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SUPPORT FOR SMALL RICE THRESHERS IN NIGERIA

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PrOpCom Nigeria

Making Nigerian Agricultural Markets Work for the Poor

SUPPORT FOR SMALL RICE THRESHERS IN NIGERIA

Submitted to

DFID/PrOpCom

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EXECUTIVE SUMMARY

Many countries in Africa have over the past three decades established agricultural machinery and implements manufacturing and assembly factories. Some of these have been set up with multi-lateral or bilateral donor assistance often on a turnkey basis and relying on imported technologies. These have often been large or medium scale operations and in most cases have relied on imported CKD kits and raw materials. An example is the John Holt agricultural machinery and implements manufacturing factory in Zaria, Nigeria.

Parallel to these medium and large scale enterprises, are also numerous facilities for repair, fabrication and manufacturing of agricultural machinery and implements set up by individual entrepreneurs, usually operating on a small scale level. At the lowest end of these types of enterprises in the machinery and farm implement development sector are the local fabricators and blacksmiths. In Nigeria, these small scale enterprises operate in the informal and formal sectors, usually, employing one to two people and often less than ten employees, do not enjoy any government, or credit facilities, and struggle on their own to provide key services to farmers and agricultural machinery and implement owners. Their contribution to the national economy is not recognized in most cases, and in some cases they are not supported by the official organs of state. The underdevelopment of this category of enterprises is partly responsible for the labour intensive nature of farming in Nigeria.

Like many other farm production systems in Nigeria, the rice production system is labour intensive. There is minimal mechanization and this is mostly at the level of land preparation.

The purpose of this study is to review the existing rice thresher designs and products available within Nigeria and neighbouring countries and to propose prototype small threshers that will be able to thresh harvested rice grains on panicles as well as those on the straws. The impetus for the study is the concern that low and poor quality of local rice in Nigeria may be due, in important measure, to lack of appropriate and affordable small threshers. This report has benefited from workshops with cross section of Stakeholders from Ofada and Kano rice region.

On this basis, a reconnaissance work in Five Local Government Areas in Ogun State, Erin – Ijesha in Osun State, Igbimo in Ekiti State; Abakaliki in Ebonyi State, Makurdi in Benue State as well as Kura - Kano and Tundun Wada areas of Kano State was carried out.

In pursuance of the objectives of this work, primary data were collected from eighty five rice farmers/threshers with the aid of structured, open and close ended questionnaire using both purposive and simple random techniques. Secondary data were also obtained from local fabricators, research centres and Universities to complement the primary data. The data collected were analysed using descriptive statistics and correlation analysis.

The study revealed that most of the rice farmers were married men with average farm size of 3 hectares. The varieties of rice grown are Ofada, Nerica 1, ITA 150, Igbemo and Taraba. The descriptive Statistics showed that the rice farmers were between the ages 30 – 70 years. The average rice threshing experience which is mainly dominated by women was about 15years. It is evident that none of the rice farmers/threshers had threshing machine. They relied heavily on the crude method of using legs and sticks for threshing their rice.

It was generally agreed that the provision of affordable threshing machine will reduce drudgery and increase efficiency in rice threshing. The analysis of the cost incurred in threshing and revenue accruing from the sale of rice shows that rice threshing is a profitable ventures in the study area.

The financial analysis revealed that a profit of #15 was obtained from every of rice threshed. The considerable level of profitability of rice threshing in the study area was further corroborated by the benefit cost ratio of 1.19. Also the rate of returns of 36% in rice threshing in shows that for every #1.00 invested in rice threshing there will be a return of #1.36 or 36kobo gain by the farmer. On the average all the threshing machines assessed at research

centres, universities and some companies had a threshing capacity of 133.33kg/hr with 103.33kg/hr above the capacity for manual threshing. The study revealed that an average capacity of 133.33kg/h can be achieved with a threshing machine of ₦116,666.67 having a pay back period of 4months.This therefore justifies the need for the provision of rice threshing machine for the rice farmers

The correlation analysis revealed that a significant and positive correlation exist between income and the quantity of rice threshed. This implies that more rice will be threshed with increase in the income of the farmers. However, the cost of labour and the quantity of labour had a negative correlation with the quantity of rice threshed. Insufficient funds, poor extension services, lack of credit facilities and absence of threshing machines were the major factors militating against effective rice threshing in the areas.

The results of assessment of selected threshing machines showed that power operated machines give high output and are therefore recommended for farmers growing these crops commercially. Smaller manually operated machines are suitable not only for small farmers but also for threshing grains for seed purposes. To this end WARDA/IITA, and some local fabricators were invited to demonstrate their small threshers to farmers at the stakeholders' workshop on the presentation of draft report on support for small rice threshers held in Abeokuta, Ogun State.

Based on the farmers' evaluation and assessment of existing rice threshers in Research Centres/Universities, local fabricators and some organization within and outside Nigeria, the study recommended three prototype small threshers that are pedal and petrol engine driven. The pedal operated thresher was recommended for those with farm hectrage of less than 2. For threshing freshly harvested rice at very high moisture content, the IITA/WARDA small plot spike-tooth thresher which has a threshing capacity of about 100kg/h was found to be appropriate for the small – scale farmers provided some little modifications in the area of capacity and mobility were carried out while the multi-crop thresher of the Institute of Agricultural Research and Training (IAR&T) Ibadan with a capacity of about 250kg/h was recommended for those with farm hectarage of more than 5ha.

The design of these recommended threshers which will handle both rice panicles harvested with or without straws as well as the AutoCAD drawings of the threshers have been made. The respective design capacities are 50kg/h for pedal operated thresher, 100kg/h for the cottage thresher and 250kg/h for the small thresher. Their cost ranges between N80,000 to N300,000.

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1.0 INTRODUCTION

1.1 **Background and justification**

Rice (Oryza sativa, L) is one of the most important staple food crops in Nigeria which is consumed in both rural and urban areas. It is the most widely consumed cereal after maize and sorghum in many parts of Nigeria. Rice grain is used as food and it could be prepared in various forms. Industrially, starch could be made from broken rice which is used in laundry, cosmetics and textile industries. The straw can be used as livestock feed, for thatching of houses and for making mats and hats. The husk can be used as fuel.

Rice production in Nigeria is done mainly by the peasant farmers in virtually all the agro-ecological zones under various conditions such as upland, lowland ('fadama"), deep water and mangrove rice. This implies that rice is highly adaptable to the various water regimes in different parts of the country. As a result of change in diet of average Nigerian family in favour of rice its demand is increasing substantially. The National Cereals Research Institute (NCRI) in 1992 estimated the deficit in Nigeria's rice annual needs to be about 1.5 million metric tones (mt).

Recent statistics show that as at 2004 Nigeria consumed about 5.4 million mt per year while domestic supply was about 2.3 million mt. This led to the importation of about 687,925mt in 1998 from 300,000mt in 1995. These imports constitute a substantial outflow of funds from the Nigerian economy, amounting to a whopping US $215 million in 2001. The increasing rise in rice import bills to meet up local demand has food security, socio-economic and political implications in Nigeria. This has therefore called for some intervention.

Several efforts have been made, and are still being made, by the government to bridge the domestic supply – demand gap. Some of these efforts include provision of subsidized rice production inputs, establishment of Agricultural Development Projects (ADPs), River Basins Development Projects (RBDAs), several irrigation schemes whose main mandate crops include rice, and active participation in the activities of West African Rice Development Association (WARDA) by Nigeria. The result of these efforts is that over the years, rice production in Nigeria has been on a steady increase, growing at 9.3% per annum, particularly due to vast increase in rice area (7.9%) per annum) and a lesser extent through increases in rice yield (1.45% per annum).

Despite the efforts to increase rice production, not much commensurate effort has been made to improve local rice processing especially threshing, even though it is one of the most labour intensive activities in the farmer's cropping calendar. Instead the nation has over the years relied on importation of good quality rice. Mechanized threshing has the potential to significantly improve labour productivity and develop it to an industry capable of producing rice of acceptable quality. Threshing is also one of the largest costs in the producer's budget, and therefore an obvious target in any campaign to reduce the cost of rice production. Threshing on the ground typically results in dirt, stones and other foreign matter being swept up and included in the rice. This, along with drying the rice on the ground or along the edge of the road, is the major source of contamination with dirt and stones.

Several studies have shown that rice production and processing are profitable ventures in Nigeria and what is required now is to seek to encourage investment in rice processing activity. Well-processed local rice would stimulate consumers demand and in turn stimulate paddy rice production.

One cannot but agree with the statements in one of PrOpCom's (Promoting Pro-poor Opportunity for Commodity and Service Markets) documents, that access to appropriate threshing machines will give a big boost to rice development and marketing in the Ofada and Kura-Kano rice production areas by reducing the physical drudgery of manual threshing and speeding up the process of threshing. Since paddy rice is often piled in the field to dry and await threshing, more rapid threshing will reduce the exposure to weather (with risk of loss from molding or shattering before arriving at the threshing location), birds, livestock and

other sources of predation. It will also limit the amount of contamination and breakage of the grains thereby increasing product quality and competitiveness in the market.

As noted in the PrOpCom's document, there are two main methods of rice harvesting in Nigeria–cutting the rice plant near the ground to harvesting both the straw and the panicle together, or cutting just the panicle (rice head) and leaving the straw standing in the field. Farmers in the Ofada rice project area harvest just the panicle, while farmers in the Kura-Kano area harvest the straw and panicle together. Most, of the existing rice threshers are designed for threshing rice in panicles attached to the straw.

Another advantage of using appropriate threshers is that it will boost the adoption of improved new rice varieties by farmers as previous attempts to promote certain high yielding new rice varieties were rejected due to anticipated difficulty in threshing manually.

At the Ofada Stakeholder's Planning Workshop, participants generally agreed that the addition of an appropriate, affordable and efficient small scale thresher to the Ofada rice production chain would raise the scale of production of farmers with consequent improvement in income. This study will therefore examine the existing threshing machines and determine the possibility of modification and redesign of some of them to come up with prototypes of appropriate threshing machines for the major rice production systems in Nigeria

1.2 OBJECTIVES AND TERMS OF REFERENCE

1.2.1 Objectives

The main objective of the project is to undertake a review of the designs of existing rice threshers and come up with prototype small threshers that are appropriate and affordable to poor – small rice farmers in Nigeria. The specific objectives are to:

- Review the literature and existing thresher designs and products in the Nigerian and neighboring country markets with aim of identifying small threshers appropriate for small-scale rice producers including threshers that will be practical for use with each rice harvesting methods mentioned above
- Review rice threshing by Ofada, Abakaliki, Makurdi and Kano rice farmers with the aim of identifying needs and requirements
- Undertake reconnaissance work in the five LGAs in Ogun state where rice is commercially grown, Igbimo in Ekiti State, Erin-Ijesha in Osun State, Abakaliki in Ebonyi State, Makurdi in Benue State as well as Kura-Kano corridor (lowland rice) and the Tudun Wada area (upland rice) of Kano State.
- Provide information on the source, efficiency, availability, appropriateness and cost of these small threshers; as well as contact information for the manufacturers or their representatives in Nigeria.
- Recommend appropriate thresher(s) suitable for use with each rice harvesting methods of panicles with and without straws.and
- Propose designs or a modification of existing designs for PrOpCom's consideration (In the event that existing rice threshers are inappropriate).
- Undertake financial analysis of rice threshing.

1.2.2 Terms of Reference

- Identify appropriate threshers for both rice harvest practices (harvesting just the panicle and harvesting rice panicles attached to the straw).
- If practical threshers do not exist for both harvesting methods, arrange to have an appropriate thresher designed.
- Undertake a financial feasibility analysis of the threshers selected.
- Demonstrate the appropriate threshers in the Ofada and Kura-Kano communities.
- Arrange to train fabricators to build, sell and provide parts for the selected threshers.

1.2.3 Expected Outputs

Key outputs from this review exercise would be as follows:

1. Provision of information on the threshing methods, needs and requirements of Ofada rice farmers;
2. Identification of a particular model of small thresher suitable for the production conditions of Ofada rice farmers;
3. Provision of information on the source, availability and appropriateness as well as manufacturers' contacts of such thresher.

2.0 METHODOLOGY

2.1 Description of the study areas

Based on the terms of reference, the study was conducted in two phases. The first phase was the survey of rice threshing techniques adopted by rice farmers and the various designs of rice threshers available. The second phase was the collation of data from Local fabricators, Research Institutes and Universities. This survey was undertaken in Ogun, Osun, Ekiti, Ebonyi, Benue and Kano States.

