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DESIGN AND FABRICATION OF CASSAVA MOBLE GRATER

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DECLARATION

STUDENT'S DECLARATION

I, **ISSAH BASHIRU**, declare that this Dissertation, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for an-other degree elsewhere.

SIGNATURE: .....……

DATE: …….....

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of Dissertation as laid down by the University of Education, Winneba.

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DATE: …….....

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Finally, I claim fully responsibility for all omissions, grammatical errors associated with this dissertation.

DEDICATION

This work is dedicated to the Almighty God who has given me wisdom and vision and knowledge to be able to carry out this research work to a successful end .Not forgetting my family members especially my wife, my friends who are my source of inspiration my son Bashiru Rasheed for their massive contribution and advice, may God shower his blessing on all of them.

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ABSTRACT

A portable powered cassava grater was designed fabricated and tested. Most of the common once are electrically operated, hence depend on electricity which in Ghana, is presently erratic in supply and not always available in rural areas. The erratic power, scarcity necessitate the need to address this issues to certain extent by developing a machine that will make life easier in cassava processing for the rural processers, in order to improve their economic wellbeing. This petrol engine powered grater consist of the hopper, the grating unit, the discharge, and the main frame. The mechanism is connected to a belt drive which turns the shaft on which the grater drum is mounted. The machine has a grating capacity of 89.16kg/hr. The machine is cheap, economically viable and can be used by unskilled workers.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Concerns about agricultural productivity growth in Africa have led to the New Partnership for Africa Development (NEPAD) to bring into force the Comprehensive African Agricultural Development Programmed (CAADP).

The CAADP framework projected the need for agricultural growth to attain at least six percent rate (MOFA, 2010, Sam & Dapaah, 2009). The agricultural sector in Ghana has a central role to play in promoting the needed growth and poverty reduction in the economy which is expected to lead to significant improvement in the rural livelihoods (World Bank, 2003). In this direction most agricultural interventions introduced to farmers were designed with the objectives of increasing productivity or food security and further improve the livelihood systems of the beneficiaries (Norton, 2004).

The successful adoption and utilization of the improved technologies by the target beneficiaries are expected to be channeled through their decision making and behavioral change processes. These are further expected to provide an enhancement in their productivity and then produce the desired livelihood impacts (Wu, 2005).

Cassava (Manihot esculenta) is one of the most important economic food crops in Africa. It provides the livelihood of up to 500 million households, countless processors and traders around the world (FAO, 2001). People in the tropical world particularly Africa depend on cassava as one of their major staple food (RTIP, 2004). Ghana is the fourth largest cassava grower in Africa after Nigeria, Democratic Republic of Congo and Angola (Oppong-Anane, 2013). The crop is cultivated by over 90 percent

of the farming population in Ghana, thus making it the right target crop for the reduction of poverty in the country (Oppong-Anane, 2013; Thiombiano, 2013). It also provides additional income earning opportunities and enhance the contribution of the youth to household security (FAO, 2005). Cassava contributes 22 percent of agricultural Gross Domestic Product (GDP) and employs a large proportion of the population (ISSER, 2014; MOFA, 2010).

Nevertheless, the agricultural sector continues to play a significant role in Ghana's economy despite the fall in the sector's contribution to Gross Domestic Product (GDP) from 31.8 percent in 2009 to 22.0 percent in 2013. Agriculture in Ghana employs over 50 percent of the work force, mainly small landholders (ISSER, 2014). To make the sector play a more significant role, the government of Ghana through several programmes including the West Africa Agricultural Productivity Programme (WAAPP) has targeted cassava as important economic crop for promotion in Ghana. Ghana's production of cassava is estimated to be over twelve million metric tons per annum (MOFA, 2009). Interestingly, cassava production has been increasing in the past five years since 2007. In 2007, total production of cassava was a little over 10.2 million metric tons (MT); 11.3 million MT in 2008; 12.2 million MT in 2009; 13.5 million MT in 2010; and 14.2 million MT in 2011 (MOFA, 2013). Correspondingly, the production in the Brong- Ahafo Region also saw a steady but marginal increase in yield from 2007 to 2010 (MOFA, 2013).

