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COLLEGE OF ENGINEERING

FACULTY OF AGRICULTURAL/MECHANICAL ENGINEERING

DEPARTMENT OF AGRICULTURAL ENGINEERING

PERFORMANCE EVALUATION OF A MOTORISED MINI-RICE THRESHER

A DISSERTATION SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL ENGINEERING, FACULTY OF AGRICULTURAL/MECHANICAL ENGINEERING, IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR B.Sc. (HONS) AGRICULTURAL ENGINEERING DEGREE

BY

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DECLARATION

I, QUAYE ALEX, hereby declare that this thesis is as a result of my own work towards B.Sc. degree in Agricultural Engineering and that to the best of my knowledge, it contains neither materials previously published by any other person nor one which has been accepted for award of any other degree in any university, except where due reference has been made in the text of this thesis.

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DEDICATION

This dissertation is dedicated to my late father, OSEI EKOW, my sweet loving and prayerful mother, BERKO OFORIWAA HELENA, my siblings and every individual JEHOVAH used as a blessing unto me in pursuing this first degree program. For all that I am or ever hope to be, I owe it to them. TO GOD BE THE GLORY.

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All that we know is a sum total of what we have learned from all who have taught us, both directly and indirectly.

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ABSTRACT

Rice thresher is an indispensable machine in the rice production business currently. For a newly constructed thresher (Konongo thresher), evaluating its parameters such as capacity, efficiency, optimum speed for threshing and fuel consumption is very necessary. Rice threshing had sometimes been done by outmoded means by the use of "*Bambam*" box. This process is labour intensive and requires more energy. In a country where by imported rice stands at 70% of what we consumed, it is very prudent to increase our local production by motorising threshing process. Rice quality is affected by moisture content at harvest and the cylinder speed of the thresher during threshing. The effect of cylinder speed thus the optimum speed the machine will be working at was investigated. The rice variety used was L50. Digital tachometer, electronic caliper and oven are some of the materials used. The accepted methods of calculating efficiency, moisture content and capacity was used. Higher moisture content 26.2% wb yielded an efficiency of 85.3% whiles 16.67% wb gave an efficiency of 90.61%.This results were achieved when threshing was done at 980 rpm for both cases. Capacity of the thresher at 870 rpm was 61.27 kg/hr whereas 0.37 l of petrol was used in threshing a unit mass of paddy. The optimum speed of the thresher was 980 rpm. In conclusion, higher efficiency was attained when threshing was done at lower moisture content and higher speed. The efficiency on the other hand would increase if threshing losses is minimised as much as possible. Threshing above the optimum speed would increase the losses hence minimising the efficiency of the thresher.

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ABBREVIATIONS

ARC	Africa Rice Center
cm	Centimeter
FAOSTAT	Food and Agriculture Organisation of the United Nations
hr	Hour
IDDS	International Development Design Summit
IRRI	International Rice Research Institute
kg	Kilogramme
l	Litre
m/min	Minute
mc	Moisture content
NRDS	National Rice Department Strategy
rpm	Revolutions per minute
RKB	Rice Knowledge Bank
s	Second
TCC	Technology Consultancy Centre
wb	Wet basis
WARDA	West Africa Rice Development Association

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CHAPTER ONE

INTRODUCTION

1.1 Background information

Rice, is the seed of a grass species called *Oryza sativa*. It is a monocot crop normally grown for a year but in tropical areas can survive as a perennial crop (IRRI, 2009). Rice is a stable food for majority of the world's population. More than 40% of the rice consumption in West Africa is imported, which represents 2.75 million tons per year (Barris *et al*., 2005). Worldwide there are more than forty thousand different varieties of rice species name *Oryza sativa, doongara*, *jarrah*, *kyeema*, *reizip* are a few species (IRRI, 2015). It is estimated that rice sustains the livelihood of 100 million people and its production has employed more than 20 million farmers in Africa (WARDA, 2005). Rice crop production originated from China and was spread to countries such as Sri Lanka and India. Rice is also the agricultural commodity with the third-highest worldwide production after sugarcane and maize (FAOSTAT, 2012). The African rice (*Oryza glaberrima*) is thought to have originated in the Central Delta of the Niger River where it may had been grown since 1,500BC (Chukwu, 2008). In Ghana, some of the few local varieties of rice is the L50, *jasmine*, *mansah*, and *mancho* . A recent representation on the National Rice Department Strategy (NRDS) for Ghana revealed that the per capital rice consumption in Ghana is currently 38 kg and it will rise to 63 kg in 2015, giving an aggregate demand of 1.68 million metric tons. Rice consumption has been increasing over the years with population growth, hence rice continues to be part of the main diet in most Ghanaian homes due to its relative convenience in preparation and palatable recipes. Threshing is a technical operation in rice and some cereals production. The thresher was developed for threshing, separating, and cleaning cereals. The major components of the machine include threshing, separation, and cleaning units (Ghasemi *et al*., 2005). The thrashing machine or in modern spelling, threshing was first invented by a Scottish mechanical engineer by name Andrew Meikle for agricultural purposes (Correa *et al*., 2006). It was devised (c.1786) for the separation of grain from stalks and husks. For some thousands of years ago, grains was separated by hands with flails, which made it very tedious and time consuming. The threshing machine can be put into two main categories with types. The motorized and manual rice threshers. Example is the ASI type for the motorized and the TCC/IDDS manual rice thresher (ARC, 2006).

