HAND BOOK ON USE AND MAINTENANCE OF SMALL SCALE AGRICULTURAL MACHINES




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Hakeem Ayinde Ajeigbe and Aliyu Adinoyi

Acknowledgement

This hand book has been developed in alignment with the objectives of intensification, drudgery reduction through mechanization and job creation in the Sorghum commodity under the Outreach project of the Agricultural Transformation Agenda Support Program (ATASP-1) being implemented by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). It highlights some basic small and medium scale agricultural machineries used along sorghum value chain and their effective operational requirements and maintenance. We thank the Honorable Minister, Federal Ministry of Agriculture, Nigeria, Chief Audu Ogbeh, the President Africa Development Bank, Dr Akinwumi Adesina who is also ICRISAT Ambassador of Goodwill for the opportunity given to us and ICRISAT to positively contribute to the development of sorghum value chain in Nigeria.

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TABLE OF CONTENTS

BACKGROUND

Agricultural power sources are categorized mainly into three, human, animal and motorized power. In the rural areas of developing countries like Nigeria, farmers use simple implements and tools utilizing human and animal power, associated with drudgery and low productivity. Large machinery are expensive for small- scale and traditional farming agriculture and are therefore not suitable solution for small farmers. Introduction of animal–drawn and small scale motorized equipment as intermediate technology for small farmers is becoming increasingly necessary, especially for some critical operations which includes; land preparation, planting, weeding, harvesting, threshing and milling. These small/medium scale equipments compared to manual tools have positively affected the crop production factors through improving field efficiency and capacity, increasing crop yield and reducing costs of production.

ATASP-1 HIGHLIGHT

The FMARD got the backing of the African Development Bank to finance a project 'Agricultural Transformation Agenda Support Program-phase-1 (ATASP-1)'. This project is being implemented in four Staple Crops Processing Zones (SCPZs) of Adani-Omor, Bida-Badeggi, Kano-Jigawa and Kebbi-Sokoto. Key impacts are additional incomes to an increased number of producers and entrepreneurs in the sector by the creation of about 120,000 jobs along the value chain of priority commodities, addition of 20,000 metric tons of key target commodity food crops added to domestic food supply per annum; and capacity enhancement of 200,000 youths. ATASP-1 has 3 components as follows: 1. Infrastructure development, 2. commodity value chain development, and 3. program management.

The Outreach Program was carved from ATASP-1 and given the responsibility of implementing Component 2, with the objective of transforming Nigeria's cassava, rice and sorghum sectors with three CGIAR centers. These are: IITA-cassava; AfricaRice-rice; ICRISAT-sorghum with their national partners. ATASP-1 Outreach implementation strategy is a major departure from past approaches to Agricultural development as it hopes to set a benchmark to show how a functional agricultural public-private partnership can succeed. The beneficiaries include farmer group, processor group, farmer input/service supplier group, sensitized persons (Market Information Service, open days, mass media), fabricators, marketers and transporters, seed companies, the youth, training participants, and policy makers.

This Program also has 3 components:

Component 1: Technology verification and extension with activities on (i) Technology verification, (ii) seed systems, planting material production and diffusion

Component 2: skills development activities on (i) agribusiness development, (ii) processing and marketing and (iii) promotion of youth entrepreneurship in agriculture.

Component 3: Effective Program management involving (i) Baseline studies, (ii) M&E (iii) establishment of appropriate management structure (iv) Establishment of Youth Agribusiness Training Centers

One of the key drivers of the component 2 focuses on ***facilitating Access of Smallholder Farmers to Small and Medium Scale Agricultural Equipment*** through the following:

- ***Demonstration of identified small and medium scale agricultural equipment to farmer groups and providing relevant trainings on the use of these technologies;***
- ***Facilitate linkage between farmers/processors and fabricator for acquisition of quality farm equipment for drudgery reduction;***
- ***Training of small and medium scale farmers/groups on the operation and maintenance of the identified technologies.***

A **Hand Book** on the operation and maintenance of small and medium scale agricultural equipment aligning well with component 2 of the project was necessary. Certainly, machinery and equipment form a major portion of the capital investment of any establishment that is involved in agricultural production. Machinery that is not properly selected and not operated correctly would constitute a liability to the owner and may result in delayed operations thereby leading to loss of investment.

1.0 INTRODUCTION

Small-scale farmers are estimated to account for the cultivation of about 90% of the total cultivated land area in Nigeria, producing about 90% of the total agricultural output (CTA, 1997). This category of farmers still depends on manual labour to carry out their various farming operations. However, with labour demand at critical crop production stages, high labour cost and food demand for the teaming population of over 170 million with an annual growth rate of 2.5%, the introduction of agricultural labour saving devices to Nigeria agriculture has become indispensable.

Though successive administrations in Nigeria have made concerted efforts aimed at achieving self sufficiency in food production, these efforts have failed to achieve their intended goals. There are many factors responsible for this, a major one being the lack of an integrated and appropriate labour saving agricultural tools and machines.

Therefore, the need to develop and introduce more labour saving devices on Nigeria farms has never been more critical than now. Knowing fully well that increased land productivity (greater output per unit of land) generally depends on the application of higher technology and a higher level of knowledge and management ability, it is necessary to appreciate those changes in mechanization level and farm management abilities that can have a multiplier effect on output per unit of land.

It is in view of the above that ICRISAT Nigeria is poise with the massive promotion of standardized small and medium scale agricultural machinery and equipment as well as promotes the production of locally designed prototypes in order to help increase the productivity of the poor agrarian community of the country.

2.0 EQUIPMENT FOR LAND PREPATION AND PLANTING OPERATION

At the onset of the raining season, farmers are faced with the challenge of timely utilization of the soil moisture immediately the rain falls for planting operation. Failure to plant at the appropriate time can lead to poor crop establishment or even total failure a condition which is not desirable by farmers as this can greatly affect their productivity. Hence the need for a labour and time saving machines that will help farmers to fully maximize every useful time during planting season. In view of the above, Agricultural engineers and equipment fabricators have made concerted effort to develop several small scale seed planters that have unique operational requirement in order to achieve maximum efficiency. Generally, planters can be categorized into Animal drawn, Hand held, Motorize and Tractor mounted.

