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DESIGN AND PRODUCTION OF A LOW COST PLOUGHING MACHINE

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ABSTRACT

The work presented in this thesis is to design and produce a ploughing machine that is of a low financial cost that most low and medium scale farmers can obtain it and use it to ease their work on the farm. The ploughing machine is used for loosening or turning the soil before sowing or planting od seeds and crops etc. The ploughing machine is also used for opening furrows for water flow. The ploughing machine should be used when the soil is slightly moist and used only after tilling the land once or twice. It consists of rectangular frame made of mild steel angle or channels action, blades and ploughing machine body. Upon wearing or becoming dull the blades can be replaced. The ploughing machine is operated in tilled soil by a tractor, the share point penetrates in the soil, ploughing machine body displaces the soil. The depth of operation is controlled by hydraulic system of the tractor.

Key words: Ploughing machine, construction, design, soil, ridges

1.0 INTRODUCTION

Agriculture is an important sector of the economy, in order to produce food, it takes a lot of processes using dedicated machines. One such machine is the ploughing machine. Its construction has changed over the centuries and now newer models are big and adjustable to suit its functionality.

There have been increased interest in the utilization of mechanised farming tools with low cost so that more and more farmers can get access to these farming implements that will ease the stress of labour of manual farming and also reduce the time spent in manual labour.

Farm operations such as ploughing, harrowing, fertilizer application, sowing and weeding have been done manually over the ages, there is need for improved hand tools which will facilitate farm work by reducing the stress of labour and also reducing the time spent. Prior to the modern-day mechanization, oxen have been used to pull a cart and other modified farm implements like ploughs and ridgers. farmers have to use various agriculture equipment and labor for carrying out those steps, our purpose is to reduce time taking to achieve the desired result while making ridges by using the ridger. This also aims at reducing the human effort. Human effort to wet the soil through irrigation is also simplified by creating channels with a ridger to allow water movement on the soil to be made easily. Boulal et al. mentioned that the water storage capacity of the soil surface depends almost exclusively on the surface roughness [1, 2, 3].

While designing a ridger it is necessary to put into consideration the specific function the ridger will be used for. The designing of the agricultural ridger can be done in SolidWorks software. SolidWorks software is a designing software which is used for designing 3d solid models and also used for simulation of 3d designs.

The designing of the machine can be used to assume the final object, SolidWorks software provides a suite of surfacing, reverse engineering, and visualization solutions to create, modify, and validate complex innovative shapes.

SolidWorks software enables the creation of 3D parts, from 3D sketches, sheet metal, composites, and molded, forged or tooling parts up to the definition of mechanical assemblies, it provides tools to complete product definition, including functional tolerances, as well as kinematics definition.

Nigeria is said to be an agriculturally based country with approximately 70% of the population are dependent on farming directly or indirectly. The population of farmers using mechanized farming stands at 10% in Nigeria now. (www.punchngnews,com) Most of our farmers are still using the same methods and equipment for ages. E.g. tilling, ploughing, making ridges, weeding etc. There is need for development of effective ridging machine for increasing the productivity. Agricultural implement and machinery program of the government has been one of selective mechanization with a view to optimize the use of human, animal and other sources of power, in order to meet the requirements, steps were taken to increase availability of implements, irrigation pumps, tractors, power tillers, combine harvesters and other power operated machines and also to increase the production and availability of improved animal drawn implements. Special emphasis was laid on the later as more than 70% of the farmers fall in small and, marginal category.

It is generally said that mechanization of small farms is difficult. But Japan having average land holding even smaller than ours, with proper mechanization has led agriculture to great heights. In order to minimize the drudgery of small farmers, to increase efficiency and save farmer's time for taking up additional supplementary generating activities, the use of modern time saving machines/implements of appropriate size needed to be suitably promoted. The major occupation of the Nigerian rural people is agricultural and both men and women are equally involved in the process. A ridger as a farm implement can be used for making farming simpler for the farmers because making ridges during cultivation to loosen or turn the soil into ridges in preparation for sowing seed or planting is very important.

Ridgers were traditionally drawn by working animals such as oxen and horses, but in modern farms are drawn by tractors. A ridger may be made of wood, iron, or steel frame with an attached blade or stick used to cut and loosen the soil. It has been a basic instrument for most of history, and is one of the most significant inventions. One of the primary purposes of ridging is to turn over the upper layer of the soil, bringing fresh nutrients to the surface, while burying weeds and the remains of previous crops and allowing them to decay thereby serving as manure to the soil which will then increase the growth of the crops and by implication increase the yield [4].

Land development is the costliest operation in farming. It involves bush clearing, soil opening with deep tillage equipment, moving soil from high to low spots, making farm roads, cutting big shrubs and trees, levelling. etc. These operations require use of self-propelled and heavy equipment such as crawler tractors with heavy duty ploughs and dozers, high horsepower tractors with dozing arid hoeing attachments, ditchers, chisel ploughs, subsoilers, terracers, levellers etc.
Finances to obtain this equipment and heavy-duty machines are not ease to come by so most small-scale farmers are not able to buy these implements, even hiring of tractors and other heavy-duty machines is a big problem to farmers in sub-Saharan African countries which Nigeria is not an exception. This project is geared towards reducing such problems.

The aim of the research is to design and construct a low cost ridger thus the specific objectives are;

1. To design a low cost ridger using SolidWorks CAD software.
2. To construct a low cost ridger.
3. To design a low cost ridger that will provide strength against impacts
4. To design a low cost ridger that will prevent failure during operation.

The significance of this work is to help rural farmers key into using mechanized farming but at an affordable rate via patronizing local content product such as this low cost ridger to maximize their agricultural input to obtain optimal output is to get better yield in their farming. Farm products that are cultivated observing every necessary cultivation procedure tends to give maximum harvest. The ridger which farmers can use to make ridges in their farm will help break the soil into aggregates to allow air into the soil and the seedlings will germinate in good condition.
The ridges also help in the control of weed since the soil is been turned upside down, these weed now decompose and turn to manure to further boast the germination of the seedling.
This work will also help the farmer to start thinking in the direction of constructing farm implements since it is obvious that using local content like a local hoe that was used in this project can bring out a standard design that can be used to ease work to a particular level.

