TECHNICAL ASSESSMENT OF COWPEA THRESHERS IN USE IN KONTAGORA AREA OF NIGER STATE, NIGERIA

BY

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SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY

FEDERAL UNIVERSITY OF TECHNOLOGY

MINNA, NIGER STATE

NOVEMBER 2004.

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A PROJECT REPORT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIRMENT FOR THE AWARD OF BACHELOR OF ENGINEERING (B. ENG) DEGREE IN AGRICULTURAL ENGINEERING IN THE SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY, FEDERIAL UNIVERSITY OF TECHNOLOGY, MINNA

NOVEMBER 2004.

ABSTRACT

A Technical Assessment of Cowpea threshers in use in Kontangora area of Niger State, was carried out using the Investigable Survey Research Approach (ISRA) as reported by Anazodo (1986). Data on farms visited and location and yearly cowpea production were collected through oral interviews, physical inspection and existing records. The evaluation Indices of makes of threshers such as Haske-Rana A and B, I.R.A.E.T&I.T, Fontan, O.L.J and one marked "Other" includes: Threshing Intensity, Capacity Utilization, Power Requirement, Threshing Efficiency, Cleaning Efficiency, Grain Recovery Range, Percentage Total Losses and are presented in table3. Finally, it showed that Haske-Rana A has the best performance Indices of Output Capacity(112kg/hr), Threshing Efficiency(97.72%), Cleaning Efficiency(99.85%), Capacity Utilization(88.9%), Threshing Index(82.2%), Threshing Intensity(0.012hp/kg), Percentage Losses(4.78%), Grain Recovery Range(95.22%)and Percentage unthreshed(2.28%).

DECLARATION

I hereby declare that this project work is my original work and has neither link nor has any body, anywhere for the award of a degree, done it

.

Sadiq Salihu

25-11-04

Date

CERTIFICATION

This is to certify that the project was carried out by Sadiq Salihu in the Department of Agricultural Engineering, School of Engineering and Engineering Technology, Federal University Of Technology, Minna, Niger State.

29-11-04

Engr. A.A. Balami — Date

Project Supervisor

25.11.04

Engr Dr. D. Adgidzi — Date

Head of Department

25/11/2004

External Examiner — Date

DEDICATION

This project work is dedicated to the sweet memories of my beloved sister, Late Mrs. Sikirat O. Saidu who died on the 3 April 1996.

ACKNOWLEDGEMENT

All praises are due unto Allah, the creator of the heavens, the earth and all between, the Giver and the Sustainer of life; the one on whom I have depended for all these ages and my hope in the years to come. My gratitude goes to the Holy Prophet for teaching me the path leading to a faithful life.

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SYMBOLS ABBREVIATIONS

M.c	moisture content %
M.c (wb)	moisture content wet bases, %
M.c (db)	moisture content dry bases, %
W	weight, kg
Dm	dry material
R	roundness
Ad	longest projected area, m
AC	area of smallest circumscribing circle, m
Σr	Summation of radius of curvature
N	total number of corners summed in numerator
R	radius of the maximum inscribed circle
r	radius of curvature, m
S	sphericity
a	longest intercept, m
b	longest intercept normal to "a" ,m
c	longest intercept normal to "a" and "b", m
Dt	diameter of the largest inscribed circle, m
Dc	diameter of the smallest inscribed circle, m
V2	pore space in tank, m^3
V1	volume in tank, m^3
P1	absolute pressure, Pa
P3	absolute pressure in valve 3Pa

Wa	weight in air, kg
Ww	weight in water, kg
Vt	terminal velocity, m/s^2
ρp	density of material, kg/m^3
ρf	density of fluid, kg/m^3
ρp	projected area, m
C	drag co-efficient
Hc	height of cone, m
Hp	height of platform, m
D	diameter of platform, m
Qr	angle of repose, ^{0}
A.D.P	Agricultural Development Project
A.S.A.E	American Society of Agricultural Engineers
F.A.O	Food and Agricultural Organization
I.A.R	Institute of Agricultural Research
N.C.A.M	National Centre for Agricultural Mechanization

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

In the early 1960s when agriculture was the major source of Nigeria's revenue and foreign exchange earner, the introduction and effective use of machines and equipments became very important to the agricultural production. As technology advanced, the importance of the use of machines and equipments in agricultural activities to enhance mechanisation generated a great deal of awareness in Nigeria as well as other developing countries of the world (Ng, 1990).

Nigeria as it was then and still is to a large extent now, is not a producer of these machines and equipments with the ever-increasing demand. Due to the fact that these machines and equipments are manufactured in different countries and by different manufacturers, the country is today, littered with different sizes, shapes and model. During the course of importation, some important factors and features aside their primary functions are not taken into consideration and thus has resulted into problems ranging from lack of technical skills of the user to effectively operating the machine down to capacity under utilisation and poor performance.

Some of these problems include:

- Weather condition
- Difference in the nature and type of soil
- Non-availability of spare parts
- Non-availability of reliable information and performance evaluation of these machines and equipments.

Due to these problems and so many others, it becomes obvious for the Agricultural Engineer, to think of how to design and fabricate some machines and equipments to assist the local farmers which has accounted for the number of locally fabricated machines and equipments in the country.

Nigeria is a nation situated in the western coast of Africa and endowed with plenty natural resources in which agricultural produce is her pride. Some of these economic products of agricultural produce include cash plants, and food plants like rice, soyabeans, and cowpea to mention but few. Cowpea is one of those crops that are in the leading position across the country, for everyday that passes; cowpea is consumed in one way or the other in most homes (I.I.T.A Ibadan).

Cowpea (Vigna Unguiculata) is an important legume of the tropics, with its various uses; as grains in processed food, as a vegetable and as dry haulms and fodder. It is an inexpensive source of vegetable proteins and a hardly crop well adapted to relatively dry environment. It is of major importance to the livelihoods of millions of relatively poor people in less developed countries like Nigeria. From production of this crop, rural families variously derive food, animal feeds, and cash, together with spill over benefits to the farmlands. It provides a cheap and nutritious food for relatively poor urban families, which depends on it for over 80% of their protein (I.I.T.A).

In Nigeria, it is cultivated mostly in the dry part of the Northern Nigeria; Kano, Niger State during the wet season. (Anochili, 1978).

Since the demand for cowpea is ever increasing, the need for advancement in threshing method becomes necessary as a means of processing before it is taken into the market.

Agricultural processing may be defined as any activity done on the farm or by the local enterprise that maintains or raises the quality or changes the form or characteristics of a farm product. These activities are undertaken to provide a greater yield from the raw farm product, by increasing the quality of the finished product.