1.2 Problem statement

Currently, Ghana spends about 450 million US dollars annually on rice importation to argument local demand. The country's self-sufficiency in rice production stands at about 30 per cent, leaving a shortfall of 70 percent (Amanor, 2012). However, local farmers involved in rice production in Ghana still use outmoded means of threshing. Thus using wood logs as implement to aid in the threshing. Aside from being labour intensive, the post-harvest losses is huge. Studies has shown that threshing losses were higher (6.14%) when threshing was done using the "*Bambam*" box (a big locally made wooden box) than when bag beating method (2.45%) was used (Ramatoulaye, 2010).

1.3 Justification

The most efficient mode of threshing is the use of a motorised rice thresher. To determine the optimum speed, moisture content for threshing, capacity of the thresher, efficiency and energy consumption, there is the need to carry out field evaluation of the motorised mini-rice thresher.

1.4 Objectives of study

1.4.1 General objective

To evaluate the performance of a motorized mini rice thresher (Konongo thresher).

1.4.2 Specific objectives

i. To determine the capacity and threshing efficiency of a motorized mini rice thresher.

ii. To determine the optimum speed and effect of moisture content on threshing.

iii. To determine the energy consumption per unit weight of threshed rice.

1.5 Significance of the study

The performance evaluation of a mini rice thresher is of great importance. It could serve as a source of credible information for rice farmers to compare the advantages of using a thresher to local methods of threshing. It would also enable users to know the predetermined parameters of the thresher.

CHAPTER TWO

LITERATURE REVIEW

2.1 Threshing

According to Agidi *et al*., (2013) threshing is the process of loosening the edible part of cereal grain (or other crop) from the scaly edible chaff that surrounds it. It is the step in grain preparation after which after harvesting and before winnowing, which separates the loosened chaff from the grain. Threshing can be done by beating the grain using a flail on threshing floor. Threshing floor consists of two main types namely; specially flattened outdoor surface and inside building with a smooth floor of earth (Mohammed and Alireza, 2013). Threshing is one of the most important crop processing operations to separate the grains from the ear heads or the plants and to prepare it for market (Ezzatollah *et al*., 2009).

A number of small, medium, and large threshers have been in existence for quite a long time, but due to low or poor performance in comparison with the traditional methods, they have not been adopted to a significant extent. Some are hand-held threshers and pedal operated ones (Chabrol *et al*., 2001).

2.2 Threshing machine

Threshing machine is the device use to undertake thrashing. Two main types of stationary threshing machines have been developed. The machine of Western design is known as "through-flow" thresher, because stalks and ears pass through the machine. It consists of a threshing device with pegs, teeth or loops, and (in more complex models) a cleaning-winnowing mechanism based upon shakers, sieves and centrifugal fan. In the 70 s, IRRI developed an axial flow thresher, which has been widely manufactured at local level (Olugboji, 2004). The thresher has an open axial flow peg tooth threshing drum; a throw-in feed opening and straw throwing pedals at the end of drum. Normally in axial-flow thresher, 80% of grains are separated in the first half of drum, whereas, only 20% of grains are removed at latter half of the rotor (Alizadeh and Bagheri, 2009).

2.3 Threshing methods

Threshing methods are the various means by which paddy rice ear head are separated from the plant. After being harvested, paddy bunches may be stacked on the plot. The in-field storage method results in a pre-drying of the rice ears before threshing, the purpose of which is to separate seeds from panicles.

2.4 Traditional 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 under foot. The threshing floors on which the sheaves are spread must have a hard, clean surface (Olayanja *et al*., 2009). The traditional threshing of rice is generally done by hand: bunches of panicles are beaten against a hard element (e.g. a wooden bar log, bamboo table, or stone). In many countries in Asia and Africa, and in Madagascar, the crop is threshed by being trodden underfoot (by humans or animals); this method often results in some losses due to the grain being broken or buried in the earth (Ouézou, *et al*., 2009).

2.4.1 Threshing rack

Threshing racks in threshing refers to the use of racks as a means of threshing. It is accomplish when individuals holds the crop by the sheaves and beats it against a slatted bamboo, wooden plate form, or any other hard object such as a steel oil drum. It is labour intensive. (Mohammed and Alireza, 2013). This is shown in figure 1 below:

Figure 2.1: A man threshing with the ‘’*Bambam*’’ box.

