fill the seed hopper and other obstructions were recorded.

This is the percentage of time the machine operates at its full rated.

Field efficiency was calculated by the following formula;

$$\mathcal{E} = \frac{T_E}{T_T} \times 100\%$$

Ɛ = Field efficiency (%)

T_E = Effective operating time (min)

T_T =Total time spent on field (min)

vii. **Determination of Planting Depth.**

The average depth of seed placement of the various implements was determined by taking the average depth of the used implement on the field. During the process, the time taken to travel the length of the field was recorded to determine the average time of travel during the operation in the field. Along each furrow left uncovered, four were randomly sampled and investigated for depth of planting. A measuring tape was used to measure the required depth.

$$V = \frac{D}{T_a}$$

Where; V = Working speed,

D = distance of run (m)

Ta = average time of each travel (second)

viii. **Determination of the physical properties of Peanut seed**

The mean size of the peanut seeds, used in the evaluation, was determined by randomly selecting 25 seeds samples and measuring their three principal diameters using digital caliper of 0.01 mm accuracy. The larger, intermediate and minor diameters of the seeds were designated as length, width and thickness, respectively. The mean size of the peanut seeds was determined as geometric mean diameter. The volume and sphericity of the peanut seeds was calculated using the measured length, width and thickness of the seed by equations given below (El-Raie *et al.,* 1996).

$$D_g = \sqrt[3]{L \ x \ W \ x \ T}$$

$$V = \frac{\pi}{6}(L \ x \ W \ x \ T)$$

$$S_m = \frac{\sqrt[3]{L \times W \times T}}{L} \times 100$$

Where; L = mean length (mm)

W = mean width (mm)

T = mean thickness (mm)

V = mean volume (mm^3)

D_g = mean geometric diameter (mm)

S_m = mean seed sphericity

ix. Performance Test and Evaluation

Before the performance evaluation test was done on the field at New Longoro, a preliminary test was undertaken on a field at the Kwame Nkrumah University of Science and Technology to see whether the machine was functionally good and to check the existence of any malfunctioning parts and defects. The prototype peanut planter had average stability in terms of operation and performed the intended job acceptably in its actual planting period. Both field evaluation carried out in the various field was to obtain the actual overall performance of the prototype. The tests performed on the field showed the following problems;

Before *After*

Fig. 8. The furrow cutter got plugged with moist soil.

Figure 9. Peanuts stacked and bruised at the metering device

x. Evaluation of percentage seed damaged

The hopper of the planter was loaded with 2kg of peanut seeds. The planter was raised up on a cemented floor to allow for easy count of seed delivery per a press and as well seed damaged by the seed metering device. A polyethylene bag was placed on the seed discharge tube to collect the seeds discharged. The seed metering device regulator was regulated for several times as would be obtained on the field. The seeds collected in the polyethylene bag at the end of the evaluation test were examined for any external damage or visible crack to establish the performance of the metering device. Percentage external seed damage was determined by equation given below.

$$D_{\%S} = \frac{S_D}{S_T} \times 100$$

Where $D_{\%S}$ = percentage damaged seed

S_D = total number of damaged seeds (external)

S_T = total number of seeds

CHAPTER 4

IV. RESULTS AND DISCUSSION

This study was undertaken to evaluate the performance of a Prototype peanut planter capable of planting at predetermined depths. Physical properties of peanut seeds used for the study were determined to optimize the design of the planter's component parts. The following are details of the physical properties of the seeds used and performance evaluation of the prototype.

i. Physical Properties of the peanut Seeds

The variety of peanut cultivated by the rural famers of New Longoro and used for the performance evaluation was the ''Nkosuo'' type.

Table 3 gives the mean values and the standard deviations of length, width, thickness, volume, geometric diameter, and sphericity of the peanut seed.