Since small scale farmers are constrained in the use of tractors, because of a number of factors ranging from cost, farm holding capacity and technical know-how. This section will focused on small scale tillage and planters requiring draught animal power and human effort.

2.1 Triketor

The triketor is a three (3) wheeled mini tractor designed and constructed by the National Center for Agricultural Mechanization (NCAM) in Ilorin to carry out similar operations as a conventional tractor at a small scale level. The idea was to design an indigenous tractor that will help the small scale farmer to be productive and self reliance (Plate 1).

Plate 1: Triketor with impliments

2.2 Animal Drawn Ridger

It is pulled through a chain by a pair of draught animals, oxen, mules and at times donkeys. The handle has adjustable positions to take care of the height of the operator. It produces rounded top ridges during operation, and the furrow width can be adjusted by a simple mechanism. A depth adjustment wheel of 20 cm diameter is adjusted by sliding stalk mechanism, which can be fixed by a lock pin at any desired position. It has a robust share and a reversible doubled-edged share point made of high carbon steel, hardened and tempered for long life (Plate 2).

Plate 2: Animal drawn ridger

2.3 Animal Drawn Multi-Crop Planter

The animal drawn planter is a simple locally fabricated machine with total weight of the 38 kg and 0.50 m width, made of iron. It consists of ten main parts (Plate 3);

1. Seeder box with 12 kg seed capacity.
2. Drawbar.
3. frame.
4. Two ground wheels (55 cm diameter).
5. Seed plate.
6. sprocket.
7. Seed tubes.
8. Furrow opener.
9. Presser tool, and
10. Weed cultivator and marker.

In operation: depending on the crop to be planted, choose the appropriate seed plate and coupled it to the driven sprocket inside the seeder box. Put the seed inside the seed box and hitch the planter to the drought animal. As the machine is been pulled forward, the land wheel rotates the seed plate through the help of some gear arrangement (sprocket), and the seed plate picks the seed in the seed box and discharge it by gravity through the seed tube on to the furrow opener. The dropped seed is then covered with soil by the covering wheel.

Plate 3: Animal Drawn Multi-Crop Planter

Table1: Performance of the Animal Drawn Multi-Crop Planter

Parameters	**Average Performance**
Machine width (mm)	750
Operating speed (m/s)	2
Working Depth (mm)	30
Field Capacity (ha/hr)	0.5
Field Efficiency (%)	>85

2.4 Multi – Crop Double Planter

The Multi – Crop planter is imported into the country either from China or Korea; of course, there are several types across the globe depending on the designer's choice and considerations. The planter can be operated manually by hand push or coupled to the tractor as shown in Plate 4a and 4b respectively. While Plate 4c showed a Multi-crop Hand Pushed Single Row Planter designed and fabricated in NCAM Ilorin.

Plate 4a: Multicrop Double Planter

Plate 4b: Multicrop Planter

Plate 4c: Multicrop Hand Pushed Single Row Planter

Table 2: Performance of the Multi-crop Double Planter

Parameters	**Average Performance**
Operating speed (m/s)	2
Working Depth (mm)	30
Field Capacity (ha/hr)	0.33
Field Efficiency (%)	>85

2.5 Fertilizer Broadcaster

The fertilizer broadcaster shown in Plate 5. was fabricated by NCAM and used for broadcasting fertilizer and seeds on the field. It consists of a cylindrical hopper with conical bottom, a circular distributor (spreading disc) with fins, a gear driving mechanism, cranking handle, and agitator.It also has a feed control level and strap for hanging the broadcaster on the shoulder.

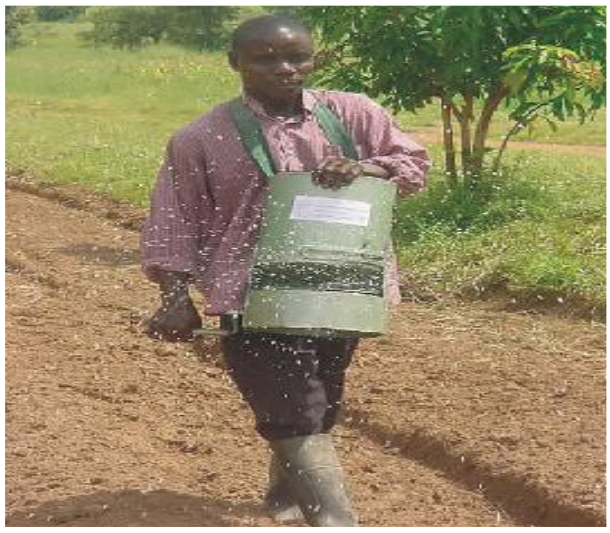

Plate 5: Fertilizer Broadcaster

2.6 Motorized Weeder

The motorized weeder (Plate 6) is a small scale weeding machine found to be very effective in weed control and can take away the drudgery associated with weeding operation as well as reduce the cost of weeding for a small scale farmer.
The motorized weeder shown in Plate 6 is a hand held machine powered by either a 2-stroke or 4-stroke petrol engine.

Plate 6: Motorized weeder

2.7 Knapsack Sprayer

This type of sprayer (Plate 7a) which is commonly used has a flat or bean shaped tank. The tank has a capacity of 16 to 20 liters and is made of plastic or stainless steel . There are two types, the lever operated and compressive. The lever operated type is operated by a lever handle which agitate the pump inside the tank by moving up and down for pressure build up inside the container. Plate 7b shows the compressed air Knapsack sprayer. They are both used for spraying field crops, vegetables and nurseries.