This work is limited to the design of a low cost ridger. The design was done using iron bars that where welded to hoes in an angle that when being pulled by a vehicle (mini tractor) the ridger will be able to make ridges on a soil that have been ploughed.

2.0 LITERATURE REVIEW

Over the research has been carried out on the development and evaluation of tillage implements which has a profound influence on the study. This chapter reviews these studies to provide some baseline information relevant to the study and to serve as a guide for the conduct of the research.

2.1.1 Chisel Ridger

Maldava et al [5] considered chisel plough a farm minimum tillage tool which leaves mulch remaining on the soil surface. The quantity of carbon dioxide that gets lost during tillage depends on the used implement; the disk harrow causes bigger loss than the chisel plough. The chisel plough has been introduced in Venezuela since 1973. The efficient performance of the chisel plough is function of the position of the bodies in the frame. The specific objectives consisted on relating the number, distances and position of the shank with the bulk density, water content, porosity, efficiency, field capacity, working depth, draft requirement, weed control and clod size. An 82 kW John Deere 4240 tractor was used, and a mounted chisel plough Bon ford Super flow standard model of 7 mobile chisel with a maximum working width of 2.44 m. A blocks design at random was used with eight treatments that consisted of varying the number, position and distance of the shanks with five repetitions. A conventional variance analysis was carried out among the eight treatments and the differences among them were detected by means of the Minimum Significant Difference Test with ($p \leq 0.05$). It was obtained, the apparent density between 1.49 and 1.63 kg m^3, the porosity between 32.59 and 37.78%; the depth between 24.86 and 28.80 cm, soil humidity between 10.63 and 14.58 cm3, the best weed control was for the position in V of five bodies, with 25 cm among bodies. On concluded, recommending the appropriate positional order of the bodies for the studied parameters, including weed residuals.

2.1.2 The Ridger (Plough Ridger)

The ridger is used for making ridges for raw crops such as Sugarcane, Potato, chilies, tobacco, banana, etc. as well as for opening furrows for water flow. The ridger should be used when the soil is slightly moist and used only after tilling the land once or twice to enable the ridger to carve the soil properly to form ridges [7].

Farmers employ the use of cattle to help pull the ridger during ridge making since mechanized farming is still expensive in this part of the world (Nigeria) the cows can be of much benefit to help ease the work of the farmer by helping to pull the ridger and any other farming implement of similar design.

The adjustable ridger as shown in figure 1 below shows the shape of the ridger and how it is being connected to the cattle to be drawn during ridge making.

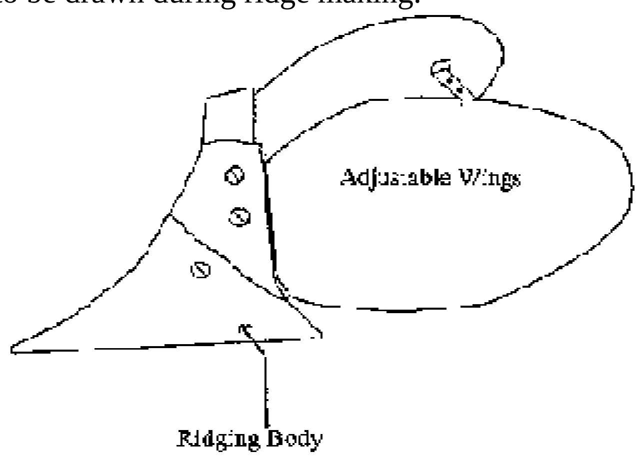

Figure 2.1: The adjustable Ridger [8]

2.1.3 Uses of a Ridger

The ridger can be used in the farm for performing the following operations

- the preparation of the field ridges.
- ridging of ridges.
- weeding.
- line application of fertilizer.
- incorporation of manure.

2.1.4 Why make Ridges

Ridging or earthing up is simply the process of adding soil to the crop such that the bed height is increased. Yields are increased by ridging because tubers are formed from the stems. Ridging also improves soil aeration, and enhances tuber growth, and minimizes tuber greening. The method of soil preparation affected of the soil surface roughness indices significantly, demonstrating the importance of soil tillage for the physical conditions on the soil surface. Boydas et al. found that soil physical properties are extremely vital to plant growth. The influence of tillage implements on soil physical properties is significant [1, 8].
Traditionally, all crops are grown on ridges or mounds.
Cropping on ridges has many advantages

- erosion control
- better growing conditions for young plants, especially root and tuber crops
- prevents water logging
- reduces spreading of fungal diseases
- harvesting of tuber / root crops is easier
- planting and weeding is easier

- incorporation of large quantities of organic matter is easier

2.1.5 Ridging system

How to make ridges with the Ridger

When the soil is under cultivation or softened by plowing it is easy to make ridges with the ridger-plow. The adjustments of the ridger are done as for the prow. In addition, you can adjust the distance between your ridges by the adjustable wings.

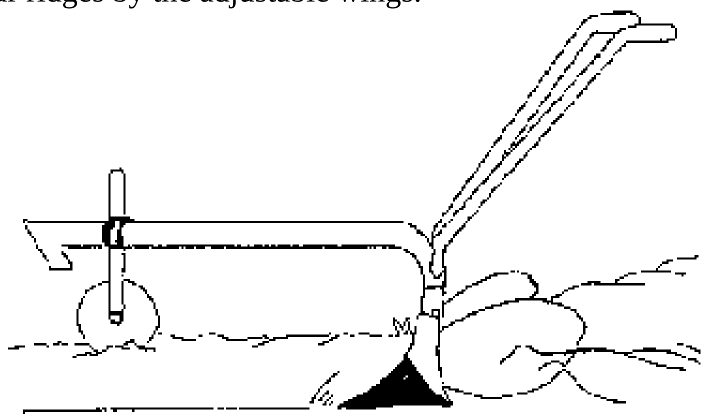

Fig.2.2: The Ridger [8].