Table 3. Physical properties of a peanut seed

Perimeters	Length (L)	Width (W)	Thickness (T)	Volume (V)	Geometric Diameter (D_g)	Sphericity (S_m)
Units	mm	mm	mm	cm^3	mm	%
1	19.64	10.23	7.89	0.83	11.66	59.37
2	21.22	10.71	8.58	1.02	12.49	58.86
3	20.34	10.33	8.26	0.91	12.02	59.10
4	19.61	10.21	8.49	0.89	11.93	60.84
5	19.80	09.48	7.54	0.74	11.23	56.72
6	19.96	10.34	7.83	0.85	11.73	58.77
7	20.34	10.21	8.63	0.94	12.15	59.73
8	19.75	10.13	8.03	0.87	11.71	59.29
9	20.83	10.48	8.47	0.97	12.27	58.91
10	20.15	10.34	8.73	0.95	12.21	60.60
11	21.02	10.21	9.04	1.02	12.47	59.32
12	19.92	09.86	7.75	0.80	11.50	57.73
13	20.31	10.62	8.43	0.95	12.21	60.12
14	20.23	10.11	8.63	0.92	12.09	59.76
15	20.12	10.03	8.51	0.90	11.98	59.54
Mean	20.22	10.22	8.32	0.90	11.98	59.25

From Table 3, it can be seen that the sphericity of the peanut was 59.25% when the mean seed sphericity ($S_m = \frac{\sqrt[3]{L\ x\ W\ x\ T}}{L}\ x\ 100$) was used, indicating that the peanut has less spherical shape. After a sample of the peanut seeds were measured and computed it was found out that the peanut cultivated by the rural farmers of New Longoro was having a mean diameter of 11.98 mm.

ii. Performance Evaluation of the prototype

i. Seed planted with the help of the various implements.

The number of groundnut seeds planted in 5 minutes with the help of the various planters i.e. the cutlass, the dibble and the groundnut planter.

Table 4. groundnut seeds planted per a trial

No. of trials	Cutlass	Dibble	Groundnut Planter
1st trial	47	39	26
2nd trial	52	43	28
3rd trial	45	42	19
4th trial	47	46	21
5th trial	38	39	15
6th trial	41	37	13
mean	45	41	20