2.4.2 Threshing with animal (Trampling)

Trampling involves the use of bare feet or animals to thresh crop. 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 sheaves of about 30 cm thick. This operation, which is also called “treading out”, and can equally be 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 (Ramatoulaye, 2010).

Figure 2.2: Threshing rice by trampling.

2.5 Pedal thresher

The pedal thresher is the most recommended manual thresher. It requires the use of the foot to power and maintain the revolution whiles threshing. It consists of the threshing drum, base, transmission unit and a foot crank. The threshing drum rotates when pedaled at the foot, and then rice can be threshed panicles are applied against the threshing drum (ARC, 2006).

Figure 2.3: A pedal thresher

2.6 Engine powered threshing

Although they are gradually being replaced by combine-harvesters, motorised 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.). 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 kg/h to 5000 kg/h (Olayanja *et al*.., 2009)

A study conducted for the development of an unequal speed co-axial split rotor thresher for rice shows the first rotor serves mainly the threshing operation, whereas, rotating at relatively higher speed, the second rotor does mainly the separation of rice grains from husk. Faster rotation of second rotor increases separation performance by increasing centrifugal force. The optimum speed for threshing rotor was considered to be 25 m/s (600 rpm with 0.8 m diameter threshing rotor). For better grain separation speed of 30.2 m/s (720 rpm with 5 hp 0.8 m separation rotor) was found optimum (Chimchana *et al*., 2008).

2.7 Types of threshers

Engine powered threshers can be classified using different standards such as feeding type, crop flow inside the machine and last but not the least threshing elements.

2.7.1 Throw-in thresher

This is the type of thresher whereby the whole crop is feed into the machine. They can also be referred as the feed-in thresher.

In a conventional threshing cylinder, stripping may also be use for paddy threshing; impulsive pass through the machine and some designs use straw walkers to initially separate the loose grain from the bulk of the straw and chaff (Ouezou *et al*., 2009).

Figure 2.4: Assela multicrop thresher

Figure 2.5: Jimma multicrop thresher

Figure 2.6: Votex thresher

2.7.2 Hold-on thresher

For the hold-on thresher, the paddy is still held still in the cylinder whiles performing impact threshing. The head of the cut crops are fed into threshing drum with the lower part of the straw being mechanically or manually fed.

Maximum care should be taken when farmers are using this kind of thresher. Harvested panicle should be kept in a definite order. The simplest of these are mechanized version of the treadle thresher in which the drum is rotated by 1-3 hp engine (Tamiru and Teka, 2015).

Figure 2.7: Hold-on thresher

2.8 Moisture content

According to Darko (2016), moisture content is the quantity of free water in a specified material. Moisture content is expressed as either as decimal ratio or as a percentage by weight in one of two ways: Wet Basis and Dry Basis.

2.8.1 Wet basis (wb)

The moisture content wet basis is defined as the ratio of the weight of water to the total weight of dry matter and water. This is mostly used in agriculture.

2.8.2 Dry basis (db)

The moisture content dry basis is defined as a ratio of the weight of water to the dry-matter weight. This method is normally used in scientific laboratory work.

Table 2.1: Moisture content calculations

MOISTURE CONTENT CALCULATIONS	
Definitions m_i = initial moisture content m_f = final moisture content MC_{wb} = moisture content (wb) MC_{db} = moisture content (db)	**Formulas** $MC_{wb} = \frac{m_i - m_f}{m_i} \times 100\%$ $MC_{db} = \frac{m_i - m_f}{m_f} \times 100\%$
From moisture content (db) to (wb) $MC_{wb} = \frac{100 \times MC_{db}}{100 + MC_{db}}$	**From moisture content (wb) to (db)** $MC_{db} = \frac{100 \times MC_{wb}}{100 - MC_{wb}}$

According to Yakah (2012), *mancho, mansah and jasmine* rice yielded an efficiency of 98.5%, 94.5% and 91.2% at a moisture content (wb) of 18%, 22.5% and 23.1% respectively.

The amount of water in rice grain is represented by the moisture content of the grain. In post-harvest handling, grain moisture content is generally stated on a wet weight basis (M_{wb}). Moisture content of grain can be measured by using a drying oven, or by using a commercial moisturemeter (Selco Foundation, 2015).

Figure 2.8: Moisturemeter

Figure 2.9: Oven

CHAPTER THREE

MATERIALS AND METHODS

3.1 Materials

These are the materials and instruments that were used in the field evaluation;

- A motorised rice thresher (Konongo Thresher)
- Paddy rice (L50)
- Plastic bucket
- Oven
- A pair of caliper
- Tape measure
- Digital tachometer
- Electronic balance
- Plastic trays
- Stop watch

3.2 Uses of the materials

Table 3.1: Materials and their uses.