2.2 Sources of Data

A combination of primary and secondary data was used for the study. Primary data were obtained from Individuals, Farmers. Groups and Associations during the survey of rice threshing clusters in Ofada, Abakaliki, Makurdi and Kura Kano.. Photographs and where necessary and feasible, video recordings were obtained of the various designs of threshers found during the survey. Information from literature review, journals, publications, documents of the ADPs, and the other agencies visited and written commentaries of knowledgeable individuals relating to the subject matter formed the bulk of the secondary data used for the study. Specifically, secondary data were obtained from the following agencies:

- University of Agriculture, Abeokuta. (UNAAB)Ogun State
- Federal College of Agricuture. IART, Moor – Plantation, Ibadan, Oyo State.
- University of Ibadan, Ibadan, Oyo State.
- International Institute for Tropical Agriclture (IITA)/ West African Rice Research and Development Agency, Ibadan, Nigeria
- National Centre for Agricultural Mechanization, NCAM Ilorin, Kwara State Nigeria.
- National Cereals Research Institute, Baddegi Niger State, Nigeria
- Federal University of Technology, Minna.
- Institute for Agricultural Research, Agricultural Engineering Department, Ahmadu Bello University, Samaru ,Zaria, Nigeria
- Local Fabricators and Engineering companies in Abeokuta, Ibadan, Lagos, Kano and Kaduna.
- Ogun State Agricultural Development Programme (ADP)
- Kano State Agricultural Development Programme (ADP)
- River Basin Development Authorities in Ogun and Kano States
- Annes Agro Processing Industries Ltd., Producer of Abakaliki Eagle Rice in Ebonyi State.
- Olam Nigeria Ltd., Agro Millers, Makurdi, Benue State.
- Songhai Farm, Engineering and Equipment Fabrication Unit, Porto Novo Republic of Benin.

2.3 Methods of Data collection

The primary data used for the study were collected from the respondents with aid of well structured open and closed ended. These were supplemented where necessary with interviews, discussions and direct observation. Five research assistants recruited from the local communities will be trained on how to administer the questionnaires .Relevant information obtained includes:

- Methods of rice threshing
- Different types of threshers farmers are familiar with
- Types of farm power used for threshing i.e. Machine, Manual labour, Animal Traction.
- Farm size devoted to rice
- Total farm size
- Other crops grown
- Non farm employment
- Input supply for rice production
- Rice yield, Total annual output of rice
- Transportation of farm produce
- Packing of threshed rice
- Cost of threshing
- Cost of threshing machines, source, age, performance, expected lifespan
- Varieties of seeds of seed planted
- ·Amount of credit obtained
- Sources of land
- Training needs for fabrication, maintenance and repairs of threshers
  Performance of existing rice threshing machine

2.4 Sampling technique

The sampling of rice farmers or farmer groups was carried out based on the location of farms and other criteria determined after the preliminary interaction with the population. Both purposive and simple random sampling techniques were employed to select the one hundred respondents used for the study. They included rice farmers and equipment fabricators. The equipment fabricators and manufacturers were purposively selected.

2.5 Methods of Data analysis

Data collected were subjected to qualitative and quantitative analyses. The analytical tools used are descriptive statistics, cross tabulations, correlations and

3.0 REVIEW OF RICE THRESHING ACTIVITIES IN NIGERIA

3.1 Traditional Rice Processing

Rice processing is the post-harvest technology applied on paddy rice. This involves two basic stages; pre milling and milling. These two stages are embedded in each of the processing methods. The pre-milling activities are carried out both on- and off-farm. These include threshing, cleaning, parboiling and drying. In many parts of Nigeria where rice is grown, these activities are undertaken in a small-scale with local tools resulting in time wasting and drudgery.

3.1.1 Threshing/Cleaning: This is normally done by trashing the harvested material with hands or legs. Manual cleaning which comprises shaking threshed materials into natural wind, using calabash, head pan, shovel, baskets, trays are still being practiced in Nigeria. Women and children are the ones charged with responsibility of cleaning (Plate 3.1). Examples of hand and feet threshing at Iboro and Ifo rice farming community of Ogun State are presented in Plate 3.1 as example. There is no way that rice handled in such a manner can have good market quality.

3.1.2 Parboiling: This is partial cooking of the paddy which causes the starch of the kernel to gelatinize, making it tougher to resist insect attack, breakage during dehusking and absorption of moisture from the air. The parboiling process involves soaking paddy in hot water and steaming (to gelatinize the starch). Equipment frequently used include earthen or metal pots, brick or metal tanks, drum parboiler, pressure vessel, continuous and batch process parboilers.

3.1.3 Drying: Careful drying after harvest, threshing and parboiling is essential to prevent mould formation, discoloration and fermentation of the rice paddy. Generally the grain moisture content is reduced to about 13-14% for safe storage and milling. Methods of drying include open air sun drying and hot air drying. The open air sun drying is the most popular among small-scale processors.

3.1.4 Milling: The milling stage is the point where actual dehulling (or dehusking) occurs. There are mainly three methods of rice dehulling (or dehusking) in Nigeria. These are traditional or hand-pounding method, the small-mill processing method and the large-mill processing method.

Plate 3.1: Manual rice threshing and cleaning at Ibooro, Yewa North, (Top left – Hand threshing) and Ifo, Ogun State (Top right – Feet threshing and bottom – winnowing)

3.1.5 Post Harvest Handling

One approach at meeting increasing demands for food supplies is reducing heavy losses of food grain at the post harvest stage (FAO, 1979). Odigboh (2004) gave post harvest losses estimate in Nigeria to be up to 25%. Harvesting and post harvest handling methods encourages the presence of contaminants such as stones, sticks, chaff and dust (Ogunlowo and Adesuyi, 1999), which needs to be cleaned. Kays(1991) reported that the total cost of losses, which occur during post harvest phase, is substantially greater than that incurred during the production phase. He pointed out that grain threshed manually using simple appliances require considerable additional cleaning before it can be used as food, whole or ground and even as seed. The cleaning process, he postulated, presents more difficulties than the actual threshing process.

Pneumatic separation is the sedimentation motion of the heavier materials while lighter ones remain suspended carried along with the fluid medium (Ogunlowo and Adesuyi, 1999) while sieving is the process whereby material mixture is moved over a perforated surface with openings of specified shape and size having one or more oscillating sieves and a fan delivering air through the sieves (Picket and West, 1988). Pneumatic cleaning is the process of using air to lift light, chaffy and dusty materials out of the grain while heavier materials move downward. Air is generated by natural or mechanical fan. However, the limitation of the natural wind method for cleaning is its unpredictable direction, speed and continuity, high labour requirement and rather imprecise degree of separation (Aguirre and Garray, 1999)

Manual cleaning is a laborious and slow operation. and there is need to improve methods of cleaning foreign matter from grains. Unless good care is taken for the rice crop during harvesting, drying, threshing, pre-storage/processing drying, all gains made during the in production can be mostly or entirely lost due to prevailing unfavorable environmental conditions (moisture, insects, rodents). Unfortunately, the post harvest and agro-processing activities in Nigeria leave a lot to be desired. Plate 3.2 shows mechanical way of threshing rice and this was presented to the farmers at workshop (plate 3.3) organized at OGADEP, Abeokuta, Ogun State.

Plate 3.2: Demonstration of Rice Threshing Machines by IART (Top Left) and IITA/WARDA (Top right and bottom) in Abeikuta, Ogun State

Plate 3.3: Presentation of Draft Report to the Rice Farming Community at OGADEP, Abeokuta, Ogun State (Top left- PrOpCom representatives, Top right – The Consultants, Bottom – Rice Farming Community)

3.2 Background Information on Rice Threshing Farmers

This section of the report presents the socio economic characteristics of rice farmers/threshers, parameters on rice threshing and the financial analysis in line with the terms of reference of the study. The socio economic characteristics discussed include age, sex , years of threshing experience, farm size, income level, varieties of rice grown, sources of funds, sources of labour used for threshing, types of labour, quantity of labour used, labour cost and quantity of rice threshed. The financial analysis was also carried out. The raw data is as shown in Appendix A1.1 to A1.3.

Table 3.2.1 Sex Distribution of Respondents

Sex	Frequency	Percentage (%)
Male	81	81
Female	19	19
Total	100	100

Source: Field Survey Data, 2007

The gender structure shows that 81% of the rice farmers were males as compared to the female farmers that represent only 19%. This indicates that rice production was dominated by male farmers in the study areas.

Table 3.2.2 Age Distribution of Respondents

Age(Year)	Frequency	(%)
≤ 40	26	26
41-50	43	43
51-60	17	17
>60	14	14
Total	100	100

Source: Field Survey Data, 2007

Table 3.2.2 shows the distribution of rice farmers/threshers by age groups in the study area. The modal age bracket was 41-50 years – about 43% of the total rice farmers. The ≤40 years bracket was the next to the modal category consisting of about 26%. This is followed by 51-60 and >60 years which represent 19.4% and 1.8% respectively. The mean age of the farmer was 45 years. The age distribution indicates that rice production is dominated by farmers who are still economically and physically active.

Table 3.2.3 Farm Size Distribution

Farm Size (ha)	Frequency	(%)
1-10	70	80
11-20	15	15
21-30	5	5
Total	100	100

Source: Field Survey Data ,2007

The structure of the farm size in the area shows that farm size of 1-10 hectares constituted 80% of the rice farm holdings. Also, 15% of the farmers cultivated between 11 and 20 hectares while only 5% of them had farm size of 21-30 hectares. The average farm size cultivated by the rice farmers was 3 hectares.

Table 32.4 Sources of Funds for Rice Threshing

Source	Frequency	(%)
Personal Savings	93	93
Relatives	00	00
Friends	05	05
Commercial bank	00	00
Cooperative/Esusu	00	00
Money Lender	00	00
Agric bank	02	02
Total	100	100

Source: Field Survey Data, 2007

The above table presents the sources of funds used to finance rice threshing in the study area. It is evident from the table that most of the rice farmers/threshers financed their rice threshing through personal savings which accounted for 93%. Financial assistance or credit facilities were also obtained from friends and agricultural banks, which accounted for 5% and 2% respectively. They complained bitterly that they could not receive financial assistance from the government to finance their rice threshing operation. Also, financial institutions were not willing to offer them credit facilities due to lack of collateral. This issue was re –echoed during the workshop.

Table 3.2.5 Source of Labour

Sex	Frequency*	Percentage (%)
Family	59	59
Exchange	0	0
Hired	86	86

Source: Field Survey Data, 2007

*Multiple responses

The sources of labour available to the threshers are family, hired and exchanged labour. Hired labour constitutes the most important source of supply of labour in the study area as it accounted for 86% of the respondents. This is closely followed by family labour which accounted for 59%. On the average, the labour cost is ₦500/day. None of the rice farmers used exchange labour to thresh their rice. Usually, the amount paid for hired labour is estimated on the quantity of rice threshed (measured in bags) by the threshers. A situation may arise when the family labour is not able to cope with the volume of rice to thresh. Under this circumstance, farmers will be compelled to employ hired labour to thresh their rice. The amount of hired labour employed depends on the quantity of rice to thresh, local unemployment rate and wage levels.

Table 3.2.6 Distribution of Rice threshers by years of Threshing Experience

Years of Experience	Frequency	(%)
<1	0	0
1-5	23	23
6-10	30	30
>10	47	47
Total	100	100

Source: Field Survey Data, 2007

The above table shows that 23% of the rice farmers had 1-5 years of threshing experience while 30% of them had 6-10 years of experience. The distribution also shows that the rice farmers had considerable experience in rice threshing with most of them (47%) having above 10 years of experience.

Table 3.2.7 Motivation for Purchase and use of Thresher

Factor	Frequency*	(%)
Efficiency	21	21
Cleanness	21	21
Commercial	08	08
Drudgery reduction	21	21
Family Consumption	09	09
All	34	34

Source: Field Survey Data

*Multiple responses

The rice farmers were interviewed on the factors that will motivate them for the purchase of threshing machine. It is glaringly evident that 21% of the threshers/farmers expected that availability of threshing machine would ensure reduction in the drudgery experience in threshing, raise efficiency and ensure the production of clean rice. Majority (34%) opined that the provision of threshing machine will increase efficiency, reduce drudgery, increase family consumption, production of clean rice and increase the quantity that will be available for commercial purpose. The result indicated that 8% and 9% of the rice farmers/threshers submitted that the availability of rice threshing machine will make more rice available for commercial purpose and family consumption.