Plate 7a: Lever Operated Knapsack Sprayer

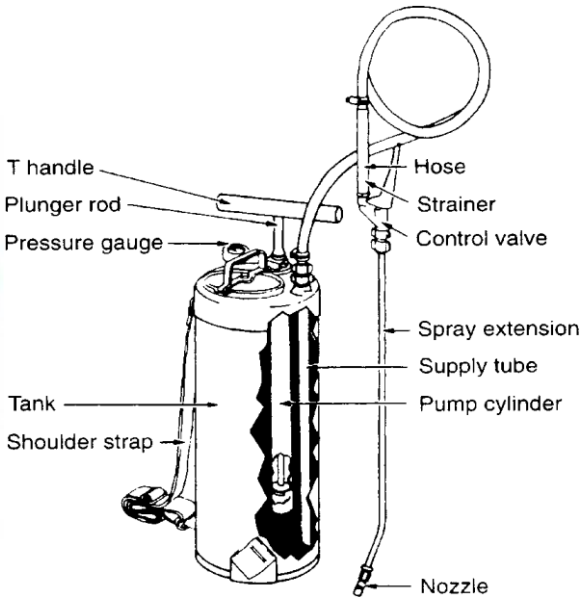

Plate 7b: Compressed air Knapsack Sprayer

3.0 POST HARVEST EQUIPMENT

3.1 Multi-Crop Thresher

Threshing operation is the removal of grains from the harvested crop. Threshing operation is considered as one of the foremost important post-harvest operation in grain production. There basically two method of threshing (Manual and Mechanical method). The manual method which is greatly ineffective involves the use of beating sticks or mortar and pestle..

Threshing Equipment

Thresher is a machine to separate grains from the harvested crop and provide clean grain without much loss and damage. During threshing, grain loss in terms of broken grain, unthreshed grain, blown grain, spilled grain etc. should be minimum. Clean unbruised grain fetch good price in the market as well as it has long storage life.

Different Parts Of A Thresher And Their Functions

A mechanical thresher consists of the following parts:

i. Feeding device (chute/tray/trough/hopper/conveyor)

ii. Threshing cylinder (hammers/spikes/rasp-bars/wire-loops/syndicator)

iii. Concave (woven-wire mesh/punched sheet/welded square bars)

iv. Blower/aspirator

v. Sieve-shaker/straw-walker.

The crop is fed from the feeding tray into the threshing cylinder. The threshing cylinder is fitted with spikes/bars/hammers or wire-loops around its periphery according to the type of thresher. Below the cylinder there is a concave and it covers lower portion of the cylinder. The cylinder rotates at high speed and thus the crop is threshed and the entire or a portion of threshed material falls from the concave on' to top sieve of cleaning system. Due to reciprocating motion of top sieve lighter material accumulate at the top and grain falls on to the bottom sieve. In case of spike-tooth thresher, an aspirator blower sucks out the lighter material from the top sieve and throws it out from blower outlet. The sieves help in further cleaning of the grain by allowing heavier straw to overflow.

Adjustments

Various adjustments are required before starting threshing operation. The machine is to be installed on clean level ground and is to be set according to crop and crop conditions. The adjustments necessary to get best performance from the machine are

(i) concavec learance, (ii) sieve clearance, (iii) sieve slope, (iv) stroke length and (v) blower suction opening.

Besides these, cylinder concave grate, top sieve hole size and cylinder speeds for threshing different crops are important for a multicrop thresher.

Factors Affecting Thresher Performance

The factors which affect the quality and efficiency of threshing are broadly classified in following three groups:

i. Crop factors:

Variety of crop,

Moisture in crop material.

ii. Machine factors:

Feeding chute angle,

Cylinder type,

Cylinder diameter,

Spike shape, size, number

Concave size, shape and clearance

iii. Operational factors:

Cylinder speed,

Feed rate, method of feeding,

Machine adjustments.

Moisture content of grains is a major factor in controlling grain damage. Decrease in moisture content greatly increases the brittleness of grains. Unthreshed grains are more at high pod moisture content whereas grain damage decreases with increase in grain moisture content. More threshing effort is required for threshing high moisture crop, which causes more internal grain damage and thus affects viability.

Plate 8a: IAR Sorghum Thresher

Plate 8b: NCAM Multi-crop Thresher

Plate 8c: Dandago Multi-crop Thresher

Table 3: Performance of the Multi Crop Thresher

Measured Parameters	Average Performance (Plate 8a)	Average Performance (Plate 8b)	Average Performance (Plate 8c)
Length (mm)		2000	2000
Width (mm)		1750	1200
Height (mm)		2000	1100
Height of feeding (mm)		1300	1300
Power source	Diesel	Diesel	Diesel
Power requirement (Hp)	7	13	7
Threshing efficiency (%)	>95	>95	>90
Capacity (kg/hr)	1000	2000	1000

3.2 Multi-purpose Hammer Mill

Hammer mills grind material by the impact of a high-speed rotary hammer; they are either tangential-feed or axial-feed types, according to their structure. Plate 9a shows the picture of the tangential-feed hammer mill with cyclone made by the National Center for Agricultural Mechanization (NCAM) Ilorin in Kwara State Nigeria. The mill comprises a feeding part, a grinding chamber and a collector. The feeding part comprises a feed hopper and a feed control flap. The grinding chamber consists of a rotary disk, a hammer, a serrated plate and a screen. The major parts of the collector include a fan, a feed conveying tube and a collection hopper.

Fed from the feed hopper in a tangential direction, the material is impacted and driven to the grinding chamber by the rotating hammers with high speed. The material in the grinding chamber is firstly hit and ground to some extent by hammers, and then thrown at high speed on to the serrated plate and the peripheral screen fixed inside the chamber to be further grounded through impact with the serrated plate and friction with the screen.

The process is then repeats until the particles pass through the screen and are discharged from the grinding chamber. The process inside the grinding chamber includes the functions of impacting, shearing and kneading, which improves the efficiency of grinding. The feed product is sucked from the discharging door to the conveying tube by a fan, then enters the collection hopper, and is finally discharged from the collection hopper after the meal settles out from the air stream.

The picture of the hammer mill in Plate 9b produce by Dandago Agricultural Machinery mill on the same principle except that it does not discharge the milled product through a cyclone but by gravity and milled grain collected at the outlet.

The main advantages of the mills are their efficiency, high productivity, wide application and fine particle output and ease of manufacture, allowing easier local construction; numerous are the artisans to produce it locally. Moreover, maintenance is easy and inexpensive.