These activities may include

- Cleaning
- Size reduction
- Drying
- Evaporation
- Heat exchanging

- Mixing
- Separating
- Threshing

All of these are aimed at giving the consumers better product. With the world population increasing on a daily bases and the corresponding increase in the demand for food, the need for mechanisation is but a welcomed development. Mechanisation is aimed at using science and technology to carry out those activities that is needed so as to increase the net output while conserving cost, time and energy.

Among such machine is the cowpea thresher used in separating the cowpea (seed) from the coat (chaffs) after harvesting. In Kontangora area of Niger State, to be specific, majority of the threshers used are locally made and as such, it becomes obviously important for a technical assessment of these machines.

1.2 STATEMENT OF THE PROBLEM

The steps involve in the traditional method of threshing of cowpea is not only time consuming, but reduces the quality and quantity of seed obtained.

The operational time and energy consumed is high since it involves beating with stick for a longer period of time. During this process, some of the seed get broken when it is hitted hard with the stick and those that were able to survive the beat, might get crack and therefore result in reduction in their market values.

With different types of machines to help carry out the operation of threshing, it becomes justified by all means for the local farmer who has very little capital to know the kind of threshers to use and to see the status of these threshers.

1.3 OBJECTIVES OF THE STUDY

This project work is aimed at determining the number, make, model and status (condition) of threshers in use in Kotangora, area of Niger State, Nigeria. It is also intended to furnish reliable information and data on farm machinery and equipments (threshers), utilisation and condition to facilitate the formation of a broad national policy on thresher uses. The specific objectives of the work include: -

- To technically evaluate/assess the different makes, models of cowpea threshers in use in Kontangora area of Niger State, Nigeria;
- To establish the condition of these threshers;

1.4 JUSTIFICATION OF THE STUDY

Achieving the objective of this project will help to improve the state of mechanisation in Niger State and Nigeria in general. It will also help to determine cowpea threshers in the country in order to facilitate the formation of a broad national policy on importation of equipments like the cowpea threshers. It will also help to optimize production of cowpea at a reasonable cost.

1.5 LIMITATIONS

In the quest to collect data and information for this project, certain set backs and difficulties were encountered. Some of such set backs include: -

i. Denial of access to some of the farms visited inspite of the letter of introduction presented to security officials of the farms.

ii. Lack of adequate data in both cowpea production and threshers in Niger State. For instance, to collect data on cowpea production and rainfall for Kontagora, I have to return to A.D.P Headquarters, Minna.

iii. Refusal of the responders to give direct answers to oral question. Most of the responders initially assumed me to be a government agent (tax officer) and as such, were not ready to respond.

CHAPTER TWO

LITERATURE REVIEW

2.1 COWPEA PRODUCTION

Cowpea (Vigna unguiculata) locally called Ewa or Ere (Yoruba); Agwa (Ibo); Wake (Hausa), occurs wild through Africa South of the Sahara. As a cultivated crop it is grown throughout the tropical and Subtropical areas of the world. It was introduced early into the New World by Slave trade. The name of cowpea was given to it in U.S.A.It is grown mainly as an animal feed and is used either, as fodder or in the form of ground seeds. Cowpea is a good source of protein for human consumption. It is also a cash crop. The important cowpea growing countries are Nigeria, Niger Republic, Burkina Faso, Mali, Senegal Ghana, Togo, Benin, China, Nepal, Bangladesh, Cuba, Haiti, U.S.A and the West Indies to mention but few (Singh and N, Tare, 1985). In Nigeria the crop is grown in the States of Kano, Bauchi, Kastina, Borno and Niger in the North and Ibadan, Oyo and Benin in the west and to a lesser extent in Enugu in the east. In Niger state, cowpea is produce in the northern axis of Mariga, Magama and Kontagora, which accounts for 80% of the annual production in Niger state (A.D.P Minna, 2003).

2.2 ENVIRONMENTAL REQUIREMENT AND LAND PREPARATION

Cowpea is adapted to a wide range of soils, from sandy soils to clays soil. They thrive better than most crops in soils not too rich in nutrient. They tend to produce more vegetative growth than pods on very fertile soils rich in Nitrogen or when planted early in the year. The crop does best on well-drained sandy loam.

Cowpea is a warm weather crop, which tends to perform best where there is high temperature and an evenly distributed rainfall of 75-100cm during the growing period. The plant has a very long taproot and once established it is capable of withstanding long periods of drought though severe drought may prevent seed formation in most varieties. A dry period at ripping time is desirable (Anochili, 1978).

The seedbed should be prepared immediately before sowing, the soil being thoroughly tilled with top few centimeters (30cm) being winked to a fine tilt. Hoeing or discing may be sufficient preparation where weeds are few. Seeds may be sown on ridges or small mounds or on flat land.

2.3 VARIETIES

Numerous cultivars exist, which may be classified on the basis of seed colour or growth habit. Prostate, climbing and dwarf cultivars are cultivated. Common varieties cultivated in kontagora Area of Niger state include Sobo, Danmisira, white Kanado, red Kanado and Eka. Some hybrid varieties in Nigeria are – IAR – TAR 48, IT 845 – 2246-4, IT86D-71, IT 86D-721, IT90K – 76, IT89KD-374, IT89KD-867-11, (I.I.T.A. Ibadan 1988).

2.4 PLANTING OPERATIONS AND HARVESTING

Planting is carried out in July – August in the north and September in the high rainfall areas of southern Nigeria. Some varieties that are photoperiod insensitive can be grown earlier in the year in the high rainfall areas before the on set of the rains.

Three seeds per hole give sown at 30cm spacing rows at 75-90cm apart for the dwarf type, giving a seed rate of 22 – 38kg/ha. Twining types needs support for climbing and 2 or 3 seeds per stand are planted at 75cm apart at the sides of ridges 90 –120cm wide, giving a seed rate of 20kg/h. When sown for foliate, cowpeas are broad cast or sown in rows 15-20cm apart at a speed rate of 100km/ha. They may mix with Sudan grass, Sorghum or even Maize.

The crop matures in about 3-4 months. Harvesting is done by hand in most places but commercially grown crops are harvested with a combine harvester. Where harvesting is by hand, the pods are picked as they ripen. Unfortunately the pods ripen unevenly and are liable to shatter if left too long on the plant.

Three to four well-spaced picking should complete the harvest and avoid shattering. Where a machine is used, the crop is harvested when about two – thirds of the pods are mature. (Anochili, 1978).