Table 3.2.8 Causes of Low/Poor Rice Threshing

Factor	No response	Not sig.	Lease sig.	Sig.	Very sig.	Most Sig.
Crop variety	0	15	4	10	22	49
Constant Machine Breakdown	93	0	5	1	1	0
Machine age	93	0	2	4	1	0
Bad machine Design	93	0	2	2	2	1
Moisture Content	0	0	0	10	40	50

Source: Field Survey Data, 2007

Table 3.2.8 indicates that two major factors –crop varieties and moisture contents are responsible for low/poor rice threshing among the rice farmers in the study area. The study revealed that 49% and 22% of the rice threshers submitted that the crop variety was most significant and very significant respectively in rice threshing. Similarly, all the respondents (100%) were of the opinion that the moisture content of rice was a major determinant of the quantity of rice threshed. When the grains are wet, threshers find it difficult to thresh than when they are dry. Also, 93% did not respond to other factors namely constant machine breakdown, machine age and bad machine. This corroborates the fact that the rice farmers had no threshing machine. The 7% of the respondents that responded to machine related issues were from research institutes and Universities where the machines are used for demonstration and training.

Table 3.2.9 Financial Commitment

Amount (#)	Frequency	(%)
10,000 – 50,000	26	26
51,000 – 100,000	32	32
101,000 – 150,000	9	9
151,000 – 200,000	3	3
201,000 – 350,000	18	18
>350,000	12	12
Total	100	100

Source: Field Survey Data, 2007

The financial commitment by majority of the rice threshing farmers, shows that 32% fall into #51,000 –#100,000 expenditure brackets. Also, 26% incurred expenses of #10,000 - #50,000 on rice threshing. The amount of average financial commitment was #200,000. This includes, among others the cost of labour, cost of transportation and purchase of bags.

Table 3.2.10 Varieties of Rice planted by Farmers

Variety	Frequency*	(%)
Nerica	44	44
ITA 150	32	32
Igbemo	10	10
Taraba	12	12
Faro	3	3
Wheatfour	14	14
Yerdaf	15	15
CP	14	14
Ofada	83	83

Source: Field Survey Data, 2007.

*Multiple responses

Table 3.2.10 shows the distribution of varieties of rice planted by farmers in the study area. It is revealed that 83% of the farmers planted Ofada while 44% planted Nerica. This is followed by ITA 150 which accounted for 32% of the respondents. The table further shows that Igbemo, Taraba, wheatfour Yerdaf and CP were all planted by almost equal number of respondents. The least planted variety was Varo (3%). It is noteworthy that Nerica, ITA 150 and Ofada were planted by farmers in Ogun state while in Igbemo Ekiti and Erin-Ijesha the varieties planted are Nerica, Igbemo, Taraba and Ofada. Others namely wheatfour, yerdaf, CP and varo were mostly planted in Kura-Kano.

Table 3.2.11 Income Distribution

Income (₦)	Frequency	(%)
≤ 100,000	37	37
101,000 – 500,000	49	49
501,000 – 900,000	5	05
≥900,000	9	09
Total	100	100

Source: Field survey Data, 2007

The annual income generated from the sale of rice by majority of rice farmers/thresher (49%) fall into #101,000 – #500,000 income bracket. The table further revealed that 37% also generated income of #100,000 or less. Only 5% obtained income of #501,000 - #900,000 while 9% generated #900,000 or more income level.

Table 3.2.12 Quantity of Rice Threshed (kg)

Quantity (kg)	Frequency	(%)
1-100	73	73
101 – 200	21	21
201 – 300	08	08
301 – 400	21	21
> 400	09	09
Total	100	100

Source: Field Survey Data, 2007

The table indicates that most of the rice farmers threshed rice quantity of 1-100 kg during the last production season. This is followed by 12%who threshed between 101-200 kg. A quantity of 301 – 400 kg and > 400kg accounted for 1% and 9% or the farmers respectively. The average quantity threshed was 300kg. This is considered small given the level of production of rice in the study area. It is believed that with the provision of threshing machines farmers will be able to thresh large quantity of rice. In the same vein, the average threshing capacity of farmers was 30kg/hr. This is also low when compared with the capacity of the threshing machine.

Table 3.2.13 Farm Size Distribution

Farm Size	Frequency	(%)
1-10	81	81
11-20	14	14
21-30	5	5
Total	100	100

Source: Field survey Data, 2007

The structure of farm holdings shows that the farm size ranged from 1 to 30 hectares with an average of 3 hectares. Most of the farmers (81%) had a farm size of 1-10. Also, 14%of the farmers cultivated as large as 11-20 hectares. Very few farmers (5%) had farm size of between 21-30 hectares.

Table 3.2.14 Assessment of Threshers Used or Seen by Farmers

Assessment	Frequency	(%)
Effective	8	8
Economical	8	8
Easy to maintain	8	8
No response	92	92

Source: Field Survey Data, 2007.

The respondents were requested to assess the available threshers. The available threshers were adjudged to be effective, economical and easy to maintain by 8% of the rice farmers/threshers who claimed to have seen them during demonstration by research institutes, Ogun State Agricultural Development Project (OGADEP) and West African Rice Development Agency (WARDA). However, 92% could not undertake any assessment since they had no access to rice threshing machine. This further corroborates the fact that there were no threshing machines in the study area.

3.3 Financial analysis

The profitability ratio were used to examine the cost and returns of rice threshing in the study area The analysis enables us to determine whether rice threshing is profitable in the study area or not. It equally helps to compare the advantage of using threshing machine over the manual threshing. The cost components include the cost of bag, cost of transportation and cost of labour. Bags are used by farmers to pack the rice before and after threshing. This constitutes 10% of the total cost incurred in rice threshing. Also 30% of the cost of rice threshing is spent on transportation. .Rice panicles are conveyed to the village after harvesting on bicycle and vehicles which attract high charges because of the bad roads. The rent of the threshing floor also accounted for 10% of the cost of threshing. Though most of the farmers use their personal house for threshing, they were asked on the amount which they would have paid if they had rented the building used. The miscellaneous consists of minor expenses such as purchase of brooms, sticks, thread and needles for sewing bags. The benefit indicators viz benefit cost ratio, rate of return and the gross margin were estimated as follows.

The Benefit Cost Ratio = TR/TC
Rate of returns = TC/TR.

Profit (Π) = TR- TC (#)

Where
TR = Total revenue (#)
TVC = Total variable cost (#)

Table 3.3.1 Cost and Return Analysis Profile per kilogramme

Item	Amount (#)	% of total cost
Bag	4.50	10
Transportation	13.50	30
Hired labour	18.00	40
Rent	4.50	10
Miscellaneous	4.50	10
Total cost	45.00	_
Total return	60.00	_
Profit	15.00	_

Source: Computed from Field Survey Data, 2007

The average total cost per kilogram bag of rice threshed was #45.00. While the average total revenue per kilogram of rice threshed was #60.00. This gives a profit of #15 per kilogram. The analysis therefore shows that rice threshing is profitable in the area. The considerable level of profitability of rice threshing in the study area is further corroborated by the benefit cost ratio of 1.19.The rate of returns in rice threshing in the study area was 36%. This shows that for every #1.00 invested in rice threshing there will be a return of #1.36 or 36kobo gain by the farmer.

3.4 Correlation analysis

Table 3.4.1 Correlation between quantity threshed, income, quantity of Labour used and labour cost

Dependent Variable	Test Variables	r- value (coefficient)	Significance
Quantity of rice threshed (Kilogramme)	Income	0.173	*
	Labour cost	0.090	NS
	Labour used	-0.082	NS

Source : Computed from Field Survey Data,2007

NS= Variable not significant * = Variable significant at 5% level

The correlation analysis was undertaken to see how the quantity of rice threshed will vary with the increase or decrease in the amount paid for threshing, income and the quantity of labour used. The analysis revealed that a significant and positive correlation exist between income and the quantity of rice threshed. This implies that more rice will be threshed with increase in the income of the farmers. This is not surprising as farmers will be able to hire and pay more workers to thresh their rice. Similarly, there is a positive correlation between the quantity of rice threshed and the amount charged for threshing. This is so because workers will be encouraged to thresh more with the assurance of receiving higher remuneration. However, a negative correlation exists between the quantity of rice threshed and the quantity of labour employed for threshing. This implies that as the number of employees increases, less quantity of rice will be threshed. This may not be unconnected with the fact that as more workers are engaged, more funds will be required to pay for the small quantity of rice threshed.

The correlation coefficient of income was significant at 5% level of significant. The implication is that there is 95% level of assurance of taken the right decision with 5% error.

4.0 REVIEW OF RICE THRESHING MACHINES WITHIN AND OUTSIDE NIGERIA

4.1 Threshing Operation: Threshing operation involves the detachment of paddy kernels or grain from the panicle. Depending on the influence of agronomic, economic and social factors, threshing is done in different ways. It can be achieved by rubbing action, impact; and stripping. The rubbing action occurs when paddy is threshed by trampling by humans, animals or tractors. The impact method is the most popular method of threshing paddy. Most mechanical threshers primarily igar e the impact principle for threshing, although some stripping action is also involved. The difficulty of the process depends on the varieties grown, and on the moisture content and the degree of maturity of the grain.

Paddy threshers may either be hold-on or throw-in type of feeding the unthreshed paddy. In the hold-on type, paddy straws are held stationary while threshing is done by the impact on the particle from cylinder bars spikes or wire loops. In the throw-in type of machines, whole paddy stalks are fed into the machine and a major portion of the grain is threshed by the initial impact of the bars or spikes on the cylinder. The initial impact also accelerates the straw and further threshing is accomplished as the moving particles hit the bar and the concave. The third type, stripping has also been used in paddy threshing. Some impulsive stripping occurs ordinarily with impact threshing in conventional threshing cylinders. In the throw-in type of thresher, large amounts of straw pass through the machine. Some designs igar e straw walkers to initially separate the loose grain from the bulk of straw and chaff.

Whatever the system used, it is very important that threshing be done with care. Otherwise, these operations can cause breakage of the grains or protective husks thus reducing the product's quality and fostering subsequent losses from the action of insects and moulds. Transportation of the product from the field to the threshing place must also be handled with special care, since it can bring about severe losses.

4.1.1 Manual threshing: One of the simplest systems for threshing rice is to pick up the sheaf of rice and strike or beat the panicles against a hard surface such as a tub, threshing board or rack; or beating the sheaves spread out on a threshing-floor with a flail or a stick or tramples it underfoot. The threshing-floors on which the sheaves are spread must have a hard, clean surface. The pedal-operated thresher consists of a rotating drum with wire loops which strip the grains from the panicles when fed by hand. It can be operated by women and can be used in hilly or terraced areas because of its portability. By using one of these methods of hand-threshing, a worker can obtain 15 to 40 kg of product per hour.

4.1.2 Threshing with animals or vehicles: If draught animals are available and there are large quantities of rice, threshing can be done by driving the animals (harnessed, in that case, to threshing devices) over a layer of sheaves about 30 cm thick. This operation, which is also called "treading out", can equally well be accomplished with vehicles. This method of threshing rice is adopted in some Asian countries, using a tractor for power instead of draught animals. Paddy is obtained by running the tractor twice over sheaves of rice that are spread in layers on a circular threshing-floor 15-18 m in diameter. The sheaves must be turned over between the two passages of the tractor. If operations are alternated between two contiguous threshing-floors, yields of about 640 kg/h can be obtained.

4.1.3 Threshing with hand-driven machines: Machines driven by a manual device or a pedal are often used to improve yields and working conditions during threshing. By means of the handle or pedal, a big drum fitted with metal rings or teeth is made to rotate. The rice is threshed by hand-holding the sheaves and pressing the panicles against the rotating drum. The

speed of the threshing-drum must be kept at about 300 revolutions per minute (rpm). The hand-held sheaves must all be of the same length with the panicles all laid in the same direction, and the grains must be very ripe and dry. The machine must be continuously and regularly fed, but without introducing excessive quantities of product. If the paddy obtained contains too many unthreshed panicles and plant residues, a second threshing must be followed by an effective cleaning of the product. Use of these threshing machines may require two or three workers. Depending on the type of machine, the skill of the workers and organization of the work, yields can be estimated at a maximum of 100 kg/h.