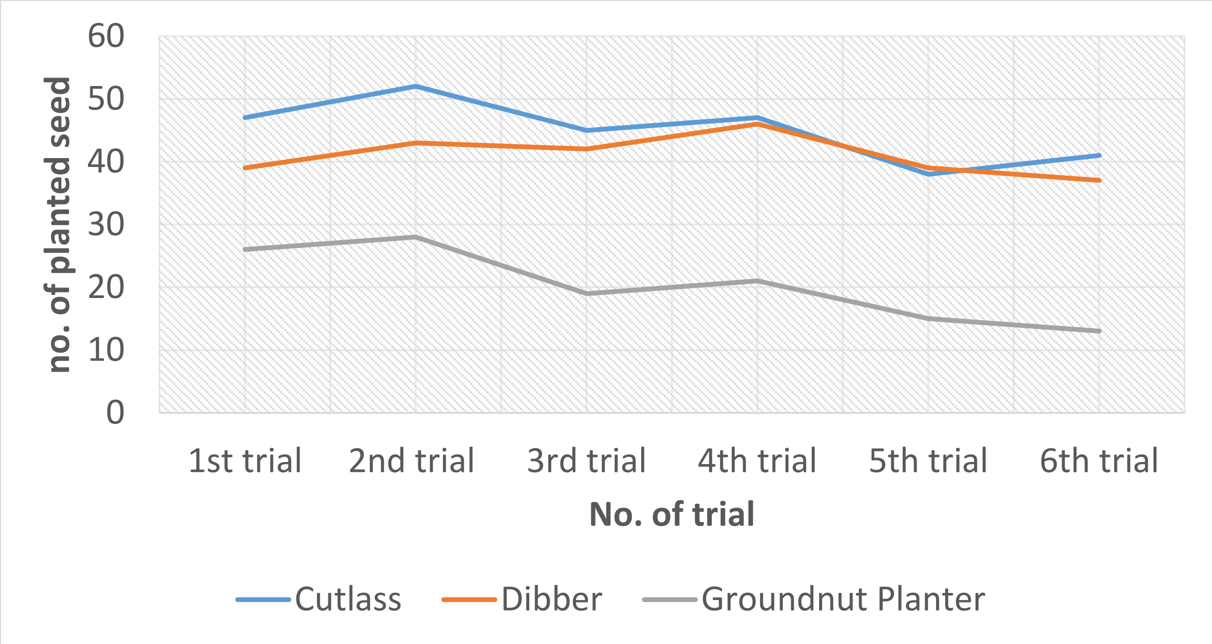


Fig. 10. Number of groundnut seeds planted per a trial

From table 4. and figure 10. the number of seed were plotted against number of trials with the help of the various planting implement, it can be seen that the number of groundnut seeds planted, cutlass had the highest followed by the dibble before the groundnut planter.

ii. Seed damage test

The number of peanut seeds mechanically damaged, i.e. bruised or crushed seeds, skin removed were counted and their percentage was computed.

Table 5. Percentage of seed damage

No.	Seed discharge	Seed damaged	% damage
1	41	2	4.88
2	37	3	8.11
3	32	4	12.50
4	37	3	8.11
5	24	7	29.17
Mean	34	4	11.76

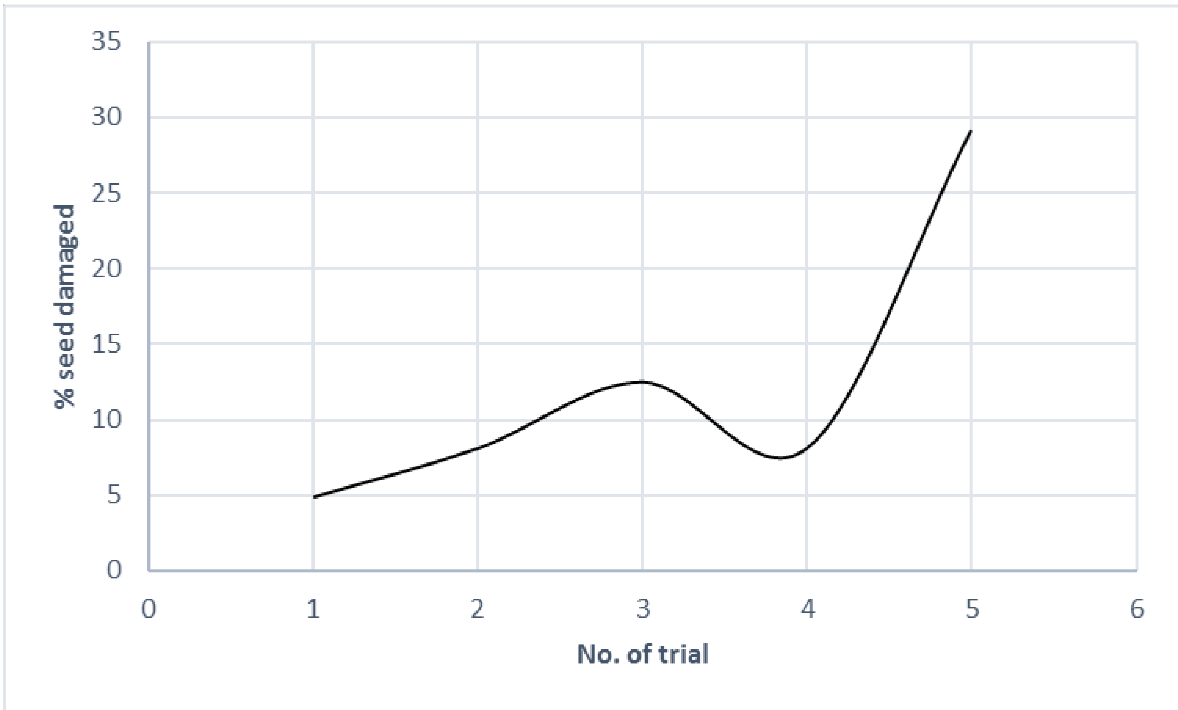


Fig. 11. % of seed damaged against number of trials.