The space in between the ridges is varied by adjusting the wings of the adjustable ridger as shown in the figure 2 below.

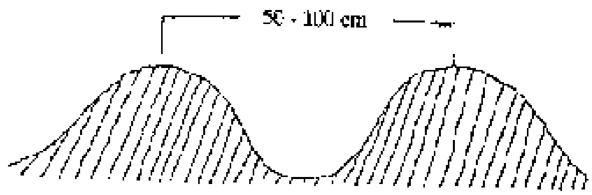

Fig.2.3a: The adjustable wings of the ridger allow the preparation of ridges with a distance of 50-100 cm.

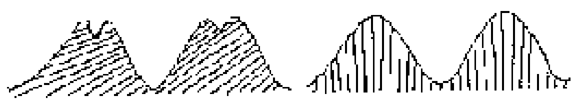

Fig.2.3b: No! These ridges are not correct, they have hollows on top. Yes! These ridges are correct all these ridges need is reridging.

The ridges must not have hollows on top! If they do not have the correct shape after ridging once, you ridge for a second tune.

Reridging.

Ridging is making ridges on the soil which ridges had already been done. This process is done either because the previously done ridges where shallow or where not well shaped(carved) then reridging is carried out immediately after the ridging is done or reridging the farmland after ridging have been carried out some weeks earlier and rain have wash down the sand from the top of the ridges, in this case the reridging helps in weeding the farm by turning over the upper layer of the soil, bringing fresh nutrients to the surface, while burying weeds and allowing them to decay thereby serving as manure to the soil which will then increase the growth of the crops and by implication increase the yield.

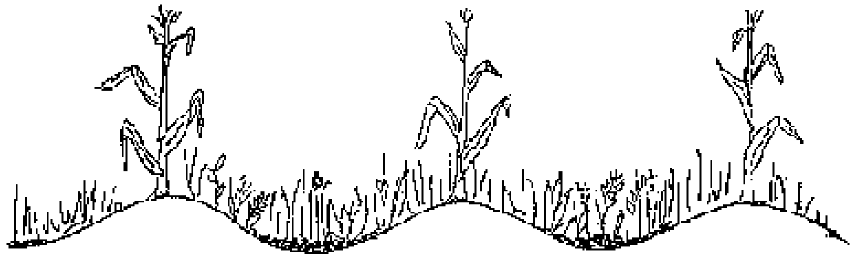

Fig.2.4a: When the rain has washed down soil from the top of the ridges into the furrows and weeds have grown, the ridger is used for weeding and ridging.

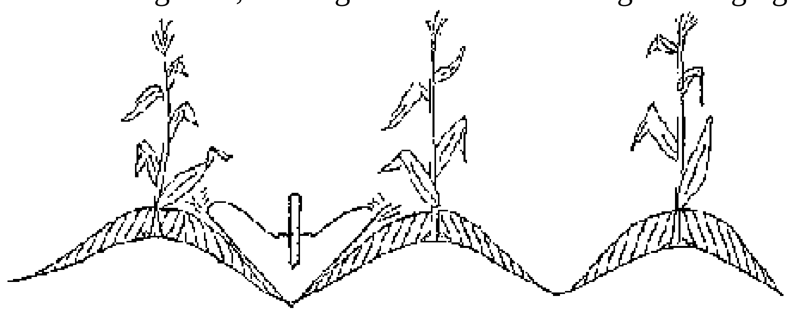

Fig.2.4b: ridging can be combined with weeding and band application of fertilizer.

- ridging gives the ridges a correct shape again and uproots the weeds at the same time (weeding).
- ridging covers the surface roots with soil and protects them against drying out
- ridging increases the ridges and the seedbed for root and tuber crops
- ridging combined with fertilizer application mixes the fertilizer with the soil and places the fertilizer grains near the plants (band application).

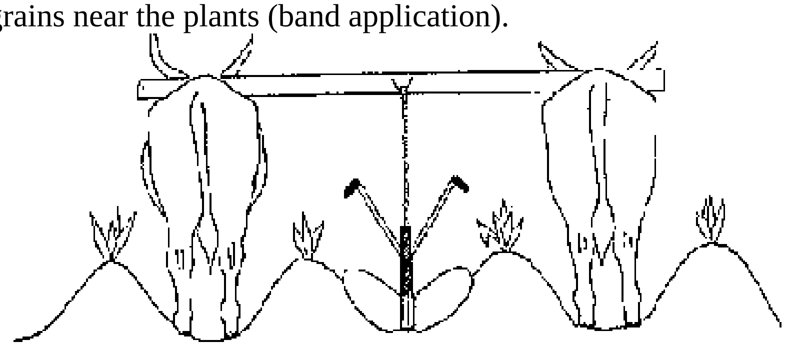

Fig.2.5: For ridging or weeding, the adjustable ridger is attached to the long yoke.

Splitting of old Ridges

When cropping on ridges, you don't have to plow after harvest. You use your ridger to split old ridges and mould new ones. If you put organic matter (corn stalks, manure, etc.) into the furrows before splitting the old ridges, you can add plenty of manure to the soil.

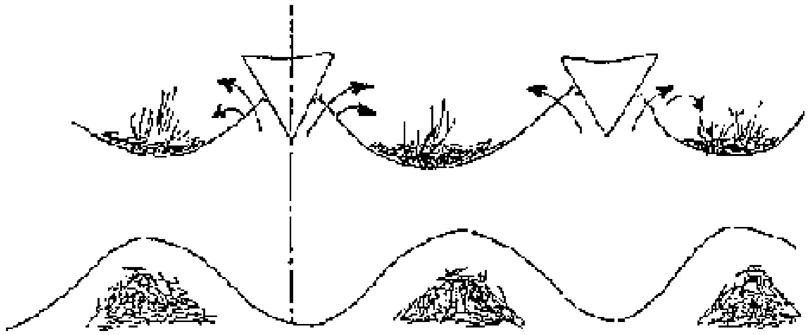

Fig.2.6: Split the old ridges after the cultivation season and incorporate organic matter in the soil.