2.5 THE CONCEPT OF TECHNICAL EVALUATION

Technical evaluation is a scientific investigation of the performance of each component part of a system as it affects the overall operation of the system. Evaluation (Technically) of cowpea. thresher therefore means to carry out a research on the performance operation, conditions and problems of the threshers, with the aim of determining the overall output and ascertain the best possible type for such operation. Methods used in technical evaluation include type test and routine test (Anazodo et al, 1986). Routine test are test carried out on a machine to check the requirements, which are likely to vary during production or use. These are grouped into essential and optional test. The essential routine tests are visual observations and provisions for adjustments and tests at no load. While the optional tests are checking of specifications and materials. Type test on the other hard, is said to be either short- run test or long-run test. The short –run test are normally carried out to ascertain the conformity of the performance of the equipment or machine to the manufactures recommendation as set out in the manual and enable the tester to obtain the following

- Total losses
- Efficiencies
- Power consumption
- Input capacity
- Output capacity

DETERMINATION OF LOSSES

a- Percentage unthreshed grains $= \frac{\text{Quantity of unthreshed grain(kg)}}{\text{Total grain at outlet (kg)}} \times 100$

b-Percentage cracked & broken grains=$\frac{\text{Quantity cracked \&broken}}{\text{Total grain at outlet (kg)}}$ x100

c-percentage blown grain=$\frac{\text{Quantity of clean grain at outlet (kg)}}{\text{Total grain at outlet (kg)}}$x100

d-Percentage of sieve losses=$\frac{\text{clean grain at(overflow+underflow+stuck)}}{\text{Total grain input (kg)}}$

e-Total losses=a+b+c+d

DETERMINATION OF EFFICIENCIES

Threshing efficiency (T.E)=$\frac{\text{Quantity of grain threshed (kg)}}{\text{Total grain fed into thresher(kg)}}$ x100

Or

100-% unthreshed

Cleaning Efficiency=$\frac{\text{Clean grain at outlet, (kg)}}{\text{Total grain at outlet, (kg)}}$

Output=weight of grain at outlet, (kg)

Input=weight of grain fed into the thresher, (kg)

Grain Recovery Range (G.R.R)=100-%losses, (%)

Capacity utilization (C.U)=$\frac{\text{Output capacity}}{\text{Input capacity}}$x100

Threshing Index=G.R.R X C.U X T.E, (%)

Threshing Intensity=$\frac{\text{Power consumed by thresher, (hp)}}{\text{Output capacity of thresher (kg)}}$

2.7 CLEANING

Cleaning is a preparatory unit of operation. The wide variety of contaminate encountered in raw food materials and the low tolerance permitted calls for a variety of cleaning method which could be classified as dry cleaning and wet cleaning methods. For cleaning to be effective, it must separate the contaminate effectively, remove the cleaned surface in the desired condition, limit recontamination of the cleaned material (Brennan et al, 1981).

2.8 SORTING

Sorting separates the raw material into groups with different physical properties. Grading and sorting are usually the last operation. Sorting is carried out on four bases (Brennan et al, 1981).

- Sorting on weight bases
- Sorting on size bases
- Sorting on shape bases
- Sorting on colour bases

2.9 GRADING

Also called quality separation, grading depends on an overall simultaneous assessment of those properties of the food which affect its acceptance as a food material or as a working substance for the machine. Grading has the following physical characteristics – size and shape, maturing and texture (Brennan et al, 1981).

Long-run test enables the tester to determine major breakdown with respect to the number of hours of operation or use, defects developed and repairs to be made. It entails operating the machine for at least twenty to fifty hours.

2.6 PROCESSING AND PRESERVATION

Processing and preservation are activities under taken to provide a greater yield from a raw material (farm product) by increasing the amount of finished product. It also implies making fit for any activities that could make the raw farm product better and attractive to the average consumer. These activities are usually carried out in the farm. Before any farm produce is taken for any of these activities to be done by machine i.e threshing as the case of cowpea, it has to undergo the stages of cleaning, sorting, grading and drying to give better product at the end of the threshing (Brennan et al, 1981).

2.10 DRYING

This is the process of removing the moisture content of the raw farm product before it is worked upon by the machine. There are different quantities of water expected for different product. Averagely, for cowpea product to be worked upon by a machine the cowpea should have moisture content of between 15-17%. (Mohsin, 1970). Drying can be carried out through any of the following processes (Brennan et al, 1981).

- Drying by natural or heated air
- Drying by direct contact with heated surface or heated medium;
- Drying by the application of energy from a radiating source;
- Freeze drying

The moisture of a material could either be determined on wet bases or dry bases as given by below.

$$M.C\,(wb) = \frac{W}{W + DM} \times 100,\ \%$$

$$M.C\,(db) = \frac{W}{DM} \times 100,\ \%$$

To convert from wet base to dry base

$$M.C\,(db) = \frac{100M(wb)}{100 - wb},\ \%$$

To convert from dry base to wet base

$$M.C\,(wb) = \frac{100M\,(db)}{100 + M\,(db)},\ \%$$

Where:

M.C = Moisture content, %

W= weight of material, kg

M (db)= material at dry base, %

M (wb) =material at wet base, %

DM= Dry materials, kg

THRESHING

2.11 HISTORICAL DEVELOPMENT

Hand tools were the primary cheap sources of threshing grains for centuries. The stick is one of the oldest tool used in our country during the colonial days before further developments where made. Threshing was done by beating the grains or pods with hard beating the "ground heap" thresher was invented in 1800. The machine was a small stationary thresher /sheller that knocked the grains from the straw or the seed from pod in which the grain/ seed had to be separated by winnowing (Sulton 1974).

In 1830, Mc- carmick designed a reaper machine that cuts and the gathers grain in combine. It cuts the grains and raked it from the flat form into bunches. These bunches are collected onto a wagon by hand and taken to the ground log" for threshing (Sulton, 1974).

The moor-hoscal harvester was one of the first harvester-thresher built that performed the basic function of cutting, threshing and cleaning grain. In 1889 the steam powered combine was patented by Daniel Bea in which the steam engine is mounted on the combine and a large steam tractor pulls the combine through the field (Kepner et al, 1982).

Lastly between 1950-1970, sophisticated self-propelled threshers were developed; it becomes gradually larger and more efficient. In the 1955, self-propelled combine were adopted to harvest cereals and legumes (Kepner et al, 1982).

Design improvement to achieve faster work rate are still arising, an example is the addition of an extra rotor to provide extra threshing capacity in combine harvester. Thus the modern method chosen by John Deere and Cleans which have both amounted to new model for the year 1973 harvesting season (Kepner et al, 1983).

Class described the additional rotor as a new 218 mega combine as in accelerator" and its job is to pre- thresh the incoming crop before it gets into the main separation system. Pegs on the surface of the acceleration motor carry out the re-threshing process. These made replacement easier.