The cassava root is an extremely resilient crop which performs well on marginal lands, and it is regarded sometimes as nutritionally strategic famine reserve crop in areas of unreliable rainfall (Hendershot, 2004). Considering the prediction that the impact of changing rainfall patterns will worsen in the coming years and the confirmation by the

Intergovernmental Panel on Climate Change (IPCC) 2007, that some African countries particularly those who depend on rain-fed agriculture like Ghana will see crop yields decline by up to 15 percent by 2020, it is most appropriate for cassava production to be given a much more attention than ever due to its ability to withstand the shocks of climate change. Due to the above reasons, coupled with the increasing pressure on the land, rapid decline in soil fertility, increases in conflicts and natural and manmade disasters, donors and governments in the sub-region are now paying more attention to roots and tubers in efforts to enhance food security and alleviate poverty (Sam & Dapaah, 2009). To achieve this, a number of projects have been funded or are being funded by various donors to strengthen the provision of support services in a number of areas including research, extension, credit, rural infrastructure, marketing, and input delivery (Sam &Dapaah, 2009).

One of such supporting organizations which is currently investing huge capital and other resources to support cassava farmers to increase productivity in Ghana is the West Africa Agricultural Productivity Programme (IFAD, 2005). The West Africa Agricultural Productivity Programme (WAAPP) is part of the World Bank's instrument for the implementation of Africa Action Plan (AAP) aimed at supporting regional integration and making agriculture more sustainably productive (MOFA, 2010; Sam & Dapaah, 2009). In order to significantly reduce poverty in the region, an annual Gross Domestic Product (GDP) growth rate of at least 8-10 percent is required to be sustained in the countries of the region. The WAAPP was initiated in 2007 with implementation starting with Ghana, Senegal and Mali as part of a 10-year World Bank funded programme. The phase One focused on mechanisms for sharing technology, establishing National Center of Specializations (NCOS) and funding of technology

generation and adoption in the participating countries' top priority areas. These top priority areas are: roots and tubers (Ghana), rice (Mali) and drought tolerant cereals for Senegal (MOFA, 2010; Sam & Dapaah, 2009).

The objectives of the initiative were two folds: The first was to promote growth in the agricultural sector by facilitating access to improved technologies for the benefit of agricultural producers and agro-industries so as to ensure improved agricultural productivity and competitiveness of African agricultural products on the international market. The second was to improve the living conditions of consumers, especially those in the extreme poverty brackets through the provision of agricultural products at competitive and affordable prices (Sam & Dapaah, 2009).

1.2 Statement of the Problem

The Food and Agriculture Sector Development Policy (FASDEP II) document (2007), indicated that agriculture in Ghana is characterized by a large, smallholder sector and a very small large commercial sector, which comprises of both farming and agro-processing. Small-scale or micro enterprises contribute significantly to economic growth, social stability and equity. The goals for micro enterprise are to increase income and assets, to improve skills and increase productivity (Timpo et al., 2008) as well as to produce new products or improve on existing products.

Cassava production is a very important and widespread livelihood strategy in Ghana. The importance of the crop stems from the fact that it provides employment, food, and cash to majority of Ghanaian farmers, processors and producers along the value chain.

For example, joint (2006) estimated that 1, 998,184 farming households were engaged in the cultivation of cassava in Ghana.

In a bid to address the demand-supply gap various processing machinery have been developed to help reduce the drudgery associated with cassava processing and also to increase productivity. But with the influx of the numerous processing equipment, most of the rural small-scale processors still depend on the traditional methods which makes their work more labor intensive with low production. This is due to the high prices of the machines. This project work seeks to come up with very affordable equipment that would be very accessible to the small-scale farmers in the rural areas.

The current method of processing cassava is associated with problems such as:

- The traditional mode of cassava processing is labor intensive.
- Tubers are carried to far places before grating is done (farm to the house).
- Production is low, hence low income
- Insufficient funds to purchase high capacity cassava processing equipment.
- The effectiveness is low.

1.3 Aim of the Study

The main aim of this work is to design and fabricate a mobile cassava grater for the local cassava processors who are still using the traditional way of grating their cassava due to the cost involved in acquiring a mechanized equipment for the processing.

1.4 The Objectives of the Study

General Objective

The general objective of the project is to curb the hindrance affecting the local cassava processors.

Specific Objectives

The specific objectives of the study are to:

a. make the grating of cassava very easy and increase productivities in the production sector:
b. increase revenue generation to enhance living condition of the farmers:
c. reduced the laborious nature of the traditional process of the production of cassava to the modern methods of grating of the cassava in garri and cassava past.

1.5 Guiding Questions

1. What appropriate design mechanism will be used to reduce the laborious nature of the traditional cassava grating process for farmer in our communities.
2. How to make the grating of the cassava very easy and simple for our poor farmers.
3. How do we increase the production of cassava product **garri** in order to increase more revenue for our poor farmers in our communities.