Plate 9a: NCAM Hammer Mill with Cyclone Plate 9b: Dandago Multi-crop Hammer Mill

Table 4: Performance of the hammer mills

Measured Parameters	Average Performance (Plate 9a)	Average Performance (Plate 9b)
Length (mm)	1600	200
Width (mm)	550	120
Height (mm)	850	130
Height of feeding (mm)	930	109
Power source	Diesel	Diesel
Power requirement (Hp)	7	7
Milling Capacity (kg/hr)	1000	700

3.3 Aspirator Cleaner

The aspirated grain cleaner (Plate 10) is a winnowing machine that is used for cleaning grains like sorghum, millet, maize, cowpea, and soybeans after threshing and shelling operation. It was designed for small and medium scale farmers with a capacity of 600 – 800 kg/hr.

It consist of the hopper meant to hold grains for winnowing, blower meant to blow off chaffs, adjustable metering device, frame and 4.5 kw petrol engine as a source of power.

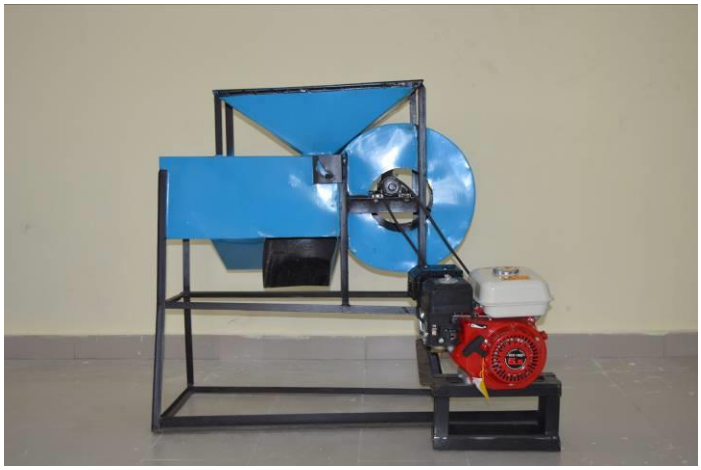

Plate 10: Aspirated Grain Cleaner

3.4 Crop Residue (Stalk) Crusher/Grinders

The idea of designing crop stalk crusher is to enhance agricultural productivity of -livestock farming system. Improvement of this technology has greatly helped in alleviating the problem of crushing stalk for animal used during dry-season .

The equipment comprises of three systems. A pair of rollers horizontally fixed for admission of stovers in the lateral direction, a hexagonal shear cutter with knifes which motion is synchronized with that of the pair of rollers and a hammer for the final crushing of the chopped stovers. Plate 11a and 11b shows a crop stalk being fed to a chopping machine through the action of a pair of rollers. The motion of the chopping machine is synchronized with that of the roller to ensure that the required sizes are cut from the crop stover. Action is positive when the motion of the top roller and the chopping disc are anticlockwise and that of the lower roller is in the clockwise direction. The chopped pieces of crop stalks fall into the hammer chamber by gravity.

The hammer mill is conventionally a hammer-like projection mounted on a rotating shaft. The hammers are hung in such a way that they can swing either ways depending on centrifugal force or impact on the materials. The hammers revolve at high speed and grind the materials fed into the chamber by beating. The material is grounded till it passes the screen holes of the detachable sieve. Hammer size, number and arrangement are very important. Hammers are usually installed on high speed (3600rpm) shafts. The distant between the screen and hammer should be 12mm to 14mm for size reduction of cereal grains and about 5mm for fibrous material.

Plate 11a: Multi-crop Stalk Grinder

Plate 11b: Dandago Crop Residue Grinder

Table 8: Performance of the Stalk Grinder

Measured Parameters	Average Performance (Plate 11a)	Average Performance (Plate 11b)
Length (mm)	1500	1200
Width (mm)	600	1200
Height (mm)	1300	1150
Height of feeding (mm)	1000	1300
Power source	Diesel	Diesel
Power requirement (Hp)	7	13
Capacity (kg/hr)	1000	1500

4.0 Groundnut Harvester

Groundnut cultivation in the Semi-Arid zone of West Africa is characterized by high labour demand especially for land preparation and harvesting. It has been reported in literature that it takes from 120 – 150 man-hr to harvest a hectare of groundnut manually, while this method pose the risk of depletion of soil fertility due to removal of the complete root system along with nitrogenous nodules. However, this can be eliminated with the use of mechanical harvesters (Ademiluyi *et al.* 2011). The mechanical harvesting of groundnut has advantages of reducing the cost of labour and the drudgery. Concerted efforts have been made in developing several prototypes of groundnut diggers in many part of the world, one of such is the animal drawn groundnut digger developed and promoted among the groundnut farmers in the Semi-Arid zone of West Africa by the joint effort of ICRISAT Nigeria and the Department of Agricultural and Environmental Engineering Bayero University, Kano Nigeria.

4.1 Principle of Operation of the Groundnut Digger

The developed groundnut digger (Plate 12) was designed as an animal drawn implement and to dig a row at a swath. In operation, the two ground wheels are placed on separate furrows, living the ridge in-between the digger wheels. The draft pole is then hitched to the work bulls and the implement blade is adjusted to the desired depth of cut through the calibration made on the two depth control wheels. The handle can be adjusted for comfort during operation (depending on operator's height). As the work bulls are made to move forward pulling the implement, the blade cut the ridge below the pod root zone of the groundnut plant. The plant is then uprooted and move over to the digger blade which is coupled with levelers spaced at interval to facilitate the separation of the groundnut plant from the soil clod that may be cut by the blade. The groundnut plant is then discharged behind the digger on top of the ridge.

Plate 12: Animal Drawn Groundnut Digger

Table 5: Performance of the Animal Drawn Groundnut Digger

Parameters	**Average Performance**
Machine width (mm)	890
Length (mm)	1950
Height (mm)	556
Cutting width (mm)	520
Operating speed (m/s)	2.0-2.5
Working Depth (mm)	200
Field Capacity (ha/hr)	0.25
Field Efficiency (%)	53.4
Digging Efficiency (%)	>97.21
Draft Requirement (N)	424-828

4.2 GROUNDNUT SHELLER

The Groundnut Sheller, shown in Plate 13 was developed by the Institute for Agricultural Research (IAR) Zaria and it comprises of a shelling unit and a prime mover - which could either be a petrol or diesel engine.