The drum has its own multi-crop concave, which is linked to the main concave so that both can be adjusted at the same time by using a single laver.

Pre-threshing helps to reduce the separation to be carried out by the straw walkers and this allows the combine to handle a bigger output to cover more acres per day (Kepner et al, 1982).

John Deere is also using an additional cylinder to raise threshing of the new 2-660 dual threshing system and it is available in a range threshing of five new straw walker modules in the high capacity sector with engine from 180-270 .

The main threshing cylinder in all the new two combines is one of the largest available with long bars and a 660mm diameter. The crop material is passed from the main cylinder to the extra or secondary cylinder which is 450mm diameter and provides the additional threshing capacity to cope with bigger volume of materials and faster working speed (Kepner et al, 1982).

Today, combine is a complex machine as a result of centuries of development in harvesting of agricultural produce. Not only are the harvesting and threshing unit complicated to the farmers, but add to that the engine, power rating, electrical system and hydraulic system became of the most complex machine in agriculture. The name combine develops when the harvesting and threshing operations are combined into one complete machine (Hall, 1981).

2.12 PRINCIPLE OF THRESHING AND SHELLING

Threshing and shelling are two terms that can collectively be said to mean the removal or detachment of seeds from pods e.g bean or seed from cobs e.g maize. Threshing is beating the grain from its link or beating the grains from the head, as in wheat. In the case of cowpea, it will be removing the beans from the pod.

Threshing can be accomplished by action in the following

- Impact
- Compression
- Friction
- Shearing
- Combination of all.

In general however, force must be applied in one form or more in the way stated in order to accomplish threshing.

According to Autumn, (1990) all threshing machines have a threshing drum, which consist of a long cylindrical-shape member to which a series of pegs, knives or rasp bars are attached on it surface. The threshing drum is mounted on two bearing and relates in a perforated troughs like member, "concave". During threshing, crop is feed between the threshing drum and the concave, where it is subjected to a high degree of impact and frictional forces, which detach grain from the panicles.

Sulton (1974), stated that threshing involves the detachment of grains from the pinnacle and can be achieved by rubbing action, impact and stripping.

Hunt (1954), also reported that the pods moisture content must be considered for threshing. He stressed that the efficiency of threshing of crop grains could be significantly affected by the moisture content. He found that there was a linear relationship between the amount of grains left on the pod/cob after ejection from the thresher and the moisture content. This type of loss however was found to be significant when the moisture content was up to 30%, (Hall, 1981).

2.13 FACTORS AFFECTING THE PERFORMANCE OF THRESHERS

Dada (1985), reported that when too many rods are used on the drum, high percentage of broken grains is recorded. He suggested that the wedges could also be welded on the concave to help reduce the speed of the chaff or cob during threshing.

It was also noted that when the clearance was too open, threshing of crops would not be effective. The crop type determines the type of threshing. When the clearance is too close, breakage and damaging of grains occurs. Moisture content plays an important role in threshing. Crops not well dried up would not be properly threshed, even if the content clearance between the concave and the rods on the drum was provided for. Grains would only be affected if the correct moisture content is not considered before threshing.

Turner (1973), noted that the faster the speed of threshing drum, the more severe the threshing. The severity of threshing is also increased as the clearance between the drum and the concave is reduced. He also said that the larger-size grains are threshed satisfactorily when the drum speed is slow, while for small-size grains, the drum speed should be fast.

Kepner (1972), reported that the efficiency of a thresher depends on such criteria as the peripheral speed of the cylinder, the clearance between the cylinder and the concave moisture content, maturity of the crop, the rate at which the crop is fed into the machine.

2.14 METHODS OF THRESHING

The following are the methods used in threshing:

2 .14.1 MANUAL METHOD OF THRESHING: This method of threshing was practiced in the early centuries. However, it is still being practiced where the farmers do not have access to the threshing machine; (F.A.O.,1976). It has an average threshing efficiency of 12-25kg/hr. Also, the USDA, (1960) reported that a man could thresh 7-8bushels in 10hours (25.5 – 29.12l/hr).

2.14.2 STRIPPING METHOD OF THRESHING: The stalks are laid on a clean surface and the end panicles of the stalks are beaten off against a log. The threshed products are packed for cleaning using a calabash for winnowing. This results in high losses. It involves much labour, time consuming and the job is tedious. Threshing output is 13-20kg/hr (Juo and Lowe, 1986).

2.14.3 THREADING METHOD OF THRESHING: This is accomplished by treading the grain under the feet of man or hoof of animals. It is tedious, time wasting and requires much labour and could result in injuries in case of man's feet. Threshing output is 17-22kg/hr (Stone and Gulvin, 1977).

2.14.4 MOTAR AND PESTLE METHOD OF THRESHING: It is accomplished by woman on a small scale farms. Cobs, pods and stalk are packed into a motar and pestle is used to pound it. The impact of the pestle removes the grains from the cobs, pods and stalk. Cleaning is achieved by using a calabash for winnowing. The threshing output is 20-25kg/hr.

2.14.5 MECHANICAL METHOD OF THRESHING: Mechanical method is practiced on a large scale land (walkes and smith, 1977). The stalks, cobs, and pods can be cleaned after threshing with little time and labour requirement. Some of the mechanical use in this method includes.

- Manually operated threshing machine with an output of 60-80 kg/hr; (I.A.R Zaria, 1988).
- Disc roller threshing machine with output of 30-35 kg/hr; (F.A.O, 1976).
- Ground-hop threshing machine; (stone and Gulvin, 1977).
- Power operated threshing machine; (Richey, 1961).
- ST-45 multi crop threshing machine uses 15-25 h.p with an output of 1200-1500kg/hr; (Culpine, 1976).

2.15 PROBLEMS AFFECTING COWPEA THRESHING: Numbers of research have been carried out on threshing so also the problem associated with the crop and the threshing machine. The physical removal of the cowpea seed from its pods when the machine and the cowpea are in contact is referred to as threshing. There are many factors, which affects the performance of a thresher. The major factors are the properties of the crop and the parameter of the machine.