2.1.6 Maintenance of the Ridger

To save money, you have to maintain and care for your ridger

- check and tighten all bolts and nuts of your ridger before starting work
- oil your ridger, especially bolts and nuts every week end
- store your ridges in a dry place (cowshed) to avoid corrosion
-

Advantages and Disadvantages of ridge farming.

2.1.7 Advantages of the ridge plant system include:

1. **Improved weed control.** In the row annual weed density can be reduced nearly 80 percent with ridge plant compared to mulch-till systems. Herbicides are more effective at lower weed densities. Also, any weeds that have germinated or are about to emerge in the ridge at planting time will be cleared away by the planter. This gives the crop an even start with weeds in the row.

By comparison, if a tandem disk or a rotary tiller is used to incorporate herbicides and prepare a seedbed, surface weed seed is “planted” in the row. This makes ridge planting one of the easiest systems to use with little or no herbicide, making it popular with organic producers. Ridge till is especially beneficial for reducing shattercane in corn.

2. **Warmer soil temperature.** Residue from the previous crop settles between the ridges, permitting the ridge to warm up sooner. The warmer soil speeds crop emergence, increases competitiveness with weeds and increases the likelihood of a good crop stand. The quick and improved crop emergence allows for earlier crop cultivation, which may control weeds between the rows better.

3. **Better soil moisture**. Without preplant tillage, ridge planting preserves soil moisture. Tillage can dry the soil to the depth of the tillage operation. In dry springs, especially in western Nebraska, soil moisture near the surface may be inadequate at planting for crop germination and growth if the soil was chiseled or disked. Realizing this, growers using tillage to prepare a seedbed often plant deeper or use a lister, which may reduce crop stands and allow excessive soil erosion.

In higher rainfall areas, water drains off the ridge so planting can be earlier than on level ground. Since the ridge dries out sooner, the system is well adapted to poorly drained soils.

4. **Volunteer crops reduced**. Ridge planting almost eliminates volunteer crops. The seeds, ears or heads are moved by the planter to the row middle where cultivation or a directed herbicide application can control seeds that germinate. Volunteer crops, especially herbicide resistant ones, often are the worst weeds in conventionally tilled fields.

5. **Reduced herbicide cost.** Band application of herbicides at planting works well with ridge planting because the system reduces weed seeds and clears the row of residue which may intercept herbicides. In general, banding reduces herbicide costs by two-thirds.

6. **Erosion control**. If ridge height is maintained and the land does not have more than a 4 percent slope, erosion will be reduced. With a 4 percent to 7 percent slope, it may be necessary to ridge plant on the contour.

7. **Controlled traffic pattern**. Soil compaction in the row is reduced if all equipment is designed to stay off the ridges.

2.1.8 Disadvantages of Ridge Planting

The disadvantages or inconveniences of the ridge plant system include:

1. **Early weeds, especially with late planted crops**. Weeds must be controlled prior to planting. The later a crop is planted the more likely that weeds may be present.
2. **Preplant incorporated herbicides inappropriate**. Preplant incorporated herbicide treatments should not be used because the tillage operation will destroy the ridge and mix weed seed into the soil. Also, unless the herbicide is incorporated extremely deep, which decreases its effectiveness, the herbicide will be moved out of the row with the soil during planting. The exception is where a ridge cleaning device is used in front of a tiller which incorporates the herbicide after ridge cleaning.
3. **Equipment changes**. The planter, cultivator and ditcher may need to be modified or new equipment may need to be purchased. Planting equipment must have a row cleaning device to push residue and weed seed to the row middles. The cultivator and ditcher need to be able to operate in crop residue. The ditcher also needs to be able to build a rounded or flat-topped ridge. Special equipment may be needed to keep the planter on the ridge.

4. **Wheel spacing and tire size adjustment**. The wheel spacing of implements and the combine must be adjusted to the row spacing. Also tire size is limited because large tires may destroy the ridge. An alternative is to use duals with spacers to fit rows if extra load-carrying capacity is needed.
5. **Limited traffic pattern**. All traffic must follow rows.
6. **Works best for continuous row crops**. With modification, small grains have been drilled on ridges.

2.2 Theory

Field capacity

According to Mileusnić et al. [9], calculating field capacity is just part of the overall concept of farm machinery management. The field capacity of a machine is a function of the rated width, the speed of travel and the amount of field time lost during the operation [10]. He argued that, with implements such as harrows, field cultivator, mowers and combines, it would be practically impossible to utilize the full width of the machine without occasional skips, which is a function of the speed of travel, ground condition and skill of the operator. The measure of field capacity for agricultural machines is theoretical field capacity, effective field capacity and material capacity. Naim [9] reported that most agricultural field machines performances are expressed as area per unit time or tonnes per hour. It can be measured in acres or hectares per hour and is used to size machinery and it specifies given the amount of time available to accomplish a specific task [9]. The field time includes productive time and non-productive time, where productive time is the actual time spent to do a specific field operation [11]. The theoretical field capacity (TFC) is the rating of field coverage that would be obtained if a machine is performing its function 100% of the time at rated forward speed and always covering 100% of the rated width (Gupta & Shukla, 2017). According to Lovarelli et al. (2017), it is calculated simply by multiplying the distance travelled in an hour by the effective working width.

$$TFC, ha/h = \frac{w \times s}{10}$$

Effective field capacity (EFC) is the actual area covered by the implement based on its total time consumed and its width (Naim, 2014). Mathematically, it is expressed as:

$$C = \frac{S \times W}{10} \times \frac{E}{100}$$

Where:
C is effective field capacity, hectare per hour; S is speed of travel in km per hour; W is theoretical width of cut of the machine in metre and E is field efficiency in percent.