The components of the shelling unit are ***hopper, shelling chamber, blower, chaff outlet, grains outlet and frame.*** The machine shell and clean in one operation with delivery of either clean seeds or grains.:

Requirements for Efficient Shelling Operations

The machine and prime mover requirements for efficient shelling operation are:

i. Cylinder speed: Cylinder speed determines the performance of any shelling machine. Other parameters may be within the acceptable range but if the cylinder is not in motion, no shelling action will take place. Generally, shelling efficiency is directly related to the speed of the cylinder. That is, the higher the cylinder speeds, the higher the shelling efficiency. But excessive speed can cause grain/seed damage and low speed can give unshelled pods or low rate of shelling, hence, an optimum speed is desirable.

ii. Cylinder-concave clearance: The gap between the rotor (i.e. the shelling cylinder) and the stationary concave is called cylinder-concave clearance. If this gap is too small, there will either be:

- damage to the shelled seeds/grains or broken grain, and

choking of fed material on the machine

Also, high clearance will result in non-shelling of the material or low shelling. Provision has been made in this modified Sheller for clearance adjustment to suit the physical characteristics of the materials to be shelled.

iii. Concave Opening: The physical characteristic of groundnut and the different varieties being promoted call for proper choice of concave openings. Small concave openings can cause non-release of threshed seeds/grains, resulting in accumulation of the material being threshed and/or damage to the seeds/grains. Similarly, large concave openings will result in the penetration of un-threshed pods causing low shelling efficiency. As the concaves are interchangeable, the varieties of grain size should be considered when selecting a concave for shelling operation.

iv. Pod Moisture Content: The pod moisture content is another parameter that affects shelling efficiency. Low pod moisture content can cause kernel breakage while at high moisture content, shelling can be difficult. The range of moisture content adequate for optimum shelling operations is between 10 to 18 %.

v. Supply of Clean Air and Fuel to Prime Mover: Contaminated air and fuel can lead to poor engine performance and a rapid deterioration of the prime mover. Therefore, in dusty environments, it is important to clean the air filter daily prior to the day's operation. **vi. Proper Lubrication of Prime Mover:** The prime mover should be properly lubricated to reduce friction and wear in the moving parts. Inadequate or lack of lubrication will either result in rapid wear, overheating and loss of power or total failure of the engine. For proper lubrication, follow strictly the recommended guidelines given by the engine manufacturer.

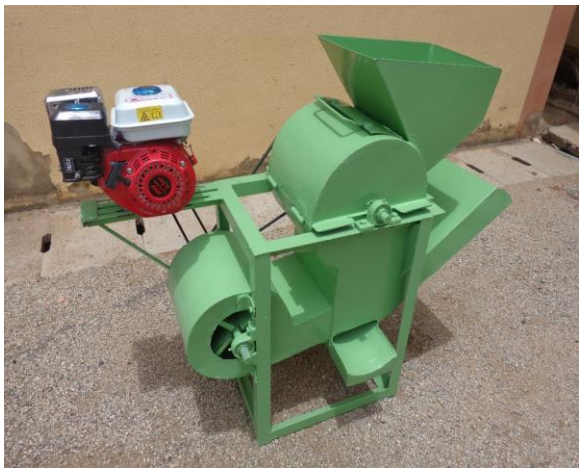

Plate 13: IAR Groundnut Sheller

Table 6: Performance of the Groundnut Sheller.

Measured Parameters	Average Performance Results
Weight:	94 kg
Length:	1.39 m
Width:	0.65 m
Height:	1.2 m
Height of feeding:	1.15 m
Power source:	Either petrol or diesel engine
Power requirement:	Either 5 or 7 horse power (hp)
Output	120 kg/hr
Shelling efficiency	98 %
Cleaning efficiency	97 %
Grain damage	< 3 %
Scattered grain	4 %

4.3 Groundnut Oil Extracting Machine

Mechanical method of groundnut oil extraction (Plate 14) involves the use of mahines to carry out unit operation (s) during oil extraction. Several groundnut oil extraction machines are available depending on the manufacturers' design considerations and user needs. However, in situations where machines are not readily available for some unit operation, manual method are usually employed.

A conventional groundnut oil extraction process requires the following stages: Shelling, Roasting, De-Skinning, Winnowing, Milling and Kneading.

The groundnut oil milling machine described in this hand book was manufactured by Dandago Agricultural Machinery as a dual-purpose machine, comprising of a milling unit and a kneading unit coupled on one frame. In operation, the already roasted, de-skinned and winnowed groundnut is introduce into the milling unit through the hopper,. After milling, the prime mover is turned off and the pulley belt transferred onto the knaeding unit. The groundnut paste collected is then fed into the kneading unit. The prime mover is then regulated to an appropriate speed limit, while the steerer inside the kneading unit gently turns the groundnut paste gradually. Water is then added gradually to facilitate the agitation of oil from the paste. The oil produce during the operation is then scupped into a container. This procedure can be repeated until enough oil has been extracted,and then the groundnut paste is evacuated from the kneading unit and then a fresh one is then introduce into the chamber.

Plate 14: Dandago Groundnut Oil Milling Machine

Table 7: Performance of the groundnut oil milling machine

Measured Parameters	Average Performance
Length (mm)	870
Width (mm)	720
Height (mm)	950
Height of feeding (mm)	700
Power source	Diesel or Petrol Engine
Power requirement (Hp)	7
Milling Capacity (kg/hr)	50
Milling efficiency (%)	>80

5.0 MAINTENANCE OF SMALL SCALE AGRICULTURAL EQUIPMENTS

5.1 Advantages of the use of small scale agricultural machinery and equipment:

- Increase food supply.
- Creates technical expertise.
- Generates Employment.
- Provision of market both directly for inputs and indirectly by virtue of the expenditure by agricultural workers.
- Provision of raw materials for industries.
- Generation of foreign exchange through export
- Source of savings for farm families from sales of products.
- Standardizing and certification of commodities in collaboration with the Standards Organization of Nigeria and equipment and engineering practices in use in Nigeria.
- Bring into focus mechanical technologies and equipment developed by various institutions/agencies or bodies and evaluates their suitability for adoption.
- Assist in the commercialization of Nigeria (SON) agricultural machines, of proven machines, equipment, tools and techniques.