2.15.1 PROPERTIES OF THE CROP- these include:-

a- PHYSICAL PROPERTIES: - These are important in many problems associated with design of a specified machine or analysis of the behavior of the product in handling of the materials. Theses properties include

I. **SHAPE AND SIZE**: - They are inseparable in a physical object, and both are generally necessary if the object is to be satisfactory described. Some criteria for describing shape and size are Round; Oblate; Oblong; Conic; Ovate; Oblique; Obviate; Elliptical; Truncate; Unequal; Ribbed; Regular; Irregular. The most vital of these is roundness. It measures the sharpness of the corner of the crop. (Mohesin, 1970) It is given by:-

$$R = \frac{AP}{AC} \quad \text{or} \quad R = \frac{\sum r}{NR}$$

Where;

R=Roundness

AP= largest projected area of object in rest position, m

AC = Area of smallest circumscribing circle, m

N = Total no of corners in numerator.

$$\text{Roundness ratio} = \frac{r}{R}$$

Where

r= radius of curvature, m

R= Radius of maximum inscribed circle, m

ii. **SHERICITY**: this rest entirely on the geometry of the material. It is given by

$$S = \frac{(abc)^{1/3}}{a} \text{ or } \quad S = \frac{dt}{dc}$$

Where;

a=longest intercept, m

b=longest intercept normal to a, m

c=longest intercept normal to a, b, m

dt=diameter of largest inscribed circle, m

dc=diameter of smallest circumscribed circle, m

ii. SURFACE AREA

iv. POROSITY: - it is given by $\frac{V_2}{V_1} = \frac{P_1 - P_3}{P_3}$

Where;

V1=volume in tank 1, m^3

V2=volume in tank 2, m^3

P1=absolute pressure, Pa

P3=pressure in valve3, Pa

v. **SPECIFIC GRAVITY**:- it is given by

$$\frac{Wa}{Wa - W_w}$$

Where;

Wa=weight in air, kg

Ww=weight in water, kg

b. **MECHANICAL PROPERTIES**: Machine damage to seeds occurs during harvesting. Threshing and handling can have a great effect on the viability, germinating powers, insect and fungi attack and low market value. The amount of damage is apparently affected by moisture content, impact loading, and temperature. Some damages are attributed to mechanical properties (Mohesin, 1970). They include

I. **MECHANICAL DAMAGE:** One by-product of mechanizing in agricultural activities is mechanical damage. Most of the damages occur during threshing and in some cases, during conveying. Damages is a failure that occurs either;

-Under excessive deformation when it is forced through a fixed clearance or

-Under excessive force when it is subjected to impact.

These damages are of much concern since even a small crack in the seed coat could allow bacteria into the food to cause damages.

Factors that influence the mechanical damages of material include age, moisture content, and temperature.

Some of the factors that are used to defined mechanical damage externally are (Moshein 1970) – Abrasion, Bruising, Distortion, Crack, Cut, Puncture, Shatter Cracks, Skin break, Skinning , split, Stem end tearing and swell- cracking.

ii. **IMPACT DAMAGE**: - One of the most common causes of mechanical damages to agricultural products is shock and impact during handling. The concept of impact is differentiated from the case of static rapid loading by the fact that the forces created by the collision are excerted and removed in a very short period of time and the collision products stress waves which travel away from the region of contact. There are four phases of impact; (Mohesin, 1970).

- Initial elastic deformation during which the region of contact will be deformed elastically and will recover fully without deformation;
- Onset of plastic deformation during which the mean pressure passes the dynamic yield pressure of the material and the resulting deformation will not be fully recovered;
- Full plastic deformation during which the deformation continues from elastic-plastic to fully plastic until the pressures falls below yield pressure;
- Elastic rebound during which a release of elastic stress stored in both bodies takes place.

III. **FRICTION**: - A knowledge of the co-efficient of friction of an Agricultural product is used in the design of a machine. Whenever a body is pressed against another body by a force equal to its weight, the first body will not move in the transverse direction except the frictional force between them is over come. The concept of friction is summarized as follows (Mohesin, 1970).

i. The force acting in a plan containing the contact points in such a manner as to resist relative motion of the contact surfaces.

ii. A force being composed of two main component;

iii. A force dependent on the sliding velocity of the contacting surfaces because of the effect of the velocity on temperature of the contacting materials;

iv. A force dependent on the nature of the materials in contact;

v. A force not dependent on the surface roughness except in the extreme on very fine and very rough surfaces.

The following are also very vital in the consideration of mechanical properties.

a. **TERMINAL VELOCITY**: - It is an aero-dynamic property used in handling agricultural products in air. It is used for separating the desirable product from the unwanted materials i.e cowpea from the chaffs. The terminal velocity of a material is given by:

$$Vt = \left\{\frac{2w\ (P_p - P_f)}{P_p\ P_f\ A_p\ C}\right\}^{1/2} m/s^2$$

Where;

Vt= terminal velocity, m/s^2

W= weight of material, kg

Pp= density of particles, kg/m^3

Pa= density of fluid air, kg/m^3

A = project area, m

C = Drag co-efficient

b. **ANGLE OF REPOSE**: These occur in two forms; the static angle of repose and the dynamic angle of repose. Angle of repose is determined using an apparatus called angle of repose measuring box. (Moshein, 1970) and evaluated by

$$Qr = \tan^{-1} \frac{2\ (Hc - Hp)}{D},\ ^{0}$$

Where;

Qr= angle of response, ^{0}

Hc= Height of cone, m

Hp= Height of platform, m

D= Diameter, m

Other properties of agricultural material that affect threshing includes

- Electrical properties;
- Optical properties;
- Thermal properties.

2.15.2 **MACHINE PARAMETER**: - Just about some few years ago much work has been done on machine parameter and factors affecting machine performance (Baskas, 1953). The parameters include:-

Cylinder concave clearance: This is the gap between the cylinder and concave. The clearance contributes to most seed damage and the performance of the threshing machine.

Feed rate: This refers to the rate at which the crops are being feed into the threshing unit. When feed rate is increased the mechanical damage is reduced.

Fan capacity: The main function of the fan is to aid cleaning while threshing. The speed should not be either very high or very low. When the speed is high, it blows the seeds and the unwanted product away and when low, it does not clean the product well.

Conveyor helical speed: If the speed of the helical conveyor is higher, it causes the seed to crack and at a lower speed the grain may remain unthreshed.

CHAPTER THREE

METHODOLOGY

3.1 METHOD OF STUDY

This study was base on the Investigative Survey Research Approach (ISRA) as was reported by Anazodo (1986). The investigative survey for this project has to do with schedule of visit to established farms in Kontagora and Baban-Rami. During the visit, the following tasks were accomplished:

i Physical inspection of the threshers;

ii Oral interview with owners and operators of the threshers;

iii Measurement of output capacity of the threshers;

iv Carring of type-test;

v Computation of parameters.

The data obtain from that visit and interview, were based on observations, information and/ or option of owners and operators.

3.2 FARMS VISITED

In caring out the investigation, farms within Kontagora town and Baban-Rami; 20-30km west of Kontagora Township where visited. In all, a total of 12 farmers were visited. Table 1 shows the names of farms visited, its location, thresher make and number available and operationally.