According to Oduma (2015), factors that influence draught include depth of cut, working speed, the sharpness of cutting edge, the width of cut, implement type, soil condition and attachments. Mathematically it is expressed as,

$$D = P cos\theta$$

Where D is draught force (kN); P is pull in (kN) and θ is angle between the line of pull and horizontal.

2.3 Review

David Amidu W. [1] worked on development and evaluation of a double row disc ridger. In his work he developed and tested the performance of a double-row disc ridger for root and tuber crop cultivation the functional analysis (FA) and computer-aided design methodologies (CAD) were applied. The prototype was tested at varied tractor speed ranging from 1.67 – 2.5 m/s (6 – 9 km/h) and disc angle from 40° - 45° to determine the draught force, fuel consumption, wheel-slip, depth and width of cut. Their results indicate that optimum performance was achieved at disc and tilt angle of 42.5° and 25° and tractor speed of 2.23 m/s (8 km/h). The ridger recorded a field capacity of 1.45 ha/h and average fuel consumption of 6.3 l/ha (9.14 l/h). It was observed that increased tractor speed and disc angle resulted in increased draught force from 1.8 – 2.4 kN, increased fuel consumption from 5.2 – 7.04 l/ha (7.81 – 10.45 l/h) and increased depth and width of cut from 30 – 40 cm and 250 – 280 cm, respectively.

Madhava et al [5] worked on modelling and analysis of chisel plough. Their specific objectives consisted on relating the number, distances and position of the shank with the bulk density, water content, porosity, efficiency, field capacity, working depth, draft requirement, weed control and clod size. An 82 kW John Deere 4240 tractor was used, and a mounted chisel plough Bon ford Super flow standard model of 7 mobile chisel with a maximum working width of 2.44 m. They used a block design at random with eight treatments that consisted of varying the number, position and distance of the shanks with five repetitions. Their results obtained the apparent density between 1.49 and 1.63 kg m3, the porosity between 32.59 and 37.78%; the depth between 24.86 and 28.80 cm, soil humidity between 10.63 and 14.58 cm3, the best weed control was for the position in V of five bodies, with 25 cm among bodies.

Balaji et al [1] carried out research on design and fabrication of ploughing machine. In their work they developed a multipurpose agricultural vehicle which is small, compact in size for performing major agricultural operations like ploughing, seeding, harvesting. They concluded that the project made cultivation much simpler. Their design was done using CATIA V5 CAD software.

Nkakini [12] evaluated the performance of disc ridging tractive force model in loamy sand soil using sensitivity measured parameters. Results from his study revealed that the best tillage speed for disc ridging operation is 2.22 m/s

Selvakuma et al [1] worked on design and fabrication of agricultural land tilling and planting machine. Their objective was to design a machine which will do multipurpose work like tilling, ploughing and seed sowing simultaneously, so that it makes work so simple and reduces man power. Their aim and objectives were achieved which resulted into a single operated machine which will reduce stress and effort and can also be handled by a single person for farming processes.

2.4 Summary

Ridge planting removes up to 80 percent of the weed seeds out of the crop, setting the stage for economical and effective weed control. Ridge planting is particularly adapted to furrow irrigation where the ridges are formed for irrigation. Ridge planting may make it possible to lower crop production costs by implementing a weed control program which includes both mechanical (with the use of the ridger) and chemical (using herbicides) weed control methods.

3.0 MATERIALS AND METHOD

3.1 MATERIALS

Material selection for the construction of this project is one of the key design decisions that have great influence on the safety, reliability and performance of the ridger. It also decides the weight of the ridger, its fabrication processes and cost.

This chapter presents all the tools and materials used for the construction of this work in a tabular form. These includes design simulations produced with SolidWorks. Material for construction was primarily mild steel, which was secured from the open market. The soil engaging parts and others such, as discs, hubs, bearings, category pins and bolts/nuts were also outsourced from the market. The ridger was constructed at the Department of Mechanical Engineering workshop of the College of Engineering, Joseph Sarwuan Tarka University, Makurdi.

This chapter of the work is presented in two sections. The first section deals with the material and the second deals with the methods for design and construction of the ridger.

3.1.1 Materials Used

The material used includes

Table 3.1. Materials used during construction

S/N	Materials
1	Mild steel plates
2	Disc
3	3-point linkage construction 210 x 85mm rectangular frame
4	3-point linkage materials 50 x 50mm mild steel angular bar
5	Frame materials 100 x 100 x 6mm mild steel frame;
6	The bearing hubs
7	Ball-bearing
8	The shank

Table 3.2 Equipment's used during construction

S/N	EQUIPMENT	MODEL NUMBER
1	Hand Cutting Machine	
2	Angle Grinder	Dewalt DW810-B1PH Angle Grinder.
3	Table Cut Off Saw	XWL01Z

3.2 DESIGN METHODOLOGY

The ridger design was accomplished using Computer-Aided Design methods with the aid of SOLIDWORKS software for standard design and fabrication of agricultural tools.

3.2.1 Design Principles and Criteria

The purpose of the designed ridger is to form ridges wide enough to accommodate the cultivation of raw crops and simple tuber crops like potatoes. As a fundamental principle postulated by Pahl *et al.* (2007), technical systems whose main flow is energy-based are referred to as machines, those that are material-based as equipment or apparatus, and those whose main flow is signal-based as devices. Hence, the proposed design of this ridger is equipment (implement) since its main flow is material (soil). The main function of this equipment is to make ridges for raw cropping as stated above.

The sub functions of the ridger are to;

i. makes water ways for irrigation purposes,

ii. Make terraces to check erosion,

iii. reridge to propagate weed control.

The subsidiary flow of the technical system will be energy (i.e., powered by draught power from internal combustion engine-Tractor).