1.6 Significant of the Projects

The identification of the processing methods and qualities of the cassava products would help boost the marketing of the cassava product both locally and internationally and some strategies would be outlined to support the industry to improve on quality**.**

It would give more information on the equipment and also add new information to already existing knowledge.

1.7 Delimitation of the Project

The study could have discovered two or more alternative machines but due to time and financial constrains it is limited to only downsized cassava grating machine.

1.8 Limitation

The limitation of this project includes inadequate resources like, time and finance

1.9 Organization of the Study

The whole study is organized into five chapters. Chapter one which consists of the introduction has the following sub headings; background of the study, statement of the problem, aim, the objectives, guiding questions, significant of the study delimitation and the limitation. Chapter two is basically literature that has been reviewed. Chapter three consists of the methodology. Chapter four contain results and discussion of the study. The chapter five consists of the summary, conclusions and recommendations of the study

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The literature review of a study denotes the gap between the researcher's curiosity and knowledge of the subject area (Boswell & Cannon, 2014). It helps the researcher to improve the research design and instrument (Cottrel, & McKenzie, 2010). According to O'Leary (2004), a well presented literature review provides credibility of the researcher such that the entire benefits of the study can be obtained. The literature review sought to present the existing theoretical and empirical studies that provided the background and basis for the study. It discusses writings and study that other people have done which helped the researcher in the present studies.

The following thematic areas have been covered:

Agricultural technology, technology adoption theories, programme impact assessment, working with farmer groups, principles of perception, technology transfer in agricultural programmes, elements of sustainable livelihoods approach, conceptual framework and demographic and farm related characteristics of cassava farmers.

2.2 Agricultural Technology

Technology can simply be defined as the process by which nature is modified by human beings for the acquisition of his basic needs. Hornby (2000) defined technology as the scientific study and use of mechanical arts and applied sciences as well as their practical application in industries. Atala (2002) also defined technology as organisation of capacity for a purposive task.

According to Science and Development Network, agricultural technologies and knowledge have until recently been largely developed and disseminated by public institutions (SciDev.Net, 2014). Over the past two decades, due to the rapid development of biotechnology for agricultural production as well as the globalized and liberalized nature of the world's economy, countries in the sub-region have witnessed a boost in private investment in agricultural research and technology (Rubenstein & Heisey, 2005). This phenomenon has led to the exposure of agriculture in developing countries to international markets and also influence of multinational corporations. However, the key role played by public sector agriculture, particularly in managing the new knowledge, supporting research to fill any remaining gaps, promoting and regulating private companies, and ensuring that their effects on the environment are adequately assessed, cannot be over emphasized (SciDev.Net, 2014, Rubenstein & Heisey, 2005).

James (2004) and Pineiro (2007) identified a new and more complex model for transferring technology, which he called the Evolving Model (EM). Evolving Model has four main components namely; knowledge management, gap filling research, promotion and regulation of the private sector, and environmental impact analysis. Under knowledge management, the public agricultural sector continues to be largely responsible for knowledge management. It articulates national needs, matches them to scientific opportunities, mobilizes available technology, and adjusts them to farmers' needs (James, 2004). With gap-filling research, major responsibility lies on National Public Research Institutions (NPRI) to research in areas ignored by the private sector. The public institutions research into agriculture in developing countries represents about a quarter of worldwide expenditure in agricultural research (Pineiro, 2007). If

this will produce high quality research to augment internationally available technologies and also help developing countries have access to them, then there is a need for effective management of the process (James, 2004).

According to Pineiro (2007) with regards to promoting and regulating the Private Sector, the public sector agriculture needs to promote private investment and regulate private companies. It means that policies can be developed to help and encourage the private sector to invest in technologies that are relevant to farmers in developing countries and for that matter promote pluralistic technology transfer. With environmental impact analyses, policymakers are advised to consider the environmental consequences of agricultural research. It is known that new agricultural technologies often use natural resources intensively and potentially damage the environment. Examples are, through land degradation or contamination of water bodies. This especially happens if the new technology is imported without being tested in local conditions (James, 2004 & Pineiro, 2007). To overcome this menace, policy makers are once again advised to develop regulatory measures, like mandatory environmental impact assessments. This can minimize potential environmental damage and also protect consumers as well as users of the technologies (James, 2004).

2.3 Technology Adoption Theories

Extensive research has shown that Rogers' diffusion innovation theory is the most appropriately used framework with regards to adoption of technology in agricultural programmes (Foust Chapman & Health-Camp, 2005). Rogers (2003) referred to the word "technology "and "innovation" as synonymous. He defined technology as "a design for instrumental action that reduces the uncertainty in the cause-effect relationship that is involved in