From table 4, the mean percent seed damaged for the peanut was found to be 11.76%. The percent seed damage observed with the peanut seed during the evaluation, was the mean geometric diameter of the seed being greater than the discharge channel of the metering device and hence get stacked in the device resulting in seeds being bruised or skin removed. The retention spring of the metering device being loosen as a result of extended in duration of planting during the various trials which also resulted in damaging the seeds.

iii. Field efficiency and field capacity of the planter

From table 5, the field efficiency and field capacity of the prototype planter were 37 % and 0.011 ha/hr respectively. The field efficiency of the prototype planter, as recommended for planters, is not within the acceptable range. The less value got for the efficiency was due to time spend in setting or adjusting the prototype when peanut seeds of large diameter got stacked in the metering device and as a result delay in the working hours.

Table 6. The mean Field efficiency and field capacity of the peanut planter.

No. of trials ''Activities''	1st trial ''Time (s)''	2nd trial ''Time (s)''	3rd trial ''Time (s)''	4th trial ''Time (s)''	Mean ''Time (s)''
Clearing/removal of clogs	162	162	162	162	162
Setting/adjusting	635	686	785	863	742
Actual planting	422	579	536	587	531
Total time	1219	1427	1483	1612	1435

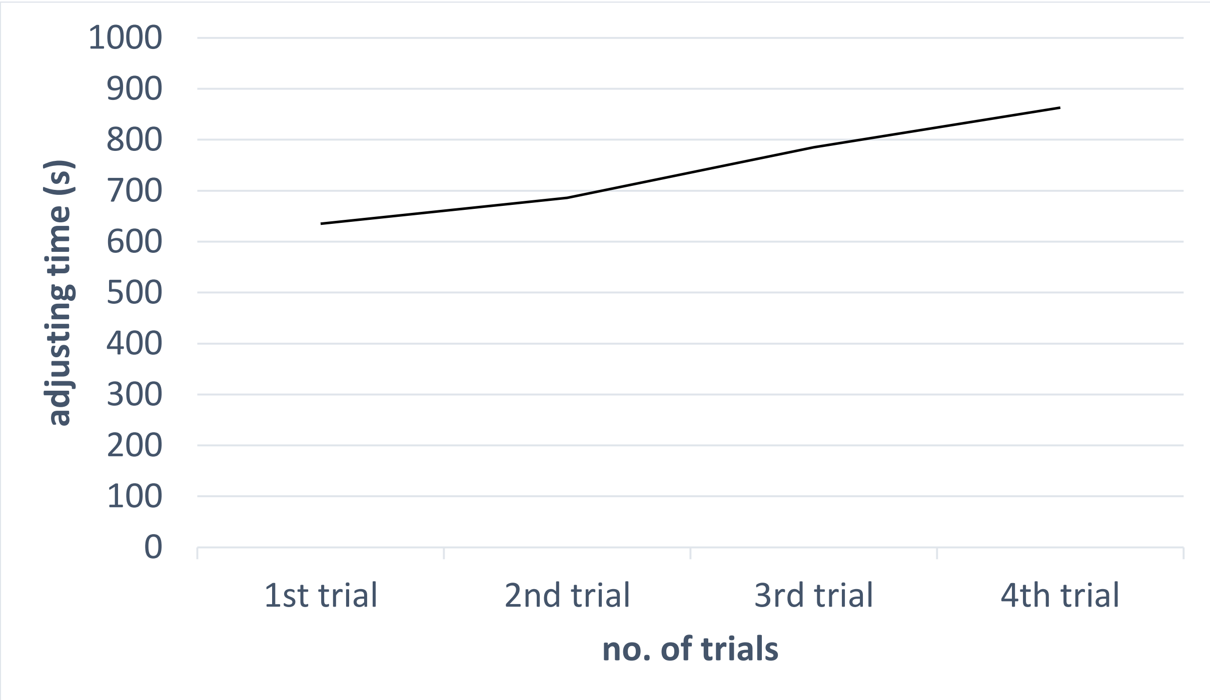


Fig. 12. Adjustment time against number of trials.

From figure 12. It can be seen as the number of trials are extended corresponding with time spent on the field, the time spent on adjusting or setting the planter during planting increases along hence decreasing the efficiency of the planter.