Material	**Uses**
Motorised rice thresher	This machine is used in threshing the rice mechanically. It is engine powered and uses petrol.
Paddy rice	This is the rice stray that was used for the performance evaluation. The rice variety used was L50.
Plastic bucket	This was used in collecting the threshed rice from the outlet of the rice thresher

Oven	This was used in drying the threshed rice in order to determine the moisture content.
Stop watch	For timing the duration of threshing.
Plastic trays	For collecting threshing losses of the Konongo Thresher.
Electronic balance	For weighing the rice straw and threshed rice.
Tape measure	For taking dimension of the Konongo Thresher
A pair of caliper	For measuring diameter of circular part.
Digital tachometer	For measuring the speed of the threshing drum.

Figure 3.1: The Konongo thresher

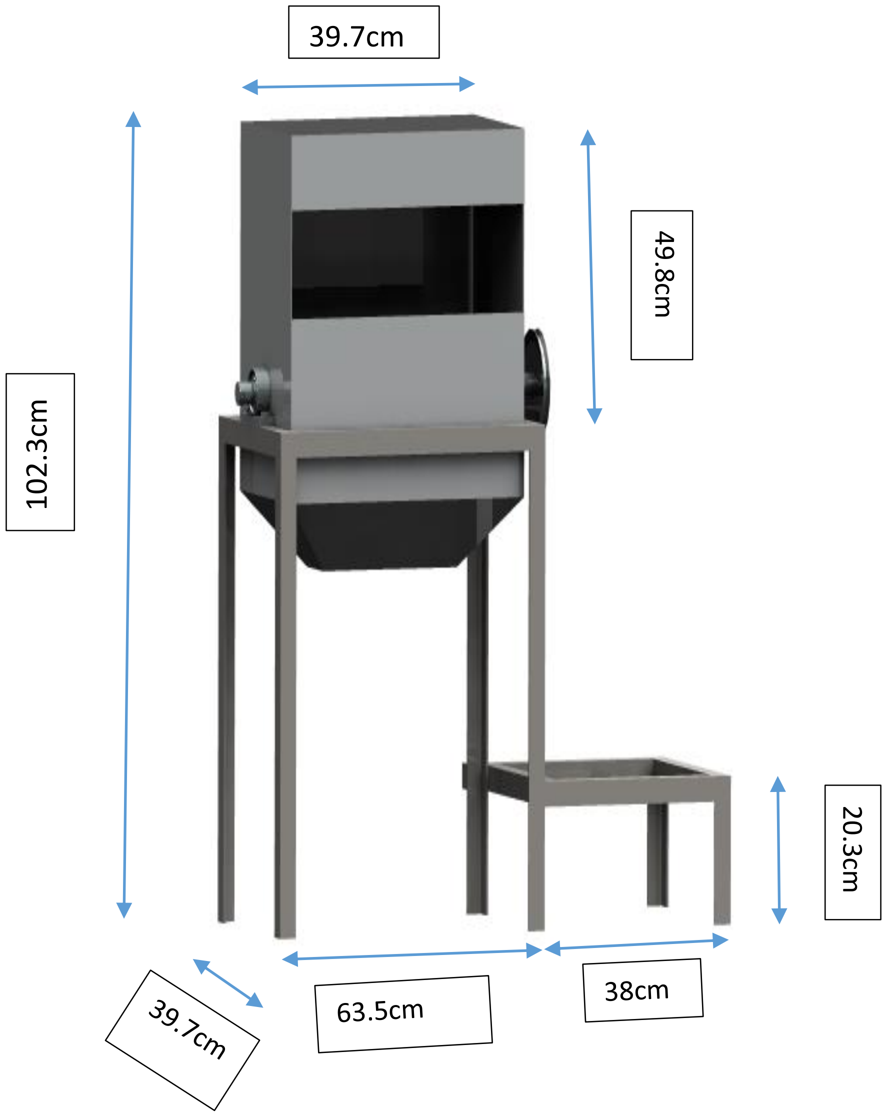

Figure 3.2: Computer aided drawing of the Konongo thresher

3.3 The Thresher

3.3.1 Functional components

The Konongo rice thresher was used. It is a motorised rice thresher which uses an engine. The dimensions of the thresher reads 102.3 cm × 63.5 cm × 39.7 cm. The threshing unit consists of a rotating cylinder. The cylinder drum is 8.9 cm in diameter and 48.3 cm in length. There is only one type of threshing element on the cylinder. The threshing drum has loops which are perpendicular to the axis of the cylinder. The threshing is set in motion by the started motor. The threshed paddy is collected through a chamber with size 29.8 cm × 10 cm beneath the threshing drum.

3.3.2 Threshing mechanism

The thresher is specifically designed for rice. Threshing occurs by a combination of impact and rubbing action as the harvested rice heads passes over the rotating cylinder. Threshed paddy motor. The thresher requires only one person to operate it.