5.2 Appropriate Selection and use of small scale machine

Appropriate machinery and equipment selection is required for efficient performance of any agricultural operation.
Machinery/ equipment selection for use in any agricultural operations must be based on careful study, putting into consideration the available resources and the desired or projected output.

5.3 Factors to be considered when selecting machinery/equipment

- ✓ The required or desired output of the machine
- ✓ The efficiency of the machine
- ✓ Health factors that is if the machine meets the requisite standard and safety requirements for the product.
- ✓ Power requirement of the machine. (Is the machine petrol, diesel, electrically driven. If petrol, diesel or electricity available in the locality where the operation will be taken place and at what cost.)
- ✓ The availability of power in the location.
- ✓ Ease of repair.
- ✓ Availability of spare parts.
- ✓ Ease of maintenance.

5.4 General Consideration in the Use and Selection of Small Scale Agricultural Machine

Agricultural machine and equipment are unique in the sense that they are designed just like any other machines to solve a need. Selection of agricultural machine and equipment is influenced by the type of operation, cost of labour, cost of machines and energy requirement.
Some of the factors to put into consideration in the selection and use of small scale agricultural machines and equipment's are;

1. **Reliability of the machine or equipment.**

Reliability is the ratio of the time that the machine or equipment is operational (i.e., not "in the shop" for repairs) to the total time available for using the equipment.

2. **Usability of the machine.**

Usability is an attribute of the quality of a machine in relation to the task which the machine is intended for. The following are some of the benefits of machine usability:

- ✓ Increased productivity
- ✓ Increased sales and revenues
- ✓ Decreased training and support costs
- ✓ Reduced development time and costs
- ✓ Reduced maintenance costs
- ✓ Increased customer satisfaction.

5.4.1 Importance of machine usability

A highly usable machine offers benefits to both users and the operator. The primary benefits to users are that they are able to achieve their tasks easily and efficiently.

A machines that is difficult to operate result in the following:

- ✓ Reluctance to work
- ✓ Loss of productive time
- ✓ Requires more support is necessary
- ✓ More changes are necessary

5.4.2 Reliability, Availability and Serviceability (RAS)

- ❖ **Reliability**

The term reliability refers to the ability of a machine to consistently perform according to its specifications.

- ❖ **Availability.**

Availability of a machine is the ratio of time the machine system is functional to the total time it is required or expected to function.

- ❖ **Serviceability**

Serviceability is an expression of the ease with which a machine, device or equipment can be maintained and repaired.

- ❖ **Maneuverability.**

This refers to the ease to which a machine or equipment can be moved from one location to another. In an agricultural operation it becomes sometime necessary to move machines from one point to the other in other to improve productivity or change the operation patter.

- ❖ **Suitability**

The suitability of a machine is the ability of the machine to perform it intended function efficiently and competently.

- ❖ **Durability**

A machine is said to be durably if it can perform its operation continuously in good condition. It is the ability of the machine to remain in good condition for a long time. A durably machine saves operating and production cost and reduces down time.

5.5 MAINTENANCE OF SMALL SCALE AGRICULTURAL MACHINES

Maintenance is a set of operations which are carried out periodically to keep a machine in a good working condition throughout its service life. The maintenance of a machine can either be;

- ❖ Routine maintenance,
- ❖ Preventive maintenance or
- ❖ Maintenance

Routine Maintenance

This is the day to day action that is carried out on the machine so as to make it perform its functions effectively. Routine maintenance is always indicated in the operator's manual by the manufacturer. e.g. checking water and oil level before the start of an operation, cleaning the machine parts like filters etc , ensuring that all moving parts are well lubricated e.t.c.

Preventive maintenance

This is an extremely important function in the reduction of maintenance cost and ensuring that the machine is always in good operational condition. This action not only reduces the production cost but also increases the productivity of the agricultural machines

The major objective of carrying out preventive maintenance is to remove the source of fault in any machine or equipment that is capable of disrupting the functionality of the machine or equipment and correcting the identified fault before it leads to a breakdown of the machine or equipment.

Breakdown maintenance

Breakdown could be as a result of any of the following factors;

- ✓ Negligence,
- ✓ Inappropriate handling of machinery,
- ✓ Improper usage,
- ✓ Under or over use
- ✓ Lack of service and maintenance

5.6 Advantages of Proper Machine Maintenance

- ➢ Reductions in forced stoppage of work due to machinery break down.
- ➢ Enhancement of timeliness of operations.
- ➢ Non-disruption of production schedules.
- ➢ More economical use of maintenance labour.
- ➢ Removal of anxiety and pressure from the management, machine operators and the mechanics.
- ➢ Enhancing a wider spread of the cost of machinery maintenance over the year.
- ➢ It also enhances better supervision of work and record keeping.
- ➢ It enables the management to plan ahead since intending break down can easily be detected.

5.7 TROUBLESHOOTING

This is the act of diagnosing or detecting a fault in machinery and being able to decide appropriate solution(s) to the problem.

5.7.1 Principles of Trouble Shooting

In trouble shooting procedures, the following principles are used:

- ✓ When a part is not functioning, do not open the parts immediately; examine the connections leading to it.
- ✓ Start from simple to complex operations.
- ✓ Start from less time consuming checks to the more time consuming ones.
- ✓ Start from the outside to inside.
- ✓ Ensure safety for yourself and for the machinery.

5.8 GENERAL PRECAUTIONS IN THE USE OF SMALL SCALE MACHINES

In the operation and use of small scale machines, some of the precautionary measures required for the safe operation of the machine either machine propelled or self-propelled are;

- ➢ Always ensure that the prime mover on the machine is securely mounted.
- ➢ Agro processing operation should be carried out in a well-ventilated area.
- ➢ Do not wear loose clothing's near moving parts.
- ➢ Ensure that all exposed moving parts are covered with protective guards.
- ➢ Rectify all fuel and oil leaks as soon as practicable and clear any spillage.
- ➢ If machine is powered by an electric motor, make sure the machine is first turned off before disconnecting the motor.
- ➢ Ensure there is adequate workspace and machine networking.
- ➢ Agro processing should be carried out in such a manner that there will be a synchronized interrelationship between man and machine so as to ensure high performance and efficiency on the job and the production.