3.4 Factors Considered in the Development of the Ridger

Factors affecting equipment and machinery design may be summarized under the following aspects: need; technical and economic requirements; manufacturing techniques, skills and materials; ergonomic considerations; economic and technical acceptability.

A. Need

Functional analysis of need was conducted using modern value analysis methodologies before and during the development of the disc ridger. The results of the functional analysis basically informed the choice of design model adopted in this study.

B. Technical and Economic Requirements

The disc ridger was designed to accommodate ridge spacing varying from 60cm for crops such as Soya bean up to 100cm for root and tuber as practised in Ghana. This includes ridge spacing for other crops such as maize which fall within this range. The dimensions were also determined to permit re-ridging and weeding under crops up to knee height. Adjustments were incorporated to allow varying of the disc angles to regulate draught and penetration subject to local conditions. It was also designed as a double-row disc ridger to accomplish two ridges/bonds in one pass so as to increase field capacity and reduce operating cost.

C. Manufacturing Techniques, Skills and Materials

Designs requiring machining processes were generally avoided to make the technology accessible to rural artisans and manufacturers. No alloy steels were used, but mild steel, which is locally available. The number of steel sections and types of bolts used was kept to a minimum to make sourcing of materials and replacement of parts as easy as possible.

D. Economic and Technical Acceptability

Designs and technologies associated with high tooling costs, particularly machining, were avoided to keep the cost of production down and to make the manufacture of the disc ridger possible by rural artisan/manufacturers. Two standard ball bearings are incorporated in each disc hub. Bolt

sizes chosen were generally the same as those used on the fully-mounted disc plough to avoid the acquisition of extra spanners. The ridger was designed to have minimum possible deviations from the farmer's traditional implements and does not require further training to operate.

3.2.2 Modelling of the disc ridger

The various components of the disc ridger were modelled using standard dimensions and material properties. The optimal dimensions and material selection were determined after modelling and design simulations which took into consideration the material properties. The modelling was done using 2018 SolidWorks software. The modelling process involved creating a rough two-dimensional sketch of the basic shape of the design, applying/modifying geometric relations and dimensions to the two-dimensional sketch, extruding, revolving, or sweeping the parametric two-dimensional sketch to create the base solid feature of the design, adding additional parametric features by identifying feature relations to complete the design, performing analyses on the computer model and refining the design as needed and finally creating the desired drawing views to document the design. The results of SOLIDWORKS simulation based on that predicted load then informed the basis for materials (quality and size) selected for the construction of the ridger.

3.3 Material Selection

Strength, durability, and services of a farm implement largely depend upon the quality of material used. Selection of proper material for the application was of critical value. Proper treatment of the selected material affects the initial cost and running cost as well as the durability and performance of the machine. Implement parts/components should be designed to utilize the lowest cost materials which can perform satisfactorily and provide adequate life. Use of high-cost materials and expensive treatments sometimes become unavoidable to make for a deficiency in the original design. The factors considered in the selection of suitable materials in the design of the ridger are: Manufacturability; Static, fatigue, and fracture characteristics; Availability; Cost and Environmental effects.

The most economical materials that satisfied both process and mechanical requirements were selected.

Make bonds/ridges

Constraint Functions (CF)

CF1 Use draught power from tractor

CF2 Design should respect safety standards

CF3 Design should respect quality standards and minimize losses from accidents

CF4 Strong enough to work in difficult soil conditions

CF5 Maintenance should be simple and easy to carryout

CF6 Easily constructed with local material and technology

CF7 Materials for construction should be of good quality, locally available and cost-effective

Table 4.3: Technical Specification of the Ridger

S.N. **Parameter Specification**

1 Type of ridger Double row disc ridger

2 Frame construction square tubular rigid frame

3 3-point linkage construction 610 x 825mmTriangular frame

4 3-point linkage materials 100 x 50mm mild steel tubular bar

5 Frame materials 100 x 100 x 6mm mild steel frame;

6 Number of bottom/discs 4

7 Size of disc 660 x 4mm

8 Type of disc Plain circular concave revolving disc

9 Number of bearing hubs 4

10 Type of bearing Ball-bearing

11 Bearing size outer 60 x 130mm (6312)

12 Bearing size inner 45 x 85mm (62092)

13 Disc angle Adjustable

14 Tilt angle Adjustable

15 Size of shanks 40 x 20mm solid rectangular bar

16 Number of shanks 4

17 Maximum width of cut 3500mm

18 Working depth 330mm

3.4 Fabricating Methods

Method of welding

Welding is a localized coalescence of metals or nonmetals produced either by heating the materials to the required welding temperatures, with or without the application of pressure, or by the application of pressure alone, and with or without the use of filler materials.

With the availability of different types of welding but considerably the area of application in the fabrication of SAE BAJA Roll Cage.

Below are the four main types of welding;

- Gas Metal Arc Welding (GMAW/MIG)
- Gas Tungsten Arc Welding (GTAW/TIG)
- Shielded Metal Arc Welding (SMAW)
- Flux Cored Arc Welding (FCAW)

Gas Metal Arc Welding (GMAW/MIG) which is also known as Metal Inert Gas (MIG) welding, this process uses a thin wire as an electrode. The wire heats up as it is fed through the welding instrument and towards the welding site. Shielding gas must be used to protect the weld from contaminants in the air, typically, this comes in the form of carbon dioxide, oxygen, argon or helium. This method is often used to work on metals such as stainless steel, copper, nickel, carbon steel, aluminum, and more.

Gas Tungsten Arc Welding (GTAW/TIG) is a type of welding process also known as Tungsten Inert Gas (TIG) welding it is commonly used to weld together thin and non-ferrous materials like aluminum, copper, lead, or nickel. It’s commonly applied to bicycle or aircraft manufacturing.

Unlike other types of welding processes, TIG welding uses a non-consumable tungsten electrode to produce the weld. You will still need an external gas supply, usually argon or a mix of argon and helium.