3.4 Performance tests

Two major tests were run: preliminary and actual test. The preliminary test was run to determine how the thresher functioned by determining feed rate and threshing speed to optimize performance. The observation and values obtained from the preliminary test were used as a guide for the actual test.

3.5 Performance parameters

3.5.1 Thresher efficiency

This is the ratio of mass collected at the outlet to the mass inputted into the thresher.
It is given as;

$$\eta\ (\%) = \frac{\text{Output of the thresher}}{\text{Input to the thresher.}} \times 100\%$$

where: η (%) = Threshing efficiency in percentage

3.5.2 Capacity

This can be defined as the material output per unit time in kilogram per hour (kg/h). The formula to be used is given by;

$$C_{th} = \frac{M_{th} + M_{sc}}{t}$$

Where; M_{th} = mass of threshed paddy paddy collected in the outlet in kg

M_{sc} = mass of scattered paddy in kg.

C_{th} = capacity of thresher in kg/h.

t = time taken to threshed in hours.

3.5.3 Moisture content (MC)

3.5.4 Procedures for measuring MC with a drying oven method

1. Pre-heat the oven at 130°C;

2. Weigh three paddy samples of 10 grams each and place them inside the oven;

3. Remove the samples after approximately 16 hours, and obtain the final weight of each sample;

4. Compute the MC for each sample :

MC =(10 - Final weight of dried sample in grams)*100/(10);

5. Compute the average MC of three samples.

3.5.5 Calculation

$$MC_{wb} = \frac{m_i - m_f}{m_i} \times 100\%$$

Where ;

MC_{wb} = Moisture content wet basis [%]

m_i = Initial weight [g]

m_f = Final weight [g]

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents the results and discussion of analysed data from the field evaluation and laboratory work. The results are presented in tables and graphs. The local rice used (L50) was cultivated in Ghana at Nobewam in the Ejisu Juaben District in the Ashanti Region of Ghana. The rice was harvested from a parcel of farmland with size 18.9 m × 49.1 m. The moisture content of the rice harvested varied from 16.67 – 26.2% (wb).

4.1 Effect of moisture content on threshing

Moisture content is the quantity of free water present in a sample. The moisture content of the rice harvested directly affects the efficiency of the thresher. According to Yakah (2012), *mancho, mansah and jasmine* rice yielded efficiency of 98.5%, 94.5% and 91.2% at moisture content (wb) of 18%, 22.5% and 18% respectively. This clearly shows that at higher moisture content the efficiency decreases.

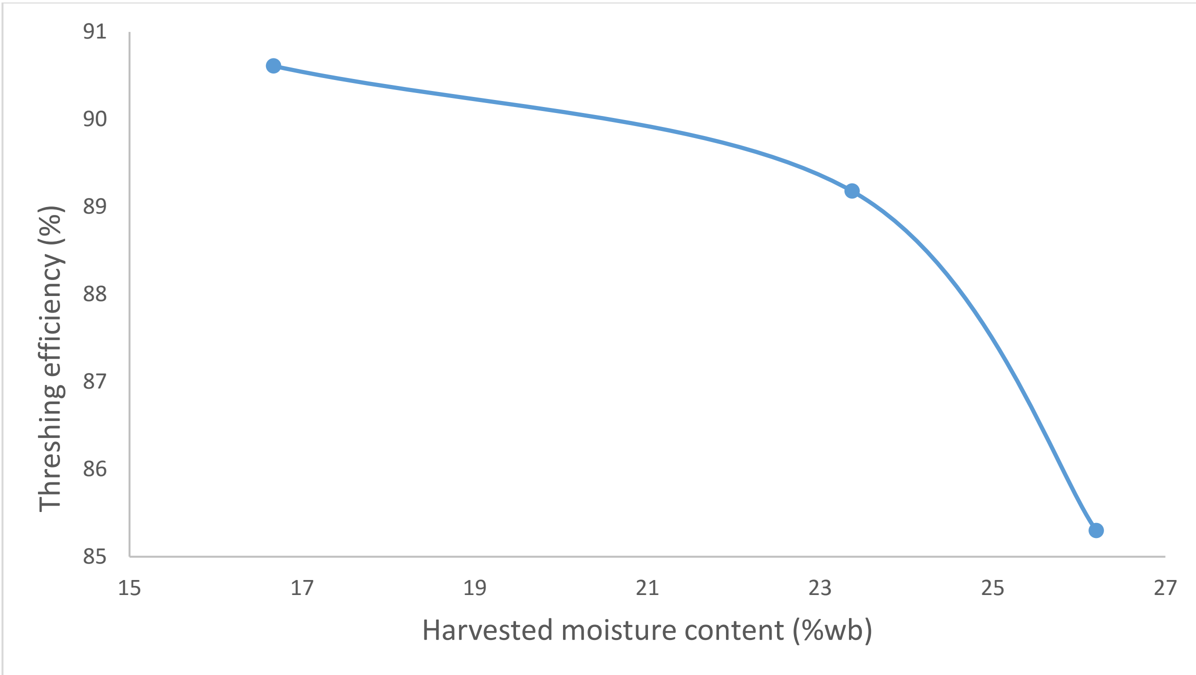

Figure 4.1: Effect of moisture content on the threshing efficiency.