4.1.4 Threshing with motorized equipment: Although they are gradually being replaced by combine-harvesters, motorized threshing-machines still have an important place in the post-harvest production process, especially for their convertibility. By the simple replacement of a few accessories and the appropriate changes in settings, these machines can treat different kinds of grain (e.g. rice, maize, sorghum, beans, sunflowers, wheat, soybeans, etc.). Equipped with a rotating threshing-drum (with beaters or teeth) and a stationary counter-thresher, these machines often have devices to shake out the straw and to clean and bag the Brain.Whether self-propelled or tractor-drawn, these threshers are often mounted on rubbertyred wheels for easy movement to the field. The use of motorized threshers may require two or three workers. Yields depend on the type of machine, the nature and maturity of the grain, the skill of the workers and organization of the work, and they can vary from 100 to 5 000 kg/h

4.1.5 General Features of Threshers: Most, if not all powered paddy threshers are equipped with one of the following types of cylinder and concave arrangement: (a) rasp bar with concave (b) spike tooth and concave (c) wire loop with concave (d) wire loop without concave. Tests by the International Rice Research Institute, IRRI indicated that the spike-tooth cylinders performed well both with the hold-on and the throw-in methods of feeding and its threshing quality is less affected by changes in cylinder speed. In the axial-flow thresher, the harvested crop is fed at one end of the cylinder/concave and conveyed by rotary action on the spiral ribs to the other end while being threshed and separated at the concave. Paddles at the exit end throw out the straw and the grain is collected at the bottom of the concave after passing through a screen cleaner. Several versions of the original IRRI design of the axial-flow thresher have been developed in most countries to suit the local requirements of capacity and crop conditions. Thus, there are small-sized portable ones and tractor PTO-powered and engine-powered ones. Many custom operators in Asia use the axial flow threshers to satisfy the threshing and grain cleaning requirements of rice farmers.

4.2 Mechanics of Grain Threshing

The process of mechanical cowpea threshing involves the interaction of machine and crop parameters for the separation of the seed from the pod. Threshing is carried out between a stationary concave and a rotating cylinder. Different configurations of threshing devices have been used. The two types generally employed in present day stationary threshers and combines are rasp bar cylinders and spike tooth cylinders. The latter are used almost exclusively in pea threshers. Also, rubber covered flat bars have been employed on cylinders and concaves for threshing small seed legumes such as crimson clover, giving less damage and less unthreshed loss than the conventional spikes.

High-speed motion pictures have shown that the main threshing effect in peas or cereals results from the impact of the cylinder bars at high speeds with the pods. The primary function of the concave appears to be that of holding and presenting the material to the cylinder bar for repeated impaction. A spike tooth has been shown to have a more positive

feeding action than a rasp bar cylinder does not plug easily, and requires less power. However, rasp bar cylinders are readily adaptable to a wide variety of crop conditions; are easy to adjust and maintain, and relatively single and durable.

Various parameters are in use for evaluating the performance of threshers and determining and retaining the quality of the through-put. The parameters include; threshing effectiveness, grain damage, sieve effectiveness, cleaning efficiency and seed loss. Studies have shown that threshing effectiveness is related to the peripheral speed of the cylinder, the cylinder-concave clearance, the number of rows of spikes, the type of crop, the conditions of the crop (in terms of the moisture content and stage of maturity), and the rate at which material is fed into the cylinder.

Cylinder speed is the most important machine operating parameter that affects seed damage. Increasing the speed substantially increases seed damage. Reducing the cylinder concave clearance tends to increase seed damage but the effects are generally rather small in comparison with the effect of increasing cylinder speed. Susceptibility to damage varies greatly among crops.

Threshing trials conducted on soyabean and cowpea pods in a rasp bar cylinder thresher showed that visible grain damage was greater in cowpea for the same cylinder speed and concave clearance, and this affected seed germination. The seeds of some dicotyledonous plants such as beans may be damaged excessively at low cylinder speeds, whereas those of non dicotyledons can withstand very high cylinder speeds without appreciable damage. It has been asserted in literature that mechanically damaged grains do not keep well in storage and are prone to fungal and bacterial infections when stored. The field emergence of such damaged seeds is generally poor.

4.3 LIST AND DESCRIPTION OF THRESHERS MANUFACTURED OR USED IN NIGERIA (For Drawings and Photos – see attached document)

S/N	Make/Type of Thresher	Design Specification	Capacity/ Efficiency	Contact Information on Source /Manufacturer / Representatives in Nig	Remarks (Availabilty /Appropriatess /Cost
1	IITA/WARDA Plot Threher	It has the following components – the frame, hopper, the threshing unit, the blower and the collecting port. Driven by 5hp Petrol Engine	50kg/h/ 98.8%	Imported from England. Availalable at IITA/WARDA, Ibadan	Satisfactorily There is need to increase the size of the hopper and introduction of a bigger outlet. Cost - ₦120,000
2	IITA/WARDA Multi-crop Threher	It combines threshing with cleaning. Driven by 7.5hp Petrol Engine	100kg/h 54.5%	Imported from England. Availalable at IITA/WARDA, Ibadan	Not Satisfactory with rice. ₦ 150,000
3	IAR&T Multi crop Thresher	The concave has a rectangular opening of 60 x 30 mm size and cylinder concave clearance is 19 mm. Three rows of revolve stammer saws are provided in cleaning shoe.	250kg/h/ 94.2%	Federal College of Agriculture, IAR&T, Moor-Plantation, Ibadan	Thresher was found technically suitable. Cost:#150,000
4	FGN Pedal Operated Thresher	The thresher consists of a seed stripping disc which is rotated in vertical plane by a foot operated wheel crank mechanism at 700 to 1100 rpm. Stripper disc is made of mild steel with spikes of 5 mm diameter and 10 to 20 mm length. Spikes are radially welded on disc.	50kg/h/ 78.9%	Supplied by the Federal Government of Nigeria. Available at NCAM – Illorin and NCRI Badeggi	The chamber has to be completely round instead of the present half – size to prevent loss of grain. Cost - #80,000
5	NCAM Multi-crop Thresher	The machine consists of an hopper, the threshing unit, blower and frame. The threshing speed is from 850 – 1300rpm depending on the crop and concave clearance. The overall dimension is 90 x 70 x 14cm3. Power source is petrol or electicity.	200 – 550kg/h. ;96 – 100%	National Centre for Agricultural Mechanization (NCAM) Km 20, Ilorin – Lokoja Highway, Idofian.email – ncam@skannet.com	Cost -#150,000
6	FUT Multicrop Thresher	Power source-5 hp electric motor Threshing cylinder – Spike tooth; length of spikes adjustable from 50 to 70 mm	250 – 300kg/h; 88.5%	Developed at the Federal University of Technology, Minna.	Blower speed is kept at 800 rpm to achieve high cleaning efficiency. Cost -#150,000
8	Vortex Rice	Driven by 5hp engine	500kg/h;	Imported from Holland.	Cost -#400,000

	Fan		82.3%	Modified by Annes Agro Processing Industries Ltd., 17 Gumming Road, Abaliki, Ebonyi State. Email – atumaapilrice @yahoo.com	
9	Manual Rice Thresher		100 – 150kg/h; 83.4%	Songhai Farm, Porto Novo, Republic of Benin. Email: songhai@Songhai.org	Cost: #70,000 Satisfactory
10	Senegalese – ASI Motorised Thresher /Cleaner	Spike tooth threshing cylinder is similar to conventional grain thresher but the number of spikes is half of grain threshers.	7tonnes per day. Grain – straw separation rate is 95 – 98%.	Senegalese River Valley Development Agency (SAED), Senegal. Email-warda@cgiar.org	Cost: USS5000 Performance Satisfactory for large scale farmers
11	PAU Groundnut Thresher	The unit consists of feed trough, threshing cylinder, concave, oscillating rack, paddle type centrifugal blower, cleaning shoe with stammer saws, set of sieves, auger convey and transport wheels.	300kg/h at 450 m/min cylinder speed.	PAU, Ludhiana, India	Only dry crop is recommended to be threshed with the thresher.
12	TNAU Groundnut Thresher	It consists of feed hopper, flow-through type spike tooth threshing cylinder, concave, haulms remover, oscillating sieves, blower and power transmission system	105 kg/h at 240 rpm threshing speed. Threshing efficiency was 96%.	Developed at AICRP on Farm Implements and machinery, Tamil Nadu Agricultural University, Coimbatore, India	Percentage of shelled pods was 3.6 to 6.1 percent.
13	GBPUAT, Small Soybean Thresher	Design was based on threshing system of conventional combine harvester.	The unit had a capacity of 200 to 300 kg/h grain	Developed at GBPUAT, Pantnagar, India.	Because of elaborate design features and high cost the machines could not be commercialized.
14	Corn and Wheat Thresher	Operated by 15 hp electric motor or tractor.	800 kg/h	Hadejia River Basin Authoruty, Kadawa, Kano	Not okay for small rice farmers..
15	CIAE Multicrop Thresher	This thresher incorporates the desirable features of wheat thresher and IRRI axial flow thresher for paddy. It consists of a feed tray, spike tooth cylinder, straw thrower, blower and cleaning sieves.	250 – 300 kg/h; Threshing speed – 14m/s. Threshing efficiency /cleaning – 99.1/96.9%	Developed at the Central Institute for Agricultural Engineering, CIAE, Bhopal M.P. India	The thresher has been designed to thresh rice by operating cylinder at lower speed. Very effective.
16	APAU Sunflower Threshing	A rectangular shaped bench made of MS angle and top covered with	output is 3-4 kg/h.	Developed at AICRP on Farm Implements and Machinery, APAU,	Seed damage is low and unit costs about #20,000

	Bench	expanded metal screen		Hyderabad	
17	APAU-All Crop Thresher	The thresher consists of a rasp bar type threshing cylinder, concave, feeding chute and a cover. Different crops can be threshed by adjusting cylinder concave clearance.	34 kg/h at a seed moisture content of 12.8 to 13.5 percent.	Developed at AICRP on Farm Implements and Machinery, APAU, Hyderabad	The machine was evaluated for threshing of safflower Output was low due to low yield and bulkiness of crop. .
18	Wire loop thresher	Threshing speed is 800rpm	450 to 600	NCRI, Badeggi, Niger State	Concave and top sieve can be changed to suit different sizes of seed.
19	MPKV Phule Sunflower Thresher (Pedal Operated)	It consists of a threshing wheel, top cover, cleaning unit, seed collecting tray and power transmission unit (Fig	output capacity is 37 kg/h; 91%	MPKV, Pune centre of AICRP on FIM,	Can be improved on
20	Swaraji Multicrop Thresher	The thresher consists of a closed threshing cylinder, concave, cylinder casing, cleaning system, feeding chute and frame.	360 to 810 kg/h; 90%	Hadejia River Basin Authority, Kura – Kano	Can be improved on
21	Soybean Thresher	N.A	1ton/day	Industrial Machinery Ltd, 75 Dagbola Road, Lagos	N.A
22	Multi – Crop Thresher	Made of mild steel materials. Overall length, breadth, and height are 1180, 725 and 1500mm.	1ton/day	Agrotech Machine Tool and Equipment (Nig) Ltd., (Amtel) Old Aport Rd, Ray Field, Jos.	Use for threshing Most grains.
23	Yanmar Wire loop Thresher	It consists of concave chamber, wire loop drum and cleaning unit	500kg/h	OLAM Nig. Ltd., Agro millers, Uni. Agric. Rd., Makurdi,	Not efficient with rice
24	IDRC/GHANA Pedal Thresher	It consists of threshing chamber, drum, pedal and gearing system.	45kg/h	Technology Consultancy Centre, Univ. of Sci and Tech, Kumasi, Ghana	Performed effectively on panicles.

5.0 PROPOSED PROTOTYPE SMALL RICE THRESHERS

Based on the capacities, efficiency and assessment of existing rice threshers in Research Centres/Universities, local fabricators and some organization within and outside Nigeria as well as farmers' evaluation, this study is recommending three prototype small threshers that are pedal and petrol engine driven. The improved version of the pedal operated thresher supplied by the Federal Government of Nigeria to NCAM, Ilorin and NCRI, Badeggi will be good for those with farm hectrage of less than 2. For threshing freshly harvested rice at very high moisture content, the IITA/WARDA small plot spike-tooth thresher which has a threshing capacity of about 100kg/h will be appropriate provided some little modifications in the area of capacity and mobility are carried out while the multi-crop thresher of the Institute of Agricultural Research and Training (IAR&T) Ibadan with a capacity of about 250kg/h is recommended for those with farm hectarage of more than 5ha. The recommended models will thresh rice panicles harvested with or without straws.