Shielded Metal Arc Welding (SMAW) This type of welding process relies on a manual technique using a consumable electrode coated in flux. This method tends to be most popular among home-shop welders. This process is also more informally known as stick welding. The nickname references the electrode used to weld the metal, which comes in the form of a “stick.” Because shielded metal arc welding requires minimal equipment, it’s one of the most low-cost processes around. This type of welding does not require shielding gas and can be performed outdoors in the wind or rain. It also works well on dirt and rusty materials. The disadvantage is that Stick welds don’t typically produce the best quality products. They are prone to porosity, cracks, and shallow penetration. In general, stick welds are less durable than what other types of welding will produce.

Flux Cored Arc Welding (FCAW) it is Similar to MIG welding, flux cored arc welding revolves around a continuous wire feed process. There are two separate processes associated with flux cored arc welding. One involves the use of shielding gas while the other relies on self-shielding agents produced when fluxing agents decompose within the wire. It also allows welders to perform their work outdoors (windy conditions won’t affect the weld). The semi-automatic arc provides high welding speed and portability, making it a popular process to employ on construction projects.

Parts

The basic parts of the modern plough are:

i. Beam
ii. Hitch (British English: hake)
iii. Vertical regulator
iv. Coulter (knife coulter pictured, but disk coulter common)
v. Chisel (foreshare)
vi. Share (mainshare)
vii. Mouldboard

Other parts include the frog (or frame), runner, landside, shin, trash board, and stilts (handles). On modern ploughs and some older ploughs, the mould board is separate from the share and runner, and so these parts can be replaced without replacing the mould board. Abrasion eventually wears out all parts of a plough that come into contact with the soil.

4.0 RESULTS AND DISCUSSION

According to review of past journals, it is noted that a ridger should be able to perform the duties it is designed for such as tilling, ploughing, seed sowing etc.

The ridger designed and constructed in this work has the capability to give service to farmers efficiently during the process of operation on farm lands.

4.1 Modelling.

For setting out the dimensions of the ridger, aesthetic which has to do with the final appearance and ergonomic which has to do with the user friendliness of the ridger were considered as priority during the design and modelling phase of this research. The model was designed in SolidWorks 2018 software.

4.1.1 Ridger views.

Below is the isometric view of the ridger in this project.

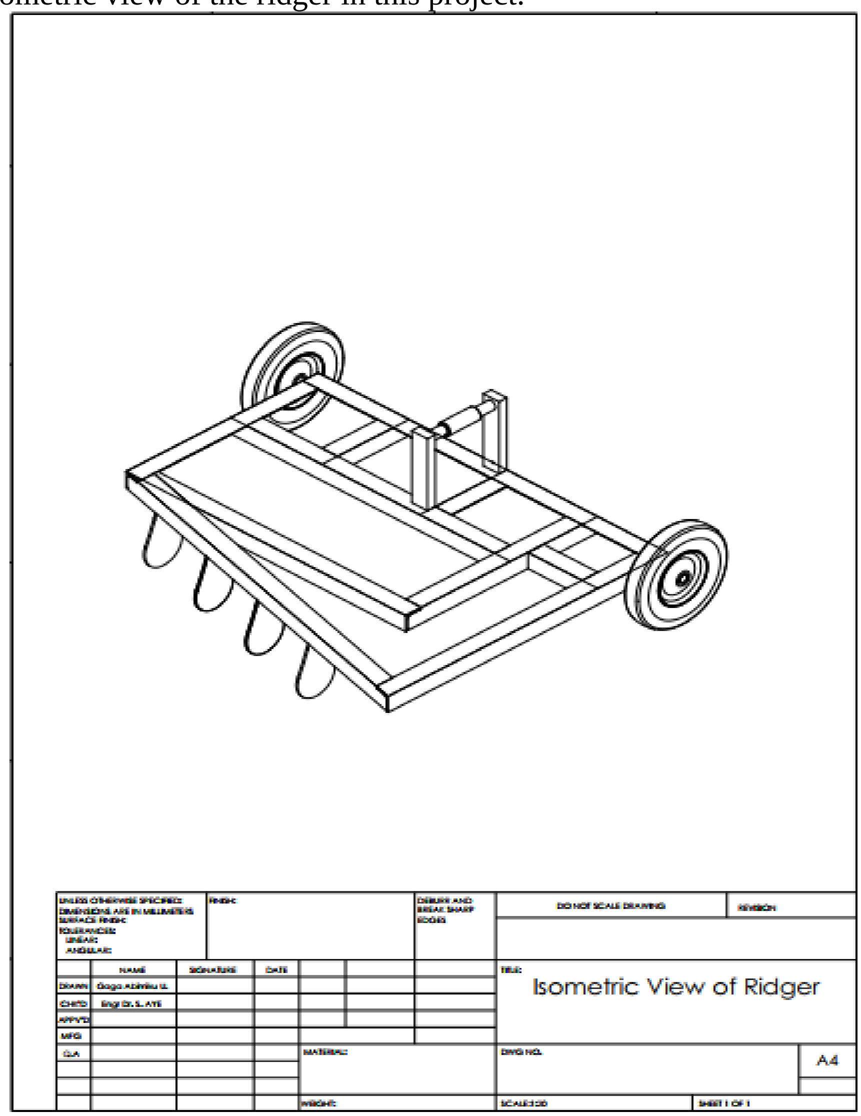

Fig. 4.1: Isometric view of Ridger.