5.8.1 General Maintenance tip for efficient operation of small machines

1) **Use of Manufacturers Manual/Repair Book.**
2) **Regular Service and Maintenance**

For some self-propelled and propelled machines there are basically some systems that need special attention and require routine maintenance, these systems include;

a. The Lubricating Systems
b. Air Cleaning System
c. Fuel System
d. Battery
e. Valve System
f. Cooling system
g. Hydraulic system

5.8.2 Service and Maintenance Guidelines Small Engine

i. Always clean the machine after every use.
ii. Store in clean dry place, away from weather factors.
iii. Parts that are operated wet should be dried.
iv. Tighten all loose bolts and nuts.
v. Lubricate allexposed bearings and moving parts.

Actual practices of maintenance do vary from one machine to the other. As a broad guideline, the following maintenance intervals are suggested.

1. Every 10 hours (daily)
2. Every 50 hours (weekly)
3. Every 100 hours (forth nightly)
4. Every 250 hours (monthly)

5. Every 500 hours (two monthly)
6. Every 1000 hours (annually)

However, appropriate agricultural mechanization technology for Nigeria must advance from a gradual development of indigenous technology for Nigerian agriculture. The mechanization approach must be an integrated one to include most, if not all, the agricultural production processes and operations and must also be part of and include the essential elements of the overall agricultural and rural development strategies in order to get to the roots of rural poverty.

The maintenance schedule for petrol engine, as provided in Owner's Manual, is as presented in Table 8 below. To be performed at every indicated month or operating hour interval, whichever comes first.

Table 8: Maintenance schedule for petrol engine

REGULAR SERVICE PERIOD ITEM		Each Use	First month or 20 hours	Every 3 months or 100 hours	Every 6 months or 200 hours	Every year or 300 hours
Engine oil	Check level	✓				
	Change		✓		✓	
Reduction gear oil	Check level	✓				
	Change		✓		✓	
Air filter	Check	✓				
	Clean				✓ (1)	
	Replace					✓
Sediment Cup	Clean			✓ (1)	✓	
Spark plug	Check and adjust				✓	
	Replace					✓
Fuel tank & filter	Clean				✓ (2)	
Fuel tube	Check	Every 2 years (Replace if necessary) (2) -				

(1) Service more frequently when used in dusty environment.
(2) These items should be serviced by a qualified mechanic.

5.8.3 The Machine Unit

- Carry-out physical inspection of all the machine components after every 100 hours of operation.
- Check the moving parts regularly for wear, looseness or damage and repair accordingly.
- Keep belt free from oil and grease to prevent swell and rot.
- Always store under cover to prevent rust of metal parts and other deteriorating effects of the weather.

6.0 STORAGE

In order to ensure safe custody of the shelling machine when not in use for a long, the following interventions are necessary:

i. Start and run the engine until it is out of fuel. Then, expel the fuel remnants from the fuel system by pulling the starter cord.
ii. Dismantle the prime mover, drain the oil and cooling water (as applicable) while the engine is still hot, then wash the crankcase and the oil filter with clean fuel.
iii. Wipe out oil stain, water stain and dust on the engine surface
iv. Apply rust-resisting oil to non-painted metal parts.
v. Wrap the inlet of the air filer and muffler with plastic sheet to prevent foreign matters dropping in.
vi. Turn the flywheel to near TDC at compression stroke. At this position, the valves are closed and the fuel injection pump is at fuel delivery condition.
vii. Store the machine and engine under shed in ventilating, dry and clean environment, away from children and corrosive materials.

6.1 TROUBLESHOOTING

Table 9: Possible petrol engine faults, possible causes and suggested remedies.

Possible Fault	**Possible causes**	**Suggested remedies**
Engine fails to start.	* Lack of fuel in the tank.	* Fill the fuel tank.
	* Air lock in fuel line.	* Remove the air by bleeding.
	* Air vent in the tank cap clogged.	* Open the air vent.
	* Main jet clogged	* Remove and clean it by blowing with air, and not with a needle or wire.
	* Engine flooded with the fuel.	* Close the fuel cock; open the throttle lever completely and turn the engine over a few times. Unscrew the spark-plug, clean and dry it.
	* Spark - plug sooted or damaged.	* Clean the spark plug and reset gap to 0.6mm. If the lead gives a spark but the plug does not, change the spark plug.
	* Carburetor dirty.	* Clean the carburetor.
	* Short circuit.	* The lead meant for stopping the engine may be in contact with the frame. Break this contact.
	* Ignition wire loosed or damaged.	* Fasten it or replace it, as need be.
	* Contact – breaker points dirty.	* Clean the points and set the clearance to 0.6mm or 0.7mm.
	* Air-cleaner dirty.	* Clean the air-cleaner.
Engine runs	* Spark plug loosed.	* Tight the spark plug.

irregularly or stops.	* Dirty fuel - pipe screens. * Main jet clogged. * Spark - plug sooted. * Lead to spark plug disconnected or insulation broken or burnt. *Contact breaker points oily. * Air lock in fuel line.	* Clean the fuel - pipe filter at the fuel cock or in the carburetor supply nipple or both. * Clean the jet. * Clean or replace it. * Fasten the lead tightly to the plug or replace it, if badly damaged. * Clean and adjust the contact - breaker point or replace it, if necessary. * Remove the air by bleeding.
Possible Fault	**Possible causes**	**Suggested remedies**
Engine does not gain momentum.	* Air filter partially choked. * Choke closed. * Carburetor partially blocked. * Exhaust port or silencer choked. * Leaking of crank-case oil seal. * Cylinder bore & rings worn-out. * Ignition timing incorrect.	* Clean the air filter element. * Open the choke. * Clean the carburetor. * Remove the carbon deposit. * Change the oil seal. * Change the barrel and the rings. * Correct the ignition timing.
Misfiring.	* Plug dirty or defective. * Silencer gasket leaking or faulty. * Poor connections to the coil. * Water in the fuel. * Ignition not set correctly.	* Clean or replace the plug. * Tight retaining nuts or replace the silencer. * Tight the connections. * Change the fuel. * Reset.
Engine overheating.	* Engine over-speeding. * Poor lubrication or lack of lubrication. * Ignition not set correctly. * Air flow to the engine obstructed. * Exhaust system choked.	* Run at recommended speed. * Drain engine oil and replace with recommended grade. * Reset. * Clean the surface of fins and fan blades. * Remove the carbon deposit.
High fuel consumption with a strong	* Float needle damaged. * Needle setting damaged.	* Replace the defective part. * Replace the defective part.

smell of un-burnt fuel.	* Float punctured. * Main jet too big. * Air cleaner dirty.	* Replace the defective part. * Replace the defective part. * Clean the air - cleaner.