3.3 DATA COLLECTED

To justify the case study of Kontagora as the major producing area of cowpea in Niger State, production data was obtain from the A.D.P headquarters in Minna. Also obtained is the data on rainfall and both are shown in table 2.

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 INVENTORY OF MAKE OF THRESHER IN USE

The investigative inventory of the make of threshers in use in the areas visited is summarized in Tables 1 and 3. Table 1 shows the total numbers of farms visited in Kontagora and Baban-Rami. There are a total of 10 numbers of threshers available at the farms visited.

Table 3 shows the different make of threshers, their threshing intensity, capacity threshing, cleaning efficiency, Grain recovery range , percentage total losses ,power requirement ,average operational hours, condition and age. It also presents the ownership pattern of the threshers.

4.2 INVENTION OF YEARLY COWPEA PRODUCTION AND RAINFALL

Table 2 presents the yearly cowpea production (ton), total yearly cropped areas (ha) as well as the yearly yield (ton/ha), for Kontagora area of Niger state. The record is for the year 1993-2003 as obtained from the A.D.P headquarters in Minna, Niger state. It must be stated however that the record excludes all small scale farmers in area. The table also present the annual and average annual rain fall data for the area. The data was also obtained from the A.D.P headquarters in Minna for the year 1993-2003.

4.3 ANALYSIS OF THE INVENTORY ON MAKE OF THRESHER

Table 1 presents the inventory of the farms visited, number of threshers and their make and the number of tractors available. There is a total of twelve (12) farms visited. Four (4) of these farm representing 33.3% are located in kontagora and the remaining eight (8) farms representing 66.7% are located in Baban-Rami.

Out of the twelve (12) farms visited within the two locations, access was granted at eight (8) or 66.70% of the farms, while access was not granted at four (4) or 33.3% of the farms with two each at kontagora and Baban-Rami respectively.

The table also shows that the Haske-rana make accounts for 50% of cowpea threshers available at the farms visited while the O.L.J., Fontan, IRAET & IT and another marked "other" accounts for one (1) each representing the remaining 50%. It could be concluded that the Haske-Rana make is the popular type of thresher among the farmers in the area.

Table 3 present a performance evaluation indices of the different makes of threshers and that of tractors. The threshers uses diesel as their source of power. All the threshers except for the one marked "OTHER", have the power rating of 8.05hp (6kw). OTHER has the power rating of 10.73hp (8kw).

The Haske-Rana has a capacity of 112kg/hr. I.R.A.E.T & L.T, Fontan, O.L.J and on marked "other" all have a capacity of 42kg/hr, 39kg/hr, 49kg/hrand77kg/hr respectively

4.4 PERFORMANCE EVALUATION

a) Haske-Rana (A)

I - Input capacity=756kg

ii - Output capacity=672kg

iii - Percentage unthresed = $\frac{\text{weight of unthreshed (kg)}}{\text{Total weight at outlet(kg)}} \times 100$

$$P.U = \frac{15.33}{672} X100$$

2.28%

v – Threshing Efficiency (T.E) = 100 – % unthreshed

T.E = 100 – 2.28

97.72%

v - Capacity utilization (C.U) = $\frac{\text{Output}}{\text{Input}} \times 100$

$$C.U = \frac{112}{126} X\ 100$$

88.9%

vi - Grain Recovery Range(G.R.R) = 100 - % losses

G.R.R = 100 - 4.78

95.22%

vii - Threshing Index(TIX) = (T.E X C.U X G.R.R) X 100

$$TIX = (0.9772 \times 0.889 \times 0.9522) \times 100$$

92.27%

Vi - Threshing Intensity(TIN) = $\frac{\text{Power consumed(hp)}}{\text{Output(kg)}}$

$$TIN = \frac{8.05}{672}$$

0.012hp/kg

vii-Cleaning Efficiency(C.E) = $\frac{\text{weight of clean seed at outlet(kg)}}{\text{Total weight at output(kg)}} \times 100$

$$C.E = \frac{671}{672} \times 100$$

99.85%

b)Haske-Rana(B)

I - Input capacity = 588kg

ii - Percentage unthreshed = $\frac{19.71}{546} \times 100$

3.6%

iii - Output capacity = 546kg

iv - Threshing Efficiency = 100- 3.6

96.4%

v - Capacity utilization(C.U) = $\frac{91}{98} \times 100$

92.9%

vi - Grain Recovery Range = 100 – 5.11

94.89%

vii -Threshing Index = (0.964 x 0.929 x 0.9489) x 100

84.98%

Viii - Threshing Intensity = $\frac{8.05}{546}$

0.15hp/kg

Ix - Cleaning Efficiency = $\frac{544}{546}$ x 100

99.63%

c)I.R.A.E.T&I.T

I - Input capacity = 336kg

Ii - Output capacity = 252kg

iii - Percentage unthreshed = $\frac{22.10}{252}$ x 100

8.8%

iv - Threshing Efficiency = 100 – 8.8

91.2%

v - Capacity utilization = $\frac{42}{56}$ x 100

75.0%

iv- Grain recovery range = 100 – 8.24

v- 91.76%

vii - Threshing index = (0.912 x 0.75 x 0.9176) x 100

62.76%

viii - Threshing intensity = $\frac{8.06}{252}$

0.032 hp/kg

ix - Cleaning efficiency = $\frac{248}{252} \times 100$

98.41%

D) FONTAN

i- Input = 294 kg

ii- Output = 234 kg

iii - Percentage unthreshed = $\frac{18.18}{235} \times 100$

7.7%

iv - Threshing efficiency = 100 – 7.7

92.3%

v - Capacity utilization = $\frac{39}{49} \times 100$

79.6%

vi - Grain recovery range = 100 – 8.71

91.29%

vii - Threshing index = (0.923 x 0.796 x 0.9129) x 100

66.57%

viii - Threshing intensity = $\frac{8.05}{235}$

0.034hp/kg

ix - Cleaning efficiency = $\frac{230}{235} \times 100$

97.87%

E)O.L.J

i-Input = 336 kg

ii – Output = 294kg

iii - Percentage unthreshed = $\frac{20.01}{24.59} \times 100$

6.8%

iv – threshing efficiency = 100 – 6.8

92.2%

v - capacity utilization = $\frac{49}{56} \times 100$

87.5%

vi - Grain recovery range = 100 – 6.22

93.78%

vii - Threshing index = (0.932 x 0.875 x 0.9378) x 100

76.48%

viii - Threshing intensity = $\frac{8.05}{294}$

0.027hp/kg

ix - Cleaning efficiency = $\frac{281}{284} \times 100$

95.58%

F)"OTHER"