4.1.2 Discussion of moisture content results

From Figure 4.1, it was realise that from the field evaluation carried on, increase in harvested moisture content decreased threshing efficiency. The preliminary test with moisture content of 26.2% (wb) yielded an efficiency of 85.3% whiles the supplementary tests with moisture content of 16.67% (wb) and 23.37% yielded efficiencies of 90.61% and 89.18% respectively.

4.2.1 Capacity of thresher

Capacity refers to the output of the thresher with respect to time in hours. Its SI unit is kg/hr. Capacity is basically affected by the speed of threshing. The higher the speed the less time it takes to thresh, hence the greater the capacity. Capacity of a particular thresher would always be given at a particular speed.

Table 4.1: Capacity determined results.

Trial	Quantity of rice threshed (kg)	Time taken to threshed (min)	Speed (rpm)
Trial 1	5	6.98	780
Trial 2	5	6.90	800
Trial 3	5	3.70	890
Trial 4	5	3.74	900
Trial 5	5	3.17	980
AVERAGE	5	4.90 (0.0816 hr)	870

$$Capacity = \frac{5}{0.0816} = 61.27\ kg/hr$$

From the field evaluation results in Table 4.1 above, the average Konongo mini-rice thresher capacity was determined to be 61.27 kg/hr. Meaning in every hour it would threshed 61.27 kg of rice straw on the average. It was also notice that for every 5 kg of paddy threshed, the time taken lies between 3.17min to 6.98 min due to the speed used in threshing. For speed of 780 rpm the time taken was 6.98 min and its capacity stands at 42.98 kg/hr. However, at higher speed of 980 rpm, the time taken was 3.17 min and its capacity stands at 94.64 kg/hr.

4.3.1 Fuel consumption of thresher

Fuel consumed by the thresher is directly proportional to the mass of paddy threshed. The higher the mass threshed, the higher the fuel consumed. It was however relised that the Konongo thresher was fuel efficient. The Table 4.2 below represents three specified mass threshed and their fuel consumption.

Table 4.2: Fuel consumption results

Mass threshed (kg)	Fuel consumed (l)
1.10	0.36
2.13	0.80
2.31	0.91

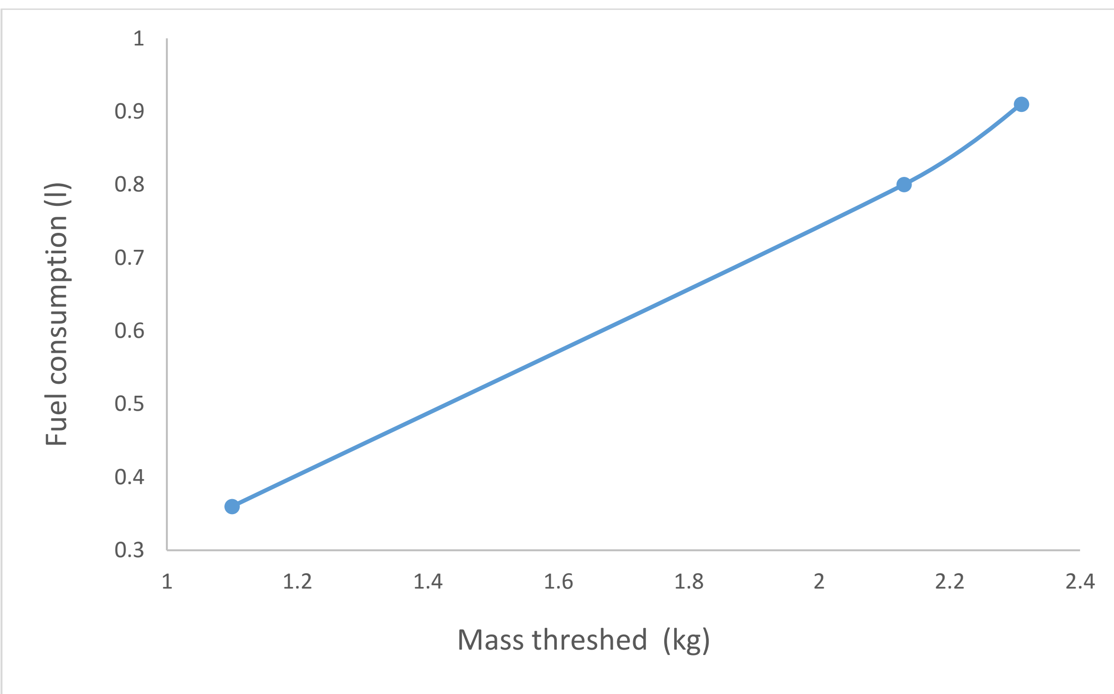

Figure 4.2: Fuel consumption of the Konongo rice thresher.