Table 10: Diesel engine faults, possible causes and suggested remedies.

Possible Fault	**Possible causes**	**Suggested remedies**
Engine fails to start.	* Lack of fuel in the tank. * Air lock in fuel line. * Air vent in the tank cap clogged. *Nozzle blocked. * Engine flooded with the fuel. * Short circuit. * Ignition wire loosed or damaged. * Air-cleaner dirty.	* Fill the fuel tank. * Remove the air by bleeding. * Open the air vent. * Remove and clean it by blowing with air, and not with a needle or wire. * Close the fuel cock; open the throttle lever completely and turn the engine over a few times. * The lead meant for stopping the engine may be in contact with the frame. Break this contact. * Fasten it or replace it, as need be. * Clean the air-cleaner.
Engine runs irregularly or stops.	* Dirty fuel - pipe screens. * Nozzle clogged. * Insulation broken or burnt * Air lock in fuel line.	* Clean the fuel - pipe filter at the fuel cock supply nipple. * Clean the nozzle. * Replace it, if badly damaged. * Remove the air by bleeding.
Engine does not gain momentum.	* Air filter partially choked. * Choke closed. * Injector partially blocked. * Exhaust port or silencer choked. * Oil seal of the crank - case leaking. * Cylinder bore and rings worn-out. * Ignition timing incorrect.	* Clean the air filter element. * Open the choke. * Clean the injector. * Remove the carbon deposit. * Change the oil seal. * Change the barrel and the rings. * Correct the ignition timing.
Misfiring.	* Silencer gasket leaking or faulty.	* Tight retaining nuts or replace the silencer.

	* Poor connections to the coil. * Water in the fuel. * Ignition not set correctly.	* Tight the connections. * Change the fuel. * Reset.
Possible Fault	**Possible causes.**	**Suggested remedies.**
Engine overheating.	* Engine over-speeding. * Poor lubrication or lack of lubrication. * Lack of water in the cooling system. * Ignition not set correctly. * Air flow to the engine obstructed. * Exhaust system choked.	* Run at recommended speed. * Drain engine oil and replace with recommended grade. * Add water to the cooling system. * Reset. * Clean the surface of fins and fan blades. * Remove the carbon deposit.
High fuel consumption with a strong smell of un-burnt fuel.	* Float needle damaged. * Needle setting damaged. * Float punctured. * Main jet too big. * Air cleaner dirty.	* Replace the defective part. * Replace the defective part. * Replace the defective part. * Replace the defective part. * Clean the air - cleaner.

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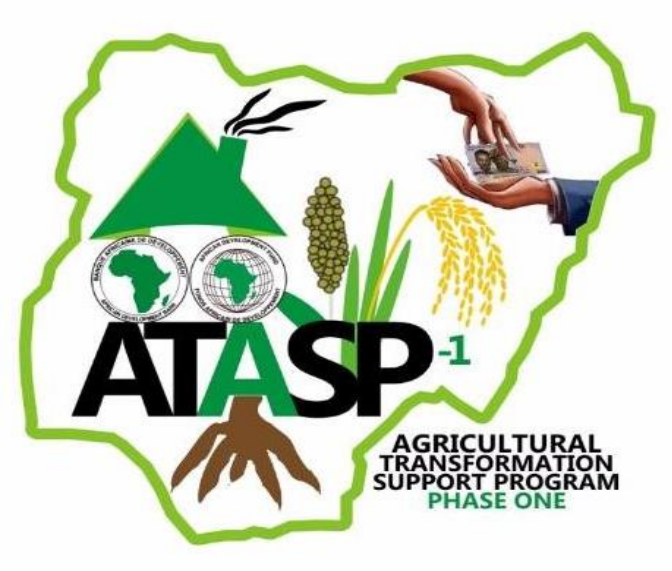
ICRISAT

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization that conducts agricultural research for development in the drylands of Asia and sub-Saharan Africa. Covering 6.5 million square kilometers of land in 55 countries, the semi-arid or dryland tropics has over 2 billion people, and 644 million of these are the poorest of the poor. ICRISAT and its partners help empower these poor people to overcome poverty, hunger and a degraded environment through better agriculture. ICRISAT is headquartered in Hyderabad, Telangana State, in India, with two regional hubs (Nairobi, Kenya and Bamako, Mali) and country offices in Niger, Nigeria, Zimbabwe, Malawi, Ethiopia and Mozambique. ICRISAT conducts research on five highly nutritious drought-tolerant crops: chickpea, pigeon pea, pearl millet, sorghum and groundnut. ICRISAT envisions prosperous, food-secure and resilient dryland tropics. To achieve this, its mission is to reduce poverty, hunger, malnutrition and environmental degradation in the dryland tropics. It approaches this through partnership-based international agricultural research for development that embodies *Science with a Human Face*. ICRISAT's strategy is anchored on socio-economic process called inclusive market-oriented development (IMOD). ICRISAT has defined six developmental outcomes that it believes will help the poor to move along the IMOD path: food sufficiency, intensification, diversification, resilience and health & nutrition, and women empowerment. Significant reductions in poverty and increases in food security in the dryland tropics are possible through this route. ICRISAT believes this is the way to meet its inspirational targets of halving the incidence of poverty in smallholder farming households, halving the incidence of hunger, halving childhood malnutrition and significantly increasing the resilience of tropical dryland smallholder farming.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