I - Input = 504kg

ii - Output = 462kg

iii - Percentage utilization = $\frac{24.59}{462} \times 100$

5.3%

iv - Threshing efficiency = 100 – 5.3

92.29%

v - Capacity utilization = $\frac{77}{84} \times 100$

91.7%

vi - Grain recovery range = 100 – 7.73

92.27%

vii - Threshing index = (0.947 x 0.917 x 0.9227) x 100

80.13%

viii - Threshing intensity = $\frac{10.73}{462}$

0.023hp/kg

ix - Cleaning efficiency = $\frac{439}{462} \times 100$

95.02%

4.5 ANALYSIS OF YEARLY COWPEA PRODUCTION

Table 2 shows that cowpea production in the area is on the fall for the last two seasons; 2002 and 2003 even though rainfall was averagely adequate. This fall is attributed to the following;

i. Attack by pests and diseases during the said seasons.

ii. Inavilability of inputs such as pesticides, Herbicides;

iii. Infertility of the farm land due to prolong use for the production of one crop (cowpea).

TABLE 1. FARMS VISITED, LOCATION, MAKE AND NUMBER OF THRESHERS AVAILABLE

S/N	NAMES OF FARM	LOCATION	THRESHER MAKE	NUMBER AVAILABLE
1	A.D.P FARM	KONTAGORA	NONE	NONE
2	F.C.E FARM	KONTAGORA	HASKE-RANA	1
3	BAKO FARMS	KONTAGORA	ACCESS NOT GRANTED	NONE
4	SANDBELL FARMS	KONTAGORA	ACCSS NOT GRANTED	NONE
5	ALH.GARB FARMS	BABAN-RAMI	HASKK RANA AND I.R.A.E.T AND I.T	4
6	ALH ALIYU ISA FARMS	BABAN-RAMI	OLJ	1
7	MAL SOBA	BABAN-RAMI	FONTAN	1

8	DANALAMI FARM	BABAN RAMI	I. R.A.E.T & I.T	1
9	KOWATASA	BABAN-RAMI		1
10	MAC BABA ISAH NALLAH FARMS	BABAN-RAMI	OTHER	1
11	NDAMA FARMS	BABAN-RAMI	ACCESS NOT GRANTED	
12	SALISU BALA FARMS	BABAN RAMI	ACCESS NOT GRATED	

TABLE 2- YEARLY COWPEA PRODUCTION AND RAINFALL IN KONTAGORA

S/NO	YEAR	TOTAL AREA CROPPED (HA)	YIELD RECORDED Ton/ha	PRODUCTION (TON)	AVERAGE ANNUAL RAINFALL (mm)	TOTAL ANNUAL RAINFALL (mm)
1	1993	171799	0.13	21970	10.81	661.7
2	1994	185905	1.02	188824	15.53	1118.0
3	1995	93375	0.99	92908	16.42	1301.1
4	1996	157908	0.42	66479	19.88	1610.4
5	1997	40000	0.77	30840	15.48	1006.1
6	1998	145609	0.36	51860	10.44	793.7
7	1999	11012	0.31	3396	12.40	843
8	2000	15189	0.33	4974	14.87	892.3
9	*2001*	*19620*	*1.20*	33498	21.13	929.7
10	20002	13747	0.53	7328	15.09	739.2
11	2003	13412	0.57	7631	13.09	1347.9

TABLE 3:PERFORMANCE EVALUATION INDICES OF MAIZE

S/NO	ITEM FOR EVALUATION	MAKES						
		HASKE RANA 1	HASKE RANA	I.R.A.E.T & I.T	FONTAN	O.L.J	OTHERS	
1	Output capacity (kg/hr)	112	91	42	39	49	77	
2	Input capacity (kg/hr)	126	98	56l	49	56	84	
3	POWER RATING (H.P)	8.05(i.c.e)	8.05(i.c.e)	8.05(i.c.e)	8.05(i.c.e)	8.05(i.c.e)	10.73(i.c.e)	
4	PERCENTAGE UNTHRESHED (%)	2.28	3.6	8.8	7.7	6.8	5.3	
5	THRESHING EFFICIENCY (%)	97.72	96.4	91.2	92.3	93.2	94.7	
6	CAPACITY UTILIZATION (%)	88.9	92.9	75.0	79.6	87.5	91.7	
7	GRAIN R.R (%)	95.22	94.89	91.76	91.29	93.78	92.27	
8	THRESHING INDEX (%)	82.2	84.98	62.76	66.57	76.48	80.13	
9	THRESHING INTENSITY (hp/kg)	0.012	0.015	0.032	0.034	0.027	0.023	
10	CLEANING EFFICIENCY (%)	99.85	99.63	98.41	97.87	95.58	95.02	

11	NUMBER AVILABLE	1	4	2	1	1	1	
12	LOSSES (%)	4.78	5.11	8.24	8.71	6.22	7.73	
13	NUMBER OF OPERATORS	4	4	3	2	3	4	
14	AGE (YEARS)	2	1	7	6	4	10	
15	OWNERSIHP	SCHOOL	PRIVATE	PRIVATE	PRIVATE	PRIVATE	PRIVATE	
16	CONDITION	WORKING	WORKING	WORKING	WORKING	WORKING	WORKING	
17	SOURCE OF POWER	DIESEL	DIESEL	DIESEL	DIESEL	DIESEL	DIESEL	

18 – Other observed factors affecting the performance of a thresher

- Moisture content of cowpea crop
- Requires continuous feeding of crop
- Number of operators
- Concave clearance
- Maturity of crop

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

A study on technical assessment/evaluation of the different makes of cowpea threshers in use in Kontagora area of Niger State of Nigeria has been carried out. The objective of the study, which includes; determining the number of model, make, and status of threshers in use in Kontagora area of Niger state, has also been achieved. From the result of the study based on data analysis, oral interview and personal observations, we arrived at the following conclusions:

i. Based on the survey of threshers in use in the area, the Haske-Rana make is the most popular and the best make with the following performance evaluation indices :threshing efficiency= 97.72% , Unthreshed grains = 2.28%,Cpacity utilization = 88.9%,Grain Recovery Range = 95.22%,Cleaning efficiency =99.85%,Threshing Index = 82.27% and threshing Intensity = 0.012hp/kg;

ii. the available types of threshers in the area are few in their numbers and locally fabricated;

iii Grain moisture content, grain number, grain size and shape, cylinder speed concave clearance are some crop-machine parameters that affects the performance of a cowpea thresher;

iv The task of matching power source with the size of a Thresher, farm size, operating cost as well as timeliness of operation are some of the management factors that must be considered in the selection and introduction of a cowpea thresher;

v As far as the area is concern, all machines and equipment are owned privately;

vi The Niger State government has little or no concern for agricultural mechanization.