5.1 MODEL 1 – NCAM Pedal Operated Rice Thresher (50kg/h)

Model 1 is a pedal operated rice thresher that can be used on an household farm scale of less than 3hectares. The thresher consists of a seed stripping disc which is rotated in vertical plane by a foot operated wheel crank mechanism at 700 to 1100 rpm. Stripper disc is made of mild steel with spikes of 5 mm diameter and 10 to 20 mm length. Spikes are radially welded on disc surface. Flower heads are brought in contact with stripping disc and threshed material is collected and cleaned separately. Output of the machine is 50 kg/h (Plate 5.1). The autoCAD drawing of the improved version is in Appendix A3.1.

Plate 5.1: NCAM Pedal Operated Thresher

5.2 MODEL 2 – IITA/WARDA Plot Thresher – (100kg/h)

This is a thresher that can be used on a cottage farm scale of 3 – 10hectares. The major advantage of this type of threshing machine is that it is easier to clean thereby allowing different crop varieties to be threshed without contamination. It is light in weight and can be

easily transported to field. Output of the machine is about 100 kg/h (Plate 5.2). The autoCAD drawing of the improved version is in Appendix A3.2.

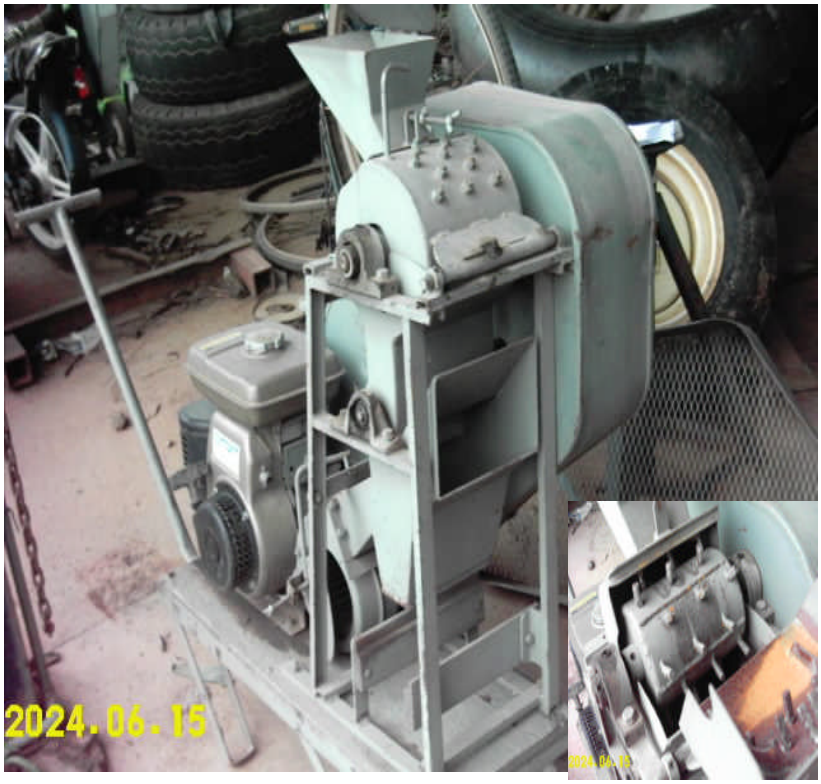


Plate 5.2: IITA/WARDA Plot Thresher (In set – The multi – spike drum)

Composition

It consists of fabricated metal component and a prime mover unit. The prime mover unit is usually a heat engine type since electricity may not be readily available in most trial fields.

Heat engine

The heat engine used for operating the small thresher has the following features:

- It is a four (4) stroke cycle
- Internkal combustion
- Spark Ignition
- One (1) cylinder
- Air cooled
- Three (3) house power engine.

Plate 5.3 Petrol Engine

Transmission of Motion

The motion is being transmitted from the engine to the machine through belt and pulley system.There is a pulley having four grooves of varying diameters attached to the engine known as the driver pulley which transmits drive with the aid of V-belt to another pulley attached to the rotary drum, known as driven pulley.

The speed at which the engine is to be operating is facilitated by selecting appropriate driver and driven pulley diameter rations.

Another groove on the driver pulley attached to the engine, transmits drive through V-belt, to a big pulley of about eight inches diameters attached to the agitator and another pulley attached to the blower.

Blower

The blower consists of metal fins folded in circular form. IT has a pulley attached to a small shaft connected to the base of the metal fins which takes up the motion through the V-belt from the engine and agitator. There is an opening at the blower housing for the admission of air from the atmosphere, the opening and closing of which determines the amount of air that is admitted into the blower housing.

Plate 5.4: Blowing Mechanism

The cover of the blower housing is activated by a spring loaded screw which could be adjusted to close or open the cover for the admission of air. The engine is in constant

engagement with the machine. It does nor rely on clutch assembly to facilitate engagement procedure nor does it require any lever to engage the engine with the machine, but the speed at which the machine is operating could be varied or controlled by controlling the speed of the engine.

Rotary Drum

The rotary drum consists of folded metal sheet in cylindrical form. It has round metal spikes welded to the drum at regular distance. It is supported at both sizes on pillow bearings which are bolted to the machine frames. The operation of the belt and pulley brings about the rotary motion of the drum which is housed in between the semi-circular drum cover and the threshing chamber.

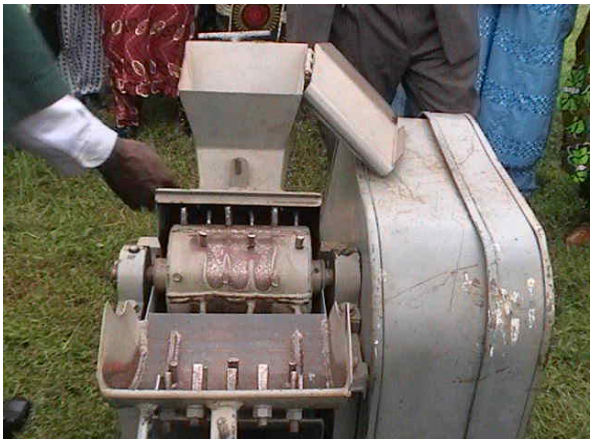


Plate 5.5: The Rotary Drum

The semi-circular drum cover has round metal spikes internally and are arranged to be in alternate position with the spikes on the drum. There is a short plate welded to the top of the semi-circular drum cover, having a threaded hole through which a long screw passes to the threshing chamber which serves as adjuster. This adjuster facilitates correct and accurate clearance or space in between the drum and the cover to prevent gains damage through breakage.

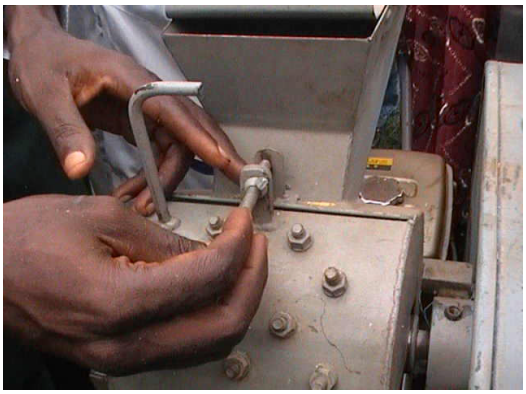


Plate 5.6: Drum – Concave Adjuster

Operation

The operator stands on the ground by the side of the machine. He holds a sizeable quantity of rice plant at the stalks and lowers the grain part through the inlet chamber to the drum. After the grain has been threshed off the plant he drops the stalks on the floor and the grain moves down to the agitator and down to the channel below where the grains are collected in a container.

Maintenance and safety procedure

- At the end of every threshing operations of a particular variety for rice, the machine should be thoroughly cleaned so that it does not contaminate other subsequent variety to be threshed.
- All bearings must be oiled or greased properly at regular intervals.
- Refueling of the engine must be carried out after the engine has been switched off and allowed to cool down for some minutes.
- B-belts should be periodically inspected for cracks and cuts and they should be immediately replaced as soon as any deformation is notices

5.3 MODEL 3 – IAR&T MULTI – CROP THRESHER – (250kg/h)

The multi – crop thresher built at the Fedral College of Agriculture, IAR&T, Ibadan Agricultural Engineering Technology was demonstrated to the farmers and found to be efficient with rice (Section 4.3). It can be used for threshing rice cultivated on small scale farmland of 10 – 25hectares and can thresh up to 250kilogram's of rice per hour. It is economical, faster and efficient in operation. Plate 5.7 shows the side view of the thresher. It has the following components units: the frame, hopper, the threshing unit, the sieve, the reciprocating mechanism, the blower and the collecting port. These are briefly described below.

Plate 5.7: IAR&T Multi crop Thresher

Frame

The frame was constructed using a 40 mm by 40 mm angle iron for stability and rigidity. The frame structure was dimensioned 1340mm long, 700 mm high and 400 mm wide. The engine seat and housing for threshing cylinders were bolted on the frame.

Hopper

The requirement of hopper assembly was to introduce rice panicle into the threshing cylinder, prevent shattering of grains and clogging. The hopper conveyed rice head in horizontal orientation to the threshing cylinder. It was inclined 30o to the horizontal so that the head flowed on its own to the threshing chamber. Hopper dimensions were obtained from rice head so that the head can be fed horizontally without obstruction. A hood made of tarpaulin was placed at the hopper opening to reduce shattering losses during threshing. The hopper was constructed from a 16 -gauge (1.6 mm) sheet metal. It forms a frustum, which tapers at the threshing cylinder. It is dimensioned 270 by 520 mm at the inlet and 130 by 370 mm at the threshing cylinder side. The height of the hopper is 460mm.

Threshing unit

Threshing unit carried out actual removal of grains from the rice heads. It comprised threshing cylinder and concave. The cylinder is a spike bar type consisting of a cylinder 140 mm diameter with length of 320-mm. 6 numbers 20 mm by 20 mm angle iron were inverted and welded equi -distant on the outside diameter of the cylinder to give an overall cylinder diameter of 175 mm. A 600 mm shaft diameter 25 mm, passed through the center of the cylinder. Spike bar combines the striking action of a spike tooth and rubbing and friction action of the rasp bar. It has positive feeding action, which portends an increase in capacity.

Concave was formed into a basket using flat bars 4 mm thick and 10 mm diameter iron rods. Concave had a semicircular diameter of 310 mm .The threshing cylinder concave was the same and fixed throughout the test at 15 mm at the inlet, 3 mm at the middle and 7 mm at the outlet.

The sieve scalped, removing larger material particles and trash out. There were two sieves, arranged horizontally and carried in separate racks one above the other reciprocating as a unit. The sieve racks have adjustable inclinations. There are four (4) supporting hangers of the sieve carrier assembly. The reciprocating motion of sieves is transmitted from an eccentric by a pair of connecting rod at each side of the machine. The upper and the lower sieves remove the larger than grain constituents. Grains and chaff passed through
sieve holes cross flow the air current, which removed lighter than grain particles. Distance ,between the sieves was 150 mm. Sieve constructed from 16 gauge (1.6 mm) metal sheet, was dimensioned 935 mm long and 300 mm wide. Sieve hole diameters are 6.5 mm
and are readily removable whenever it is necessary.

Reciprocating mechanism

Quick return mechanism was used to translate rotary motion of engine to a reciprocating motion of sieves. The reciprocating mechanism was attached to the lower sieve having the crank radius of the rotating arm 50mm. The stroke of reciprocation was 100 mm. The length of the connecting rod was 575 mm. The reciprocating mechanism exerts force on the particle in the horizontal and vertical directions.

Blower

A centrifugal blower driven via pulley and V - belt by the prime mover generated air stream. It blows air stream in between the two sieves with air current aiding in lifting up straw and stalk on the upper sieve. The housing was spiral shaped with a major diameter of 460 mm and minor diameter 350mm while the width was 300 mm. The inner diameter for air inlet was 220 mm with provision for regulation of the air opening through gates. The throat of the blower housing was 150 mm. There were 4 straight paddle blades dimensioned 160 by 120 mm bolted to a 25 mm diameter shaft. This type of blade is capable of operating satisfactorily in a dusty environment because of the self-cleaning characteristics.

Grain collector

The cleaned grain that passed the sieves was collected for analysis. The grain collector is 1000 mm long divided into eight compartments of equal distances of 110 mm each as done for alfalfa. Grains in each compartment were collected separately for analysis.