4.3.2 Discussion of results on fuel consumption

The engine attached to the thresher is a gasoline engine thus it uses petrol as it source of fuel. From Figure 4.2 above, it could be deduced that the engine is fuel efficient. Consumption of 0.36 l was used in threshing 1.1 kg of paddy rice. To threshed 2.13 kg of rice, the consumption stood at 0.8 l. Lastly, 0.91 l of petrol fuel was utilized by the engine in threshing 2.31 kg of paddy rice.

4.4.1 Optimum speed

Speed of a particular thresher can be drawn into three categories, the maximum speed, the optimum speed and the minimum speed. Lower efficiency is recorded if threshing is done at the minimum speed. However, much losses is recorded if threshing is done at maximum speed. Therefore it is very prudent to determine the optimum speed for threshing in which case lesser losses is recorded and higher efficiency is also achieved.

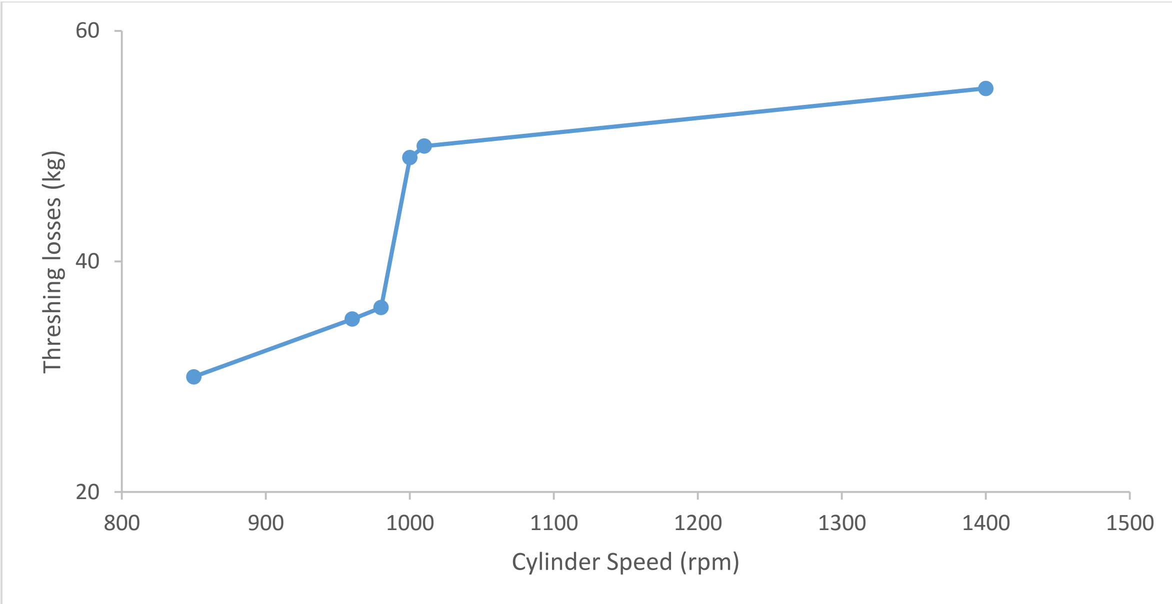

Figure 4.3: Effect of speed on threshing losses.

4.4.2 Discussion of speed results

The optimum speed of the thresher is best determine in a range. From the results in Figure 4.3 above the most appropriate range is (960 – 1000) rpm. With this speed range an average optimum speed can be calculated as 980 rpm. Within the above stated range, an average of 390 g of paddy was threshed. The average losses recorded within this same range stands at 35.5 g which is relatively low as compared with the two higher speed. The average of this two higher speed stands at (1010 -1400 rpm) 1205 rpm and average losses recorded is 57.5 g whiles the total mass threshed stands at 1.059 kg. It is very clear that at maximum speed, much losses is recorded.

4.5.1 Efficiency of thresher

Efficiency of the thresher is basically the ratio of the output to the input of the sample thresher. Efficiency of every thresher can never be equal to 100% as a result of losses recorded during threshing. As much as possible losses should be minimised since it can not be avoided in the rice threshing process.