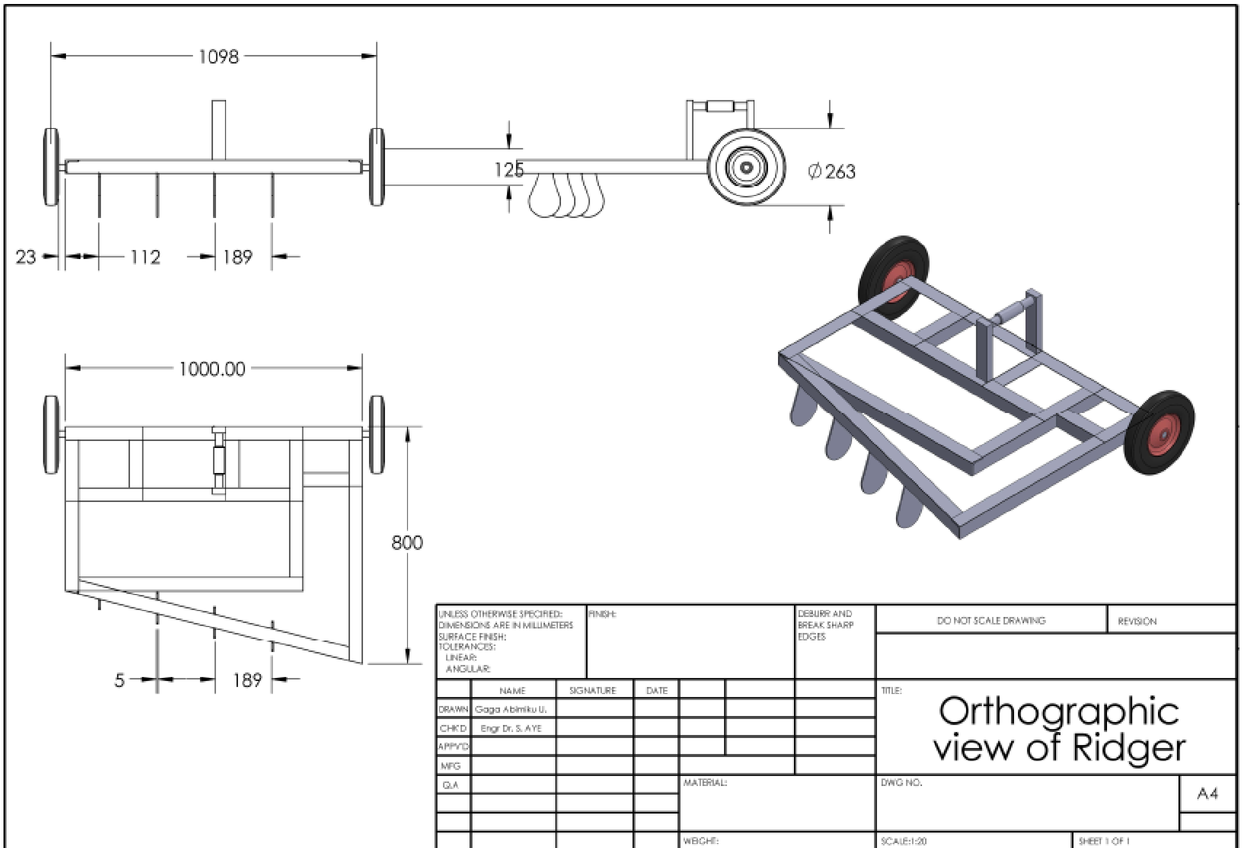

Fig.4.2: Orthographic projection of Ridger.

Plate 4.1. Pictorial Representation of Ploughing Machine.

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The design of the low-cost ploughing machine was done using SolidWorks CAD software. Safety was of utmost concern in every aspect of the ploughing machine and the host environment. The design of the ploughing machine was kept very simple keeping in view its manufacturability. Mild steel was the material used for the construction of the ploughing machine frame

5.2 Recommendation

For future design or optimization it is recommended that Finite Element Analysis of the ploughing machine should be further conducted to predict its resistance to the harsh environment since it is meant to carryout extensive task like ploughing or tilling the soil for plantation.

REFERENCE

[1] David Amidu W. (2019). Developmentt and evaluation of a double row disc ridger.

[2] Gebregziabher S., Mouazen A. M., Van Brussel H., Ramon H., Meresa F., Verplancke, H. and De Baerdemaeker J. (2007). Design of the Ethiopian plough using structural analysis validated with finite element analysis. Biosystems Engineering.

[3] Hashemi A., Ahmad D., Othman J. and Sulaiman S. (2012). Design, development and performance of a disk plough combined with rotary blades. IOP Conference Series:117 Materials Science and Engineering, 36(1).

[4] Girish and Srihari (2015). Design and fabrication of multipurpose farm equipment. International Journal for Scientific Research & Development| Vol. 4, Issue 06.

[5] Miles L.D., (2015). Techniques of value analysis and engineering. Miles Value Foundation.

[6] Abdallah A. B. (2002). Effect of ploughing depth and speed of three tillage implements on tractor performance. Available: http://khartoumspace.uofk.edu (Accessed: 24/2/2019).

[7] Raheman et al. (2006) Journal of Agricultural Research.

[8] BHASKAR S. A. (2015). Development and performance evaluation of tractor operated tie ridger (Doctoral dissertation, Mahatma Phule Krishi Vidyapeeth, Rahuri.).

[9] Mileusnić Z. I., Petrović, D. V. and Đević, M. S. (2010). Comparison of tillage systemsaccording to fuel consumption. Energy, 35(1), 221-228.

[10] Naim A. M. El. (2014). Effect of Disc and Tilt Angles of Disc Plough on Tractor120 Performance Under Clay Soil. Current Research in Agricultural Sciences, 2014, 1(3): 83-94.

[11] Mamkagh A. M. (2009). Effect of ploughing speed, disk angle and tilt angle on farm tractor wheel slip and on ploughing depth using disk plough. Jordan J. Agric. Sci, 5(3), 352- 360.

[12] Nkakini S. O. (2014). Performance evaluation of disc ridging tractive force model in loamy sand soil using sensitivity measured parameters. Agricultural Engineering International: CIGR Journal, 16(2), 15-21.

Johnston R. C. R. and Birtwistle R. (1963). Wheatland disc plough investigations. II. Discs forces. Journal of Agricultural Engineering Research, 8(4), 312-326.

Joutsenvaara J. and Vierelä R. (2013). Future Materials in Agricultural Construction: Technical report.