Principle of Operation of the Thresher

Rice panicles were fed manually into the hopper and flowed under gravity to threshing chamber where the impact of the revolving threshing cylinder threshed the grain out of the head. Grains were detached from the panicles by a combination of stripping, rubbing and impact action. This action involved application of tensile, compressive, bending and twisting forces and their combination on the panicle. After contacting the threshing cylinder, the straw and loose kernels accelerate round the concave at different rates due to the difference in the coefficient of restitution of straw and grains.

Grain that was freed falls through the concave on the reciprocating upper sieve. Threshed, unthreshed, partially threshed heads and some grains fell on the upper sieve. As the sieves reciprocated there was horizontal and vertical displacement, which moves straw to the front of the thresher to be discharged. When the blower impeller rotates, the blades at its periphery throw off air centrifugally in a direction following the rotation. Air thrown off into the scroll is forced out of the outlet as more and more left the blades. At the same time, air is sucked into the inlet to replace that, which was discharged. Air entered axially, turns at right angles through the blades, and is discharged radially. Air stream helped to disperse grain and straw allowed grain to pass through upper sieve hole to lower sieve. As grain and chaff passed across air stream, the lighter materials are blown off, while clean grain was collected in collector compartments.

Experimental procedures

One kilogram of crop samples were taken randomly from heap of harvested rice panicles and fed into the hopper manually. Feeding time, cylinder speed, blower speed and sieve reciprocation speed and frequency were taken and recorded. The feed rate was calculated in Kg/hr. Grain output was expressed in Kg/hr by recording the time taken in the threshing operation and weight of grain recovered. Unthreshed tailings were separated from the straw by manually threshing them and grains collected were weighed after cleaning manually to determine the threshing efficiency. Threshing and cleaning experiment was conducted at average rice panicle moisture content of 6% (wb) with three replications each.

The feed rate of sieve was determined by the output from the threshing cylinder cum concave. The threshing process product became the input in cleaning process. Cleaned grains in each collector compartment were collected in a transparent nylon and labeled to be analyzed. Each sample collected was weighed, and cleaned. The weight of cleaned grain was recorded for each compartment. The difference gave the weight of impurities. This was used to determine cleaning efficiency. Chaff blown out of the machine was collected in a black nylon bag and labeled accordingly. The sample was weighed and cleaned to separate the grains inside. The cleaned grain separated was used to determine the cleaning loss. The cleaning parameter represented by the combination of air speed of 5.00 m/s, sieve frequency 6 oscillations /sec, and feed rate 250kg/h gave cleaning efficiency of 98.32 %.

5.4 CAPACITY, COST AND PAYBACK PERIOD OF THRESHING MACHINES

Table 3.3.2 Capacity, cost and pay back period of recommended threshing machines

Thresher	Capacity	Cost	Amount saved daily	Payback period
NCAM-Pedal operated	50kg/hr	₦ 80,000	₦833.30	4Months
IITA/WARDA	100kg/h	₦ 120,000	₦1666.67	4Months
IAR&T multi crop	250kg/h	₦150,000	₦4166.67	3 Months
Average	133.33kg/h	₦116,666.67	₦ 2077.78	4Months

Source: Compiled From Secondary Data, 2007

The above table was prepared to assess the capacity of recommended threshing machines available in various institutions, examine the cost and determine how long it will take a farmer to recover the purchase cost in line with the term of reference. Also, it provides the opportunity to see the advantage of using threshing machines over the manual threshing. It is evident that the IAR&T threshing machine had the highest capacity of 250kg/hr. This is followed by IITA/WARDA with capacity of 1000kg/hr.The least is the Pedal operated having a capacity of threshing 50kg//hr. On the average the three threshing machines under consideration had threshing capacity of 133.33kg/h with 103.33kg/h above the capacity for manual threshing. This therefore justifies the need for the provision of rice threshing machine for the rice farmers.

For instance, using the IITA/WARDA which has a capacity of 100kg/hr, a farmer is expected to save a sun of ₦ 1666.67/day and pay back the ₦120,000 after 4months if he operates the machine 8 hours a day. The determination is based on the average capacity of 30kg/hr for manual threshing labour cost of ₦500 00 per day .Therefore, if ₦500,00 is saved for threshing an average of 240 (30×8)kilogramme in a day, the threshing of 800kg will generate a savings of ₦ 1666.67. The table revealed that an average capacity of 133.33kg/h can be achieved with a threshing machine of ₦116,666.67 having a pay back period of 4months

Mathematically, the pay back periods for the three threshing machines were determined as follows.

Average capacity for manual threshing=30kg/hr
Average quantity threshed daily (30 x8*) = 240kg
Average cost of labour per day = ₦ 500
* A daily work is taken to be 8 hours.

$$\text{Amount saved daily} = \frac{ALC}{AQM} \times AQT$$

Where:

ALC= Average labour cost per day
AQM= Average quantity threshed manually daily
AQT = Average quantity threshed by the thresher daily

$$\text{Number of days required to meet the purchase cost} = \frac{\text{Total cost threshing machine (₦)}}{\text{Amounts saved daily (₦)}}$$

NCAM PEDAL OPERATED THRESHER

Capacity = 50kg/hr
Expected quantity threshed per day = 50x8 =400kg

$$\text{Amount saved daily} = \frac{500 \times 400}{240} = ₦833.33$$

Number of Days required to pay back = ₦80,000 = 96 Days
₦833.33

Number of months = 96 = 3months+1 month =4 months.
30
One month is added to allow for the maintenance of the threshing machine.

IITA/WARDA PLOT THRESHER
Capacity = 100kg/hr
Expected quantity threshed per day = 100x8 =800kg
Amount saved daily= 500 x 400 = ₦1666.67
240
Number of Days required to pay back = ₦120,000 = 72 Days
₦166.67
Number of months = 72 = 3 months+1 month = 4 months.
30
One month is added to allow for the maintenance of the threshing machine.

IAR &T MULTI-CROP THRESHER
Capacity = 250kg/hr
Expected quantity threshed per day = 250x8 =2000kg

Amount saved daily= 500 x 2000 = ₦4166.67
240
Number of Days required to pay back = ₦ 150,000 = 35Days
₦4166.67
Number of months = 35= 2months+1 month =3months
30
One month is added to allow for the maintenance of the threshing machine.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The study has examined the rice threshing activities in Ofada farming communities of Ogun State, Erin-Ijesha in Osun State, Igbemo in Ekiti State, Kura – Kano, Abakaliki in Ebonyi State and Makurdi in Benue State..Efforts were also made to assess the various threshing machines available in Research Centres, Universities and Agro – Allied Organizations within and outside the country. From the study, it can be concluded that:

- The age distribution indicates that rice production is dominated by married farmers who are still economically and physically active with the mean age of 45 years.

- Rice threshing did not constitute any health hazard to the farmers despite the null activities of the extension agents to give necessary training on effective rice threshing to the rice farmers.

- The average quantity of rice threshed by rice farmers during the production season under consideration was 300kilogamme while the manual threshing capacity was 30kilogramme per hour.

- Performance of financial analysis of rice threshing shows that rice threshing is profitable in the study area.

- The provision of affordable threshing machine will reduce drudgery, increase efficiency in rice threshing, quantity of rice threshed and the level of profitability.

- The quantity of rice threshed can also be increased with increase in the income of rice farmers (to meet the financial requirement for purchase of threshing machines) and reduction in the labour cost.

6.2 POLICY RECOMMENDATIONS

Following the findings of the study and the interaction with farmers during the workshop, the recommendations are made:

- A locally made multipurpose thresher as demonstrated by IAR &T, Federal College of Agriculture, Ibadan should be designed for rice threshing. The capacity is 250kg/hr and the cost is ₦ 150,000. It can be operated by 5 horse power generator.
- The multispike threshing machine, demonstrated by IITA/WARDA which has a capacity of 30-40 kg/hr should be made available for threshing in the study area. The multipurpose thresher is of high interest to most of the rice farmers. It is an imported machine which costs #12000.The cost can be reduced if it is fabricated locally. The feeder should be expanded to take large quantity of straw at a time. Similarly, the receptor should be expanded to take large quantity of threshed rice. Jute bags should be used to collect the rice paddy the outlet should be designed to in such a way that the chaff , stone and the paddy will to come out through different outlets to prevent any loss of grain or paddy.
- Financial institutions should be encouraged to provide financial assistance to rice farmers at affordable interest rate. This will enable them to purchase rice threshing machines and meet other financial obligation in respect of rice threshing.

- Another method of making threshers available to farmers is to sell directly to farmers association who will then rent them to farmers in exchange for a supply of rice.
- Demonstration of the developed appropriate threshers in the Ofada and Kura-Kano communities should be carried out.
- Evaluations of the machinery should be undertaken in conjunction with RIFAN, this will allow immediate contact with farmers.
- Training of fabricators to build, sell and provide parts for the selected/developed threshers.
- A threshing house with a solid threshing floor should be built in the study area.
- Environmental impact assessment of rice threshing should be carried out in the study area.

APPENDIX

A1. NAMES AND CONTACT INFORMATION OF KEY INFORMANTS DURING FARMERS EVALUATIONS AND INTERRACTIONS

A1.1 OFADA RICE THRESHING COMMUNITY

S/No	State/LGA	Name of farmer/Primary Contact	Address/location Phone No	Type of /Make/Age Machine	Source of Machine	Type of Service/ Position	Remark/Observation/Comment
1.	Ogun / Obafemi-Owode	Mr. Sikiru Popoola	Lufoko	No machine			-Planted Ofada, Nerica and ITA 150. -No thresher. -No formal training on rice threshing.
2.	,, ,,	Mrs. Esther Popoola	Lufoko	,,			-No thresher. -No formal education. -Had 3 acres of rice farm.
3.	,, ,,	Mr. Dairo	Lufoko	,,			- No thresher. - No formal education.
4.	,, ,,	Mr. Kamilu Rafiu	Lufoko	,,			-No formal education. -No thresher. -Had 1 acre of rice farm. -Planted Ofada and ITA 150.
5.	,, ,,	Mrs. Titilayo Ayinla	Lufoko	,,			-No formal education. -No thresher.
6.	,, ,,	Mrs. Anifat Abudu	Lufoko	,,			-No formal education. -No thresher. -Had 1 acre of rice farm.
7.	,, ,,	Pastor Bode Adenekan	Moloko Asipa	,,			-Chairman, RIFAN, Ogun State. -Had formal education. -Had no threshing machine. -Had 10 hectares of rice farm.
8.	,, ,,	Mrs.	Lufoko	,,			-No formal

		Oluyemi Dauda					education. -She is 55 years old. -Had no thresher.
9.	,, ,,	Mrs. Amope Popoola	Lufoko	,,			-Planted 2 acres of rice farm. -Had 5 years threshing experience. -No formal training on rice threshing.
10	,, ,,	Mr. Gabriel Olonade	Ogbe-Eruku	,,			- No thresher. - Had no formal education. - Planted only Nerica 1.
11	,, ,,	Chief Adekunle Soyoye	Lemode	,,			- Had no thresher. - Had 1 hectare farm size.
12	,, ,,	Mr. Isola Oloyede	Lemode	,,			- No formal education. - No thresher. - Had 40 years threshing experience.
13	,, ,,	Mrs. Mosimotu Popoola	Lufoko	,,			- No formal education. - No thresher. - Had 2.5 hectares of rice farm.
14	,, ,,	Mr. Ayinla Oloyede	Lufoko	,,			- Planted 5 types of rice varieties. - Had 50 years of threshing experience. - Had farm size of 3 hectares.
15	Ogun/ Ewekoro	Mr. James Olu Okewole	Obada-oko / Abese village	,,			-No formal education. -Had 1 hectare of farm. - He is 50 years old.
16	,, ,,	Mr. Olusegun Fadairo	Obada-oko village	,,			-Resides at Obada-oko. -Farm size is 2 hectares. -Had 20 years of threshing experience.