Table 4.3: Efficiencies of the Konongo rice thresher

CYLINDER SPEED (rpm)	MASS OF RICE THRESHED (g)	MASS OF LOSSES COLLECTED (g)	THRESHER EFFICIENCY (%)
850	350	30	91.4
960	380	35	90.8
980	400	36	91.0
1000	450	49	89.1
1010	459	50	89.1
1400	600	65	89.2

The efficiency of the machine is directly affected by the threshing speed of the cylinder drum. From Table 4.3 above the more high the speed gets, the lesser the efficiency. This is normally the case because at maximum speed, threshing losses is very high. It can be noted that at a speed of 1010 rpm the efficiency estimated was 89.1%. Conversely, at a much lower speed of 980 rpm the efficiency is 91.0% with very less losses as compared to the speed at 1010 rpm. In conclusion, the efficiency of the Konongo rice thresher was 91.0% at a speed of 980 rpm.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

These are the conclusions drawn after successfully undertaking the field evaluation of the motorised mini-rice thresher (Konongo thresher). They were based on the specific objectives of the project work.

First and foremost, higher moisture content resulted in lower threshing efficiency whereas lower moisture content resulted in higher threshing.

Secondly, the optimum speed for threshing was determined to be 980 rpm. Increasing the cylinder speed above the optimum speed increases the threshing losses.

Thirdly, the capacity of the Konongo thresher was determined to be 61.27 kg/hr when threshing at a speed of 870 rpm.

Furthermore, the efficiency of the Konongo thresher was determined as 91.7% when threshing at the optimum speed of 980 rpm.

Lastly, fuel consumption per unit of mass threshed (1 kg) is 0.37 l on the average. A total of 5.54 kg of paddy was threshed in determine the fuel consumption of the thresher. The thresher required 2.07 l of fuel to thresh 5.54 kg of paddy.

5.2 Recommendations

Following the results from the field evaluation: the capacity, fuel consumption, optimum speed, efficiency and laboratory analysis of the moisture content, these recommendations were made:

- Since the paddy rice should be harvested at a lower moisture content, a moisturemeter can be use to quickly determine the moisture content before harvesting the rice. This will ensure higher efficiency during threshing.

- It is also recommended that an external plate be wielded tangential to the inlet in order to control losses hence increasing the efficiency of the thresher.

- The thresher should have two wheels so that it is easily transportable.

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APPENDIX

Table 1: Computation of moisture content [SAMPLE 1]

Can number	Mass of can (g)	Initial mass of rice, $m_i\ (g)$	Final mass of rice, $m_f\ (g)$
(1)	25.0	30.0	25.0
(2)	25.5	30.0	25.0
(3)	25.5	30.0	25.0

Table 2: Average

Replica	Moisture content (%wb)
1	16.67
2	16.67
3	16.67
Average	16.67

Table 3: Computation of moisture content [SAMPLE 2]

Can number	Mass of can (g)	Initial mass of rice, $m_i\ (g)$	Final mass of rice, $m_f\ (g)$
(1)	25.1	30.0	23.0
(2)	25.4	30.0	23.0
(3)	25.5	30.0	23.0

Table 4: Average

Replica	Moisture content (%wb)
1	23.3
2	23.3
3	23.3
Average	23.3

Table 5: Computation of moisture content [SAMPLE 3]

Can number	Mass of can (g)	Initial mass of rice, $m_i\ (g)$	Final mass of rice, $m_f\ (g)$
(1)	25.1	30.0	22.14
(2)	25.4	30.0	22.14
(3)	25.5	30.0	22.14

Table 6: Average

Replica	Moisture content (%wb)
1	26.2
2	26.2
3	26.2
Average	26.2

Table 7: Preliminary test

Trial	**1**	**2**	**3**	**4**	**5**	**6**
Quantity Of Straw (g)	190	450	300	300	450	650
Moisture Content (%)	16.67	16.67	16.67	16.67	16.67	16.67
Grain Threshed (g)	150	400	250	260	400	600
Clean Threshed Grain (g)	130	390	220	240	330	520
Scatter Losses (g)	33	43	42	46	43	49
Time (min)	1:55	2:05	1:30	1:58	3:00	3:25
Cylinder Speed (rpm)	720	850	855	1000	980	1020

Table 8: Actual test

Trial	**1**	**2**	**3**	**4**	**5**
Quantity Of Straw (g)	2000	2000	2000	2000	2000
Moisture Content (%)	23.37	23.37	23.37	23.37	23.37
Grain Threshed (g)	350	350	350	420	490
Clean Threshed Grain (g)	250	250	240	330	400
Scatter Losses (g)	20	25	26	29	30
Time (min)	1:45	1:22	1:25	1:26	1:28
Cylinder Speed (rpm)	704	959	802	978	1020

Table 9: Supplementary test

Trial	**1**	**2**	**3**
Quantity Of Straw (g)	2000	2000	1000
Moisture Content (%)	26.2	26.2	26.2
Grain Threshed (g)	400	400	300
Clean Threshed Grain (g)	310	320	270
Scatter Losses (g)	20	25	26
Time (min)	1:00	1:00	1:00
Cylinder Speed (rpm)	980	980	980