5.2 RECOMMENDATION

Based on the survey, the following recommendations are drawn to improve the level of mechanization in using threshing machines.

i. Such studies should be carried out during the harvest season so as to allow for efficiency testing of the machine to determine its true efficiency;

ii. More work needs to be done by engineers in the area of design and fabrication of machine at a cheaper rate for local farmers;

iii. Government should as a way of subsidy, empower the local fabricators so that they could produce more of these threshing machines;

iv. More extension services are needed in the areas.

REFERENCES

A.D.P MINNA (1993-2003); Year technical report; News line Publishers Minna.

Anazodo U.G.N, Abimbola T.O and Dairo Y.A (1986); Agricultural machinery use in Nigeria; The experience of a decade [1975-1985] Proceedings of the 11^{TH} annual conference of the N.S.A.E PP 406-429.

Autum (1990); Development and testing of power operated Wheat threshers; John Willey and Sons, London

Anochili, B.C. [1978]; Food production; Macmillan Publication London.

A.S.A.E (1981); Terminology for combines and Grain harvesting; A.S.A.E St. Joseph, M.I, U.S.A.

Baskas (1953); Combine harvester fundamental of machine operation; John Publishing Company, USA.

Hall C.W. (1981); Drying of farm crops, agricultural Consulting Associates. INC, Wooster, Ohio, USA.

Chukuw O. (1994); Performance Evaluation of Locally manufactured Rice thresher in Niger state; Proceedings of the 4^{th} Annual Engineering conference of S.E.E.T,

F.U.T Minna, Pp23-30.

Claude Culpin (1981); Farms machinery; Granada Publications London.

Dada D.O (1985); Performance of a tangential feed threshing machines as affected by cylinder and concave design; Production of NSAE VOL7, 7-57.

Dauda, S.M and Adgidzi, D (2002); Development of Rice thresher; Proceedings of the 4th Annual Engineering Conference of S.E.E.T, F.U.T, Minna Pp31-38

F.A.O (1976); Farm-implements for arid and tropical region.Hunt D (1954); Farm power and machinery management; the Iowa State University press USA. P 3-4.

I.A.R Zaria (1988); Institution of Agricultural Research Zaria publication.

I.I.T.A. Ibadan. (1998); annual report & research highlights (87/88).

Brennan J.G., J.R. Butters, N.D. Cowell, A.E.V Liley (1981); Food Engineering; Elsevier Science Publication ltd, New York.

Juo A.S.R and Lowe J.A (1986); The wetlands and rice in sub-saharan Africa; I.I.T.A publication, Ibadan.

Kepner D. (1972); Principle of farm machinery; The avi publishing Company inc. USA P 486-487.

Mohsenin N.N. (1970); Physical properties of plant and animal Materials; Gordon & Breach science publishers New. York.

N.C.A.M (1990); TEST CODE FOR POWER maize Sheller Draft Nigeria Industrial anderd; N.A.C/M, Ilorin, Nigeria Pp18.

NG N.Q. and L.M. Monti (1990); Cowpea genetic resources; I.I.T.A Ibadan.

Kepner R.A, Baiwer and Berger E.L. (1982); Agricultural Engineers handbook; Mc Gram Hill book company Inc New York.

Richey C.B, P. Jacobson & C.W Hall; Agric ENG'G handbook; MC Grawn-Hill book company inc. USA.

Stone and Guklvin H.E (1977); Machine for farming; John Willey & Sons publishers England.

Sulton D.H (1974); A study of human expenditure in the Winnowing process; Unpublished P.HD Thesis, A.B.U Zaria.

U.S.D.A. (1960); A text book on power to produce; Year book of Agriculture P.450.

Wilkes and Smith H.E (1977); Farm machinery and equipment; Negro hill book company Inc. New York.

Turner and Shippen (1973); Basic Farm Machinery; Granada Publisher, London.

Singh, S.R. and N'Tare B.R. (1985), Development of Improved Cowpea Varietal in Africa, pp 105 -115 In Advances in Cowpea Production and Utilization. Edited by S.R. Singh and K.O Rachie; John Wiley and Sons, Chichester, U.K.

APPENDIX

The following terminology applies to grain threshing as given by A.S.A.E, 1991 and N.C.A.N, 1990.

Bushel; A unit for measuring grains or vegetables equals to 8 gallons or 36.4 litres

Cleaning; the isolating of the desired seed or grains from chaffs, small debris and unthreshed materials.

Cleaning efficiency; clean grain received at the specified grain outlet with respect to the total grain received at the grain outlet expressed a percentage by weight.

Concave; a concave shaped stationary element adjacent to a threshing cylinder or rotor, fitted primarily to promote threshing

Concave clearance; the maximum gap or clearance between threshing cylinder and concave.

Feed rate; the weight of the grain and parried feed into the thresher per unit time

Cowpea thresher; a machine operated by a prime move to separate the cowpea seed from the pod

Grain damage; for the purpose of this work, damage refers only to that attributed to the machine. It shall be expressed as the percentage by weight of damage seed in the sample

A, visible grain damage; seed damage where the coat appears broken to the naked eyes

B, invincible grain damage; seed damage which requires instrumentation or special procedure for determination

Input capacity; the maximum feed rate at which the power requirement is minimum and total losses and efficiencies are within the specified limits.

Materials- other-than- grain to grain ratio; the total weight of materials other than grain divided by the weight of grain in the sample.

Moisture content; moisture of the crop is expressed on wet bases, it is the ratio of weight of water in the product to the total weight of product, expressed as a percentage.

Output capacity; the weight of grains received at the specified grain outlet when collected at the input capacity.

Prime mover; an electric motor, engine or tractor raised for turning a thresher

Threshing; the detaching of seed or gain from the pod or cob.

Threshing cylinder; a rotating element which in conjunction with a stationary element adjacent to it, is fitted primarily to promote threshing . The crop being threshed is contained between rotating and stationary elements for less then 360 degrees.

Threshing efficiency; percentage by weight of threshed grain from all outlets of the thresher with respect to the total grain input

Threshing index; this is the product of grain recovery range expressed as a percentage, capacity utilization expressed as percentage and threshing efficiency also as a percentage.

Threshing intensity; this is the horsepower or kilowatt consumed by a thresher per unit output of crop threshed expressed as hp/kg or kw/kg.

Winnowing; pneumatic cleaning of the threshed grains.