17	,, ,,	Mr. Isiaka Kuye	Obada-oko / Ayedire	,,			-No formal training on rice threshing. -He is 54 years old with threshing experience of 50 years.
18	,, ,,	Mr. Alabi Ewedimu	Obada-oko / Abese	,,			-No formal education. -Had 2 acres of rice farm. -No thresher.
19	,, ,,	Mrs. Muibatu Rasaq	Obada-oko / Agbamaya village	,,			-No formal education. -Had 1 hectare of land. -No training on use of threshing machine.
20	,, ,,	Mrs. Milatu Sokunbi	Obada-oko	,,			-Had no machine. -Cultivate I hectare.Had 5 years threshing experience.
21	,, ,,	Mrs. Sakiratu Odeyemi	Obada-oko / Igbore village	,,			-Farm size is 1ha. -She is 50 years old. -No thresher.
22	,, ,,	Mr. Nofiu Akindele	Owowo Kere 08062164321	,,			-No formal education. -Had 1ha of rice farm. -He is a Muslim.
23	,, ,,	Mr. Isiaka Aminu	Owowo Kere / Eleyele	,,			-No threshing machine. -Had 2 acres of rice farm. -No formal education.
24	Ogun / Ifo	Elder A.A. Ojobo (Chairman)	Ifo / Alapako-Sogunye	,,			-Had formal education. -Had no thresher. -No formal training on rice threshing.
25	,, ,,	Elder Beyioku (Vice Chairman)	Ifo / Olose village	,,			-Well educated. -Had 3 hectares of farm land.
26	,, ,,	Chief (Mrs.) Lola	Alapako / Sogunye	,,			- Had no thresher.

		Adeoye Kushimo (Treasurer)					- Had formal education. - Secretary, RIFAN, Ifo LGA.
27	,, ,,	Mrs. Aremu Bolanle (Sec.)	Ifo / Coker	,,			- Had formal education. - Farm size is 5 hectares. - No thresher.
28	,, ,,	Chief Segun Akinbode (Fin. Sec.)	Ifo / Coker	,,			- Had formal education. - No machine. - Farm size is 2 hectares.
29	,, ,,	Prince A.A. Solaru (P.R.O.)	Ibogun / Alapako / Sogunle	,,			- No thresher. - Farm size is 10 hectares. - He is 50 years old.
30	,, ,,	Pastor J. Oluwasanmi Akinsule		,,			- No thresher. - He is a Christian. - No training on rice threshing.
31	,, ,,	Otunba Sonny Sangolana	Ifo / Alapako	,,			- Had no thresher. - Farm size is 10 hectares. - No formal training on threshing.
32	,, ,,	Evang. Bankole Akiode	Ifo / Alapako Sogunle	,,			- Had formal education. - He is a Christian with 10 years threshing experience. - No thresher.
33	,, ,,	Alhaji Semiu Anbelohun	Ifo / Alapako	,,			- No thresher. - Had 5 hectares of rice farm.
34	Ogun / Abk North	Mr. Mufi Alaba	Kuta village	,,			- Farm size is 1.5 acres. - No formal education. - Had no thresher.
35	,, ,,	Mr. Idowu Elegbede	Agbanla village	,,			- He had no threshing

							machine. - Farm size is 2.5 acres with 10 years threshing experience.
36	,, ,,	Mr. Morufu Suraju	Adedoyin village	,,			- He is 36 years old. - Had no thresher. - No formal training on rice threshing.
37	,, ,,	Mr. Tade Ajeneye	Abeokuta	,,			Had formal education with 3 years experience on rice threshing.
38	,, ,,	Mr. Mufutau Tade	Abeokuta / Agunmona	,,			- He is 36 years old. - Had 2.5ha of rice farm. - No thresher.
39	,, ,,	Mrs. Taiwo Dasaolu	Kuta	,,			- He is 45 years old. - Had 1 acre of farm with 9 years of rice threshing experience.
40	,, ,,	Mr. Idris Dasaolu	Kuta via Ishaga Orile	,,			Saw one rice thresher at Mokolokin demonstrated by Veetee Rice Company in 2005.
41	,, ,,	Mr. Jimoh Olalekan	Adeyori / Ishaga Orile	,,			- Had 8 years of rice threshing experience. - Had no thresher. - No training on the use of threshing machine.
42	,, ,,	Mr. Ahmed Soyoye	Arigbanla Ishaga Orile	,,			- No thresher. - Farm size is 1 acre. - Had 7 years of threshing experience.
43	,, ,,	Mr. Babatunde	Rander Ayetoro Road	,,			- No formal education.

		Olukunle					- Planted only Nerica. - No thresher.
44	Ogun / Yewa North	Mrs. Fahusat Adesina	Iboro / Iwoye	,,			- No thresher & no training on the use of rice threshing machine. - Planted Ofada and Nerica varieties.
45	,, ,,	Mr. Elegbede Adams	Iboro / Agbanu	,,			No thresher and no formal training on rice threshing. The farm size is 5 hectares.
46	,, ,,	Mrs. Asana Alegbede	Iboro / Agbanu	,,			-No formal education. -No thresher. -Had I hectare of rice farm.
47	,, ,,	Mrs. Wasilat Elegbede	Iboro / Agbanu	,,			She resides in Iboro Agbanu village. She had no formal education. Her farm size is 2 acres.
48	,, ,,	Alh. Rabiu Adesina	Iboro / Iyaniwura – Iwoye	,,			Had 3 acres of rice farmland. He is 65 years old without formal education.
49	,, ,,	Chief Moshood Elegbede	Iboro / Agbanu	,,			Had a farm size of 4 acres with over 30 years of threshing experience. He planted only Ofada rice variety.
50	,, ,,	Mrs. Fausat Tairu	Iboro / Iwoye village	,,			-No formal education. -Had 2 acres of farm. -No rice thresher.
51	,, ,,	Mr. Jimoh Tairu	Iboro / Iwoye village	,,			-No threshing machine. -Had rice farm of 1ha. -Had no formal education.
52	,, ,,	Mr. Jelili Elegbede	Iboro / Agbanu	,,			He had farm size of 2 acres. Mr.

							Jelili is 25 years old with 5 years of rice threshing. He planted Ofada, Nerica and ITA 150.
53	,, ,,	Mrs. Monsurat Lukuman	Iboro / Iwoye	,,			A married woman who cultivated 0.5 acres rice farm. She had 10 years experience of rice farm with no formal training on rice threshing.
54	,, ,,	Alh. Mutairu Oje	Iboro / Imina	,,			The farm size is 2 acres. He is 70 years old with 56 years of threshing experience.
55	Ekiti/ Ifelodun / Irepodun	Mr. H.A. Salau	Igbemo / Ekiti 08065613088	,,			-Well Educated. -A Retired Army Officer / Jurist. -He is a Muslim by religion. -He had 7 hectares of rice farm. -Involved in community development.
56	,,	Mr. Odola John	Igbemo / Efo-Igbemo	,,			-No formal education. -The age is 50 years. -Had no thresher.
57	,, ,,	Mrs. Alice Ojo	Igbemo	,,			-A fairly tall and dark in complexion woman. -She had 5 years experience in rice threshing. -Had no threshing machine.
58	,, ,,	Alh. Bello Ayodele	Igbemo	,,			-No formal education. -Had 2 hectares of rice farm with 10 years farming / threshing experience.
59	,, ,,	Mr. J.F. Ajayi	Igbemo 08082179819,	,,			-A retired army officer.

		(Chairman Ifan)	08065613088				-Chairman, RIFAN, Igbemo Ekiti. -Tall & fair in complexion. -No threshing machine.
60	Osun / Oriade	Mrs. Olayemi Fakole		,,			- Farm size is 1ha. - No rice thresher.
61	,, ,,	Mr. Akin Fatoki	08034888586	,,			- A retired Army Officer. - Had no thresher. - Planted only Ofada rice.
62	,, ,,	Mr. Julius Ayeni	08086113210	,,			- A retired Colonel. - Had 10ha of rice farm. - Had no thresher.
63	,, ,,	Mr. Oloyede		,,			Farm size is 3 hectares with 8 years threshing experience.
64	,, ,,	Chief M.B. Aladesolu	08033731069	,,			- Well educated. - An Hotelier and rice farmer. - Had no threshing machine. - No training on rice threshing.
65	,, ,,	Mr. Oguntodu Isaac	0803480442	,,			- He is 45 years old. - He cultivated 10ha of rice farm. - Had no thresher. - Farm located along Erin-Ijesha / Efonalaye road.
66	,, ,,	Mrs. Toria Olaniran		,,			- No formal education. - No thresher. - Had 30 years threshing experience.
67	,, ,,	Mr. Lawrence Aina (Photographer)	08067614707	,,			

A1.2. KURA-KANO RICE THRESHING COMMUNITY

S/N	State/LGA	Name of farmer/Primary Contact	Address/location Phone No	Type of /Make/Age Machine	Source of Machine	Type of Service/Position	Remark/Observation/Comment
1.	Kano/ Kura	Alh. Isa Yusuf (Chairman) Kankwana Rice Milling and Production Association. – Size of Farm – 10 acres	08036506151 Town – Dalili Kankwana	No rice Machine harvester	-	Apart from owning a rice farm he also has rice milling machine	Alh. Isa has two wife and six children. He harvest 200 bag of rice per season. He does threshing by beating (manual labour). He sold one bag N2800 at harvest and N3200 during scarcity. He spent N7000 – N8000 for labour
2.	Same	Ajh. Fegin Danda. Member of Association. Size of farm – 10 acres	08069771152	Same as above	-	Same as above	He has 2 wives and six children
3.	Same	Alh. Dantala. Member of Association. Size of farm – 50 acres	08066021734	Same as above	-	Same as above	He has 3 wives and 10 children
4.	Same	Alh. Rabiu. Member of Association size of farm – 20 acres	08036471894	Same as Above	-	Same as above	He has 2 wives and six children
5.	Same	Alh. Saidu. Member of Association. Size of farm – 30 acres	08035944084	Same as above	-	Same as above	He has 2 wives and 5 children
6.	KANO/ Bunkure Hq	Alh. Mamuda D. Bello (Chairman) Local rice Association. Size of farm – 10 acres	08068466506	No Rice Threshing Machine	_	_	He has 2 wives with 8 children, he harvest 160 bags and sell 1 bag for N2500 at harvest time and N3000 to N4000 a bag at scarcity time. Cost of labour is generally around N6000 – N7000.
7.	Same	Alh. Sumaila Sani. Size of farm – 20 acres (local Chairman in	08062245053	Same	_	-	He has 2wives and 8 children. Same information as above

		the town)					
8.	Same	Alh. Rabiu Mohammed . Size of farm – 10 acres	08065927245 Town: Kuruma	Same	-	-	He has two wives and six children
9.	Same	Alh. Ibrahim Shuaib. (15 acres)	Town: Gunki Local chairman in the village	Same	-	-	He has 2 wives and five children
10.	Same	Malam Maawiya (30 acres)	Town: Bunkure	Same	-	-	-
11.	Same	Malam Dayyabu	Town: Zango Buari	Same	-	-	-
12.	KANO/Garun Malam Hq	Alh. Nadabo (Chairman of Association) Size of farm 500Ha.	Town: Chiromawa. 08035872816	Own rice threshing machine and sold it	Imported from UK	Grow rice, thresh rice for commercial production	He observed that the rice threshing machine he acquired was not good. He experienced difficulty in threshing rice with the thresher he bought. He prefers manual threshing and cheap labour. He abandoned the machine. He is a big time farmer and well known in the local government. He has 3 wives and many children. He harvest 10,000 bag during during harvest time and sell them at N2500 per bag. N4500 during scarcity.
13.	Same	Alh. Salisu Dogo Member and big farmer	Town: Dorawai – sallau 08066989437	No Rice machine thresher	-	-	He has 2 wives and seven children. Well known politician.
14.	Same	Alh. Barau.	-	-	-	-	-
15.	Same	Alh. Sallau	-	-	-	-	-
16.	Same	Alh. Garba Ali	-	-	-	-	
17.	Same	Alh. Liman	Town: Yabakwai	-	-	-	-
18.	Same	Alh. Audu Yabakwai	Town: Yabakwai	-	-	-	-
19.	KANO/ Tundun – Wada	Alh. Mustapha Aliyu. Size of farm (4ha) Alh. Saidu bagobiri Tundun-Wada	08036088190	No Rice threshing machine	-	He grows rice for consumption and for selling.	He has no rice threshing machine. He will be happy if threshing machine can be brought for use by the farmer. He harvest 105 bag of threshed rice. Sell at N2000 per bag at harvest and N2500 – N2800 per