Table 7. summary of measured parameters

No.	Parameters	Observation	Units
1	Actual area covered	16	m^2
2	effective width	0.06	m
3	Travelled speed	54.24	m/hr
4	Effective field capacity	0.011	ha/hr
5	Field efficiency	37	%
7	Seed damaged	11.76	%
8	Depth of seed placement	4.2	cm

iv. The mean depth of planting

From table 6, the mean depth of planting was 4.2 cm. these measurements were taken after planting on the field with the planter without covering the furrow. This depth of planting was less than the desired depth of planting 5 cm as recommended for peanut by the farmers as discussed with them. Nonetheless, the variability being small and with acceptable range.

Table 8. The mean planting depth of the seed.

No.	Planter (cm)
1	4.2
2	4.3
3	4.1
4	4.2
mean	4.2

CHAPTER 5

V. CONCLUSIONS AND RECOMMENDATIONS

i. Conclusions

The manually operated peanut planter was developed from locally available materials to match the need and relief the difficulties of the rural and/or small scale farmers.

These are the conclusions drawn after successfully undertaking the field evaluation of the peanut planter. They were based on the specific objectives of the project work.

i. First and foremost, prolonged work of the planter resulted in higher number of seed damage hence increases the percentage of seed damaged.
ii. Secondly, extended in duration during planting resulted in higher settings/adjusting time, hence reducing the planter's efficiency.
iii. Furthermore, the efficiency of the groundnut planter was determined as 37% with effective field capacity being 0.011 ha/hr. which is unsatisfying.
iv. Lastly, the mean planting depth was 4.2 with variability being small and acceptable range.

ii. Recommendations

The performance evaluations made indicated that the prototype planter can be used on farms. Nonetheless, the following issue must be addressed to make the planter effective, efficient, adaptable and usable among the farmers.

i. Since the planter would be used lengthen in time, a new and quality retention spring of the metering device should be replaced periodically. This will ensure higher efficiency.

ii. It was recommended the weight of the planter be reduced so it can be easily operated by fabricating with lighter available material.

iii. In order to promote the groundnut planter nationwide, it is recommended further testing of the groundnut planter in the various groundnut cultivation regions be carried out.

CHAPTER 6

VI. REFERENCES

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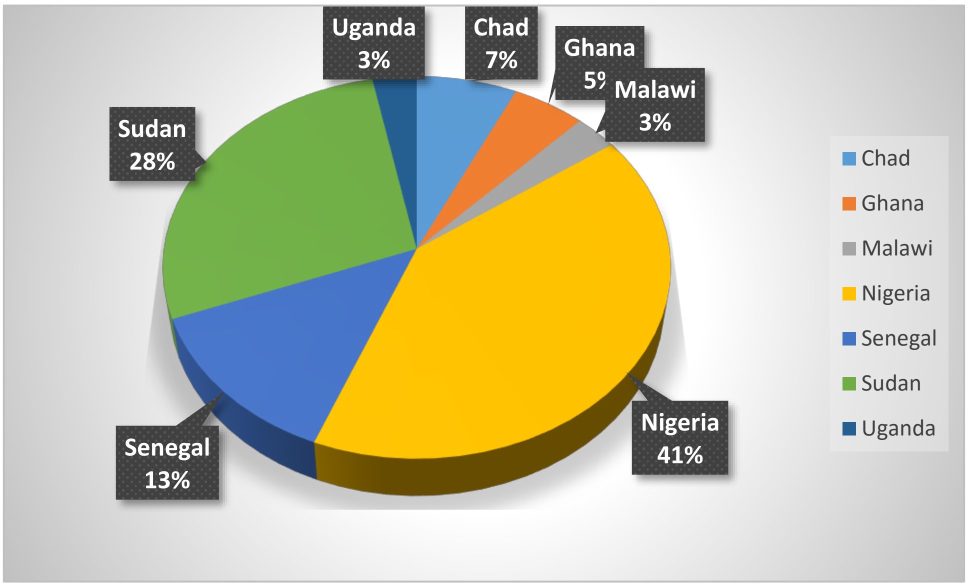
VII. APPENDIX