		(Chairman)					bag during scarcity.
20.	Same	Alh. Abdullahi Mohammed	Town: Yaryasa	-	-	-	-
21.	Same	Alh. Rabin Roger Miller	Town: Yarmaraya	-	-	-	-
22.	Same	Alh. Yusuf Tanko (local coordinator for farmer)	Town: Faska	-	-	-	-
23.	Same	Mal. Isa Magaji (local coordinator for farmer)	Town: Kurkuja	-	-	-	-
24	Same	Alh. Shugaba Iro (local coordinator for farmer)	Town: Yelwa	-	-	-	-
25.	KANO/ Kumbotso	Alh. Isa Dutse Sarki (Engineer). He is a business man dealing with wholesale and retailing of agric. Machinery (Techical Engineer and Wholesaler)	Town: Maikalwua. 08035558792 No 87 Zaria road, Naibawa Qtrs. Opp. Gidan Fiat.	RiceFan. More than 20 yrs old. Motorised.	Imported from UK around 1982	-	Ricefan machine was imported during Shagari government to Ministry of Agric. And later sold to interested individual. Alh. Sarki Dutse acquired some and sold 2 to Cameroonian about six months ago. The machine can thresh between 25 – 40 kg per day. There is constraint of training personnel on the machine. Cost of machine is N250,000. Fabricator to fabricate spare part is available.
26.	Same	Engr. J. Yusuf Fabricator of any kind of spare parts including rice thresher if brought	Town: Maikalwua. 08033873377 064-941718, 064-664677 Km 6, Zaria Road, Naibawa Qtrs Kano. P.O. Box 2664.	Specialist in Fabricating spare parts of rice threshing machine if broken down	-	-	Engr. Yusuf fabricate all kinds of machine parts if bring to his attention. He also construct machine. The workshop is quite equipped and has many hard working individual engaged in fabricating.
27.	KANO/ Tarauni	Deputy Director. Engr. Aliyu Bichi Suleiman	Ministry of Agric. Engineering Section Kano	Swaraj Multi – Crop thresher	Imported from India.	_	Rice thresher could thresh 60kg per day. Cost by 1987/88 N12,000. same machine now cost more than N1,000,000. The machine can thresh

							about 150 bag/day. Because it is costly, farmer cannot avoid it. Therefore, farmer prefer cheap labour of threshing by beating on the ground. There are only two of this machine in the state. Spare parts is not available and only rent to farmer at N5000 per day. Only few and wealthy farmer can afford the cost of rentage.
28.	KATSINA	Alh. Musa Musawa (politician)	Town: Musawa	-	-	-	-
29.	KANO/ RANO	Alh. Alirano	Town: Rano	-	-	-	-
30.	KADUNA/ Kaduna North	-Engr Charles Frimpong -Mr. Lee (08036917753)	Hanigha Nig. Ltd. 51, Isa Kaita Road Malali, GRA. P.O. Box 9861. Kaduna. 08033292132, 08029589845	Has constructed or fabricated rice thresher that is still under modification	Kaduna company	-	Hanigha constructed a rice thresher using a spike type principles. The machine as displayed to us, has a threshing drum, fan blower section, an auger, winnower an a conveyor. There is no rice that can be used as demonstration. But Mr. lee said the capacity is about 3 bags/hr. It was observed that the machine is too heavy on a tyre. Cost of production range between N300,000 – N350,000. It was was suggested that if the conveyor metal and the gear component can be changed, the machine will reduce in weight and the cost of production will also be less.
31.	Same	Alh. Ilyasu Usman	08033788303 Amil Solid Minerals and Agro Allied company (062-312330) 125/129, sabon Birni road, Kawo Extension. Kaduna.	Fabricator of Rice thresher on request	Own company	-	No rice thresher avialble. He however claimed he could fabricate rice thresher on demand

32.	Same	Engr. Abdullahi	08028841911 Abdullahi Engineering Works PC 3, Ibrahim Taiwo Road, Tundun-wada. Kaduna.	-	-	-	Alh Abdullahi was visited as a private individual that fabricate and construct machine (rice dehuller) including rice thresher on request. There is no single rice thresher seen at his shop. He also works for hanigha on part time.
33.	NIGER/ BOSSO LGA	Prof. M.G. Yisa	08035982436 08059464403 Dept. of Agric. Engineering, FUT. Minna.	Departm ental research and or Student project	Dept. Made machin e	-	FUT, Minna Rice thresher is quite effective and has gone for exhibition in Abuja and some trade fair. Presently, it has capacity to thresh 400kg/hr and discharges clean paddy rice. It has 10 horse power 3 phase electrical motor coupled. Present cost N350,000 – cost of production/unit. The rice thresher could be scaled down to thresh about 100kg/hr – The cost will then be reduced to about N120,000/unit. Prototype of this can be fabricated and demonstrated
34.	NIGER/ NCRI	Dr. Agidi Engr H.S. Hafiz	Head of Engineering Section of NCRI (08036772988) Principal Tech. Officer. NCRI 08036582566 08022693302	Multi – crop thresher including rice	Import ed rice threshe r from India	-	Two machine were seen and identified for rice thresher. - The imported one from India ordered or supply by NARP/World Bank project and given to NCRI. It is so heavy, big and 2.5m in height. This has threshed rice few times but cannot be avoided by poor farmers. It has since been abandoned in their workshop. - The second small pedal operated rice thresher was also imported from UK. This is good and can be adopted for poor farmer with modification and improvement. There is no fresh harvested rice to test the efficiency of the machine. The constructed rice thresher

							that is working was sponsored by AGIP oil and supplied to Balyesa Govt. could be fabricated on request.
35.	KWARA/ NCAM	Director – Prof. K.C. Oni – 08035724708	NCAM, Km 20 Ilorin – Lokoja Highway. Idofian. Kwara state. 08033649168 08055534286	Motorised rice thresher and pedal driven rice thresher	Pedal rice thresher imported from UK	-	Since the emphasize of fed. Govt is on cassava, the centre shifted from improving and fabricating more rice thresher to improving cassava harvester. The centre will fabricate more rice thresher if requested. The only rice thresher available can thresh 100kg/hr. Apart from the motorized rice thresher seen, the small scale rice thresher available is the pedal driven rice thresher donated by fed. Govt. as seen at NCRI.

A1.3. ABAKALIKI AND MAKURDI

S/No	State/LGA	Name of farmer/Primary Contact	Address/location Phone No	Type of /Make/Age Machine	Source of Machine	Type of Service/Position	Remark/Observation/Comment
1	Ebonyi/ Abakaliki	Anthony Muoneke	Annes Agro Processing Industries Ltd., 17, Gunning rd., Abakaliki, Ebonyi State	Flat bar Rice Thresher	Fabricated locally	Use for threshing rice	Undergoing modification
2	Benue/ Makurdi town	Daikwo L. Sylvester	OLAM Nig. Ltd., Agro millers, Uni. Agric. Rd., Makurdi, Benue State08064934043	Wire loop Thresher	Imported from Japan	Use for threshing grains	Not effective with rice

A2. PHOTOGRAGHS OF IDENTIFIED RICE THRESHERS

Plate A2.1: Rice Fan at Kura – Kano and Abakaliki

Plate A2.2: Multi – Crop Thresher at Fed. Univ. of Tech, Minna

Plate A2.3: Wire Loop Thresher at NCRI, Badeggi, Niger State

Plate A2.4: Axial Crop Thresher at Abakaliki, Ebonyi State.

Plate A2.5: Multi Crop Thresher at H.J.R.B.D.A, Kura - Kano

Plate A2.6: Yanmar Wire Loop Thresher at Olam Nig., Ltd., Makurdi, Benue State

Plate A2.7: Rice and Corn Thresher at Min of Agric., Kano

Plate A2.8: Corn and Wheat Thresher at H. J. R .B.D.A., Kadawa, Kano

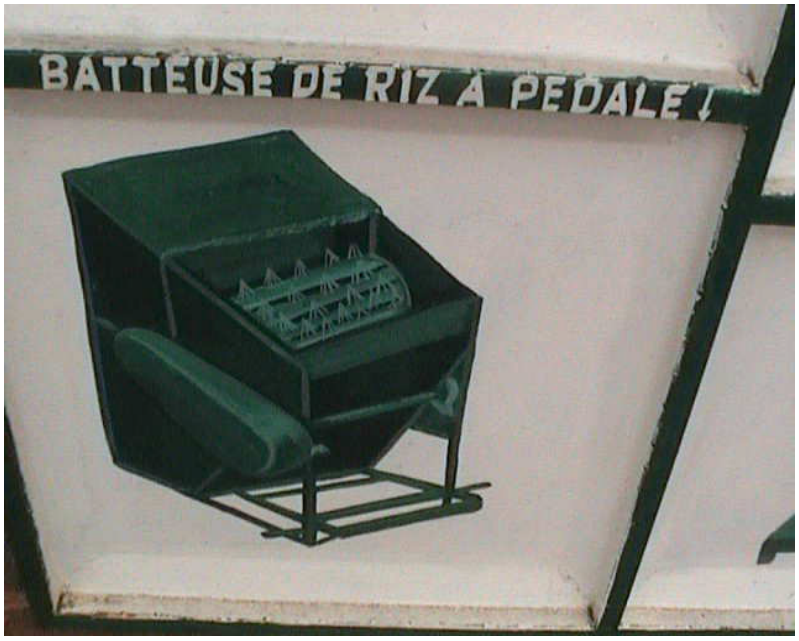
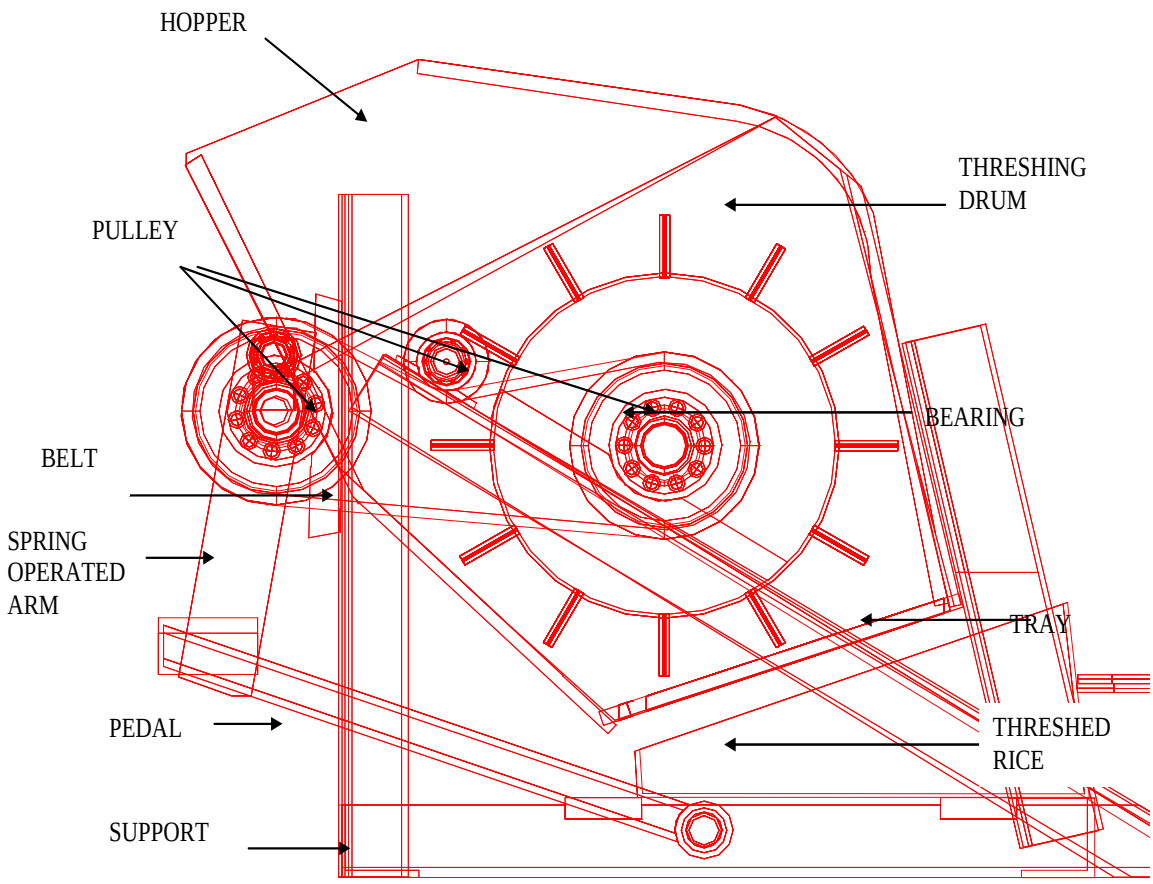


Plate A2.9: Pedal Thresher at Songhai Farm, Porto Novo, Rep. of Benin

Plate A2.10: Multi – Crop Thresher at IITA, Ibadan, Oyo State

A3. AUTOCAD DRAWINGS OF RECOMMENDED THRESHER

A3.1 PEDAL OPERATED THRESHER



PEDAL OPERATED RICE THRESHER

A3.2 POWER OPERATED THRESHER