Appendix. A. The Major Groundnut Growing Countries in Africa

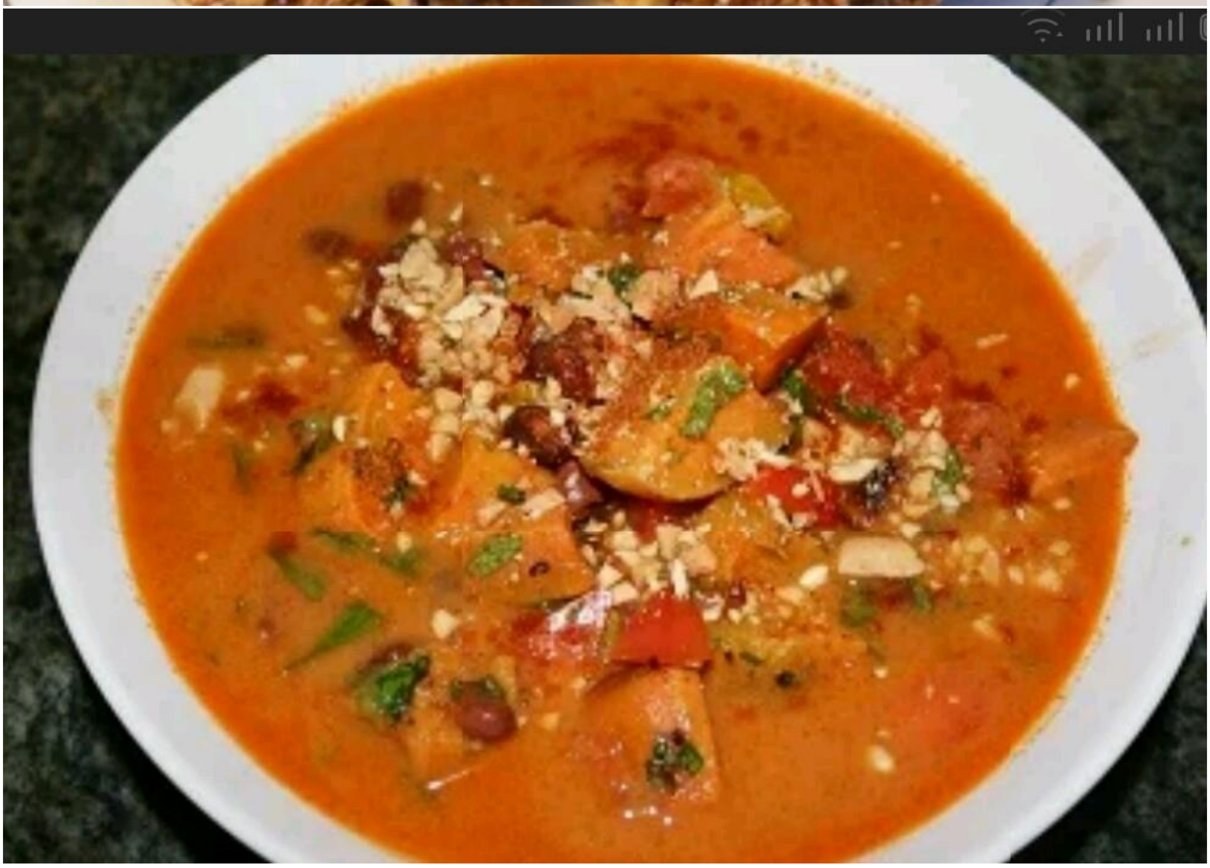
Country	Area (ha)	Production (mt)	Yield (kg/ha)
Chad	480	450	938
Ghana	350	450	1,286
Malawi	206	158	767
Nigeria	2,800	2,700	964
Senegal	900	900	1,000
Sudan	1,900	1,200	632
Uganda	211	150	711



Source: Peanut in Local and Global food Systems Series Report No.5, Dept. of Anthropology, University of Georgia, 2007.

Appendix figures.

Appendix figure 1. Photographs of the planter and testing activities.



Appendix figure 2. Economic importance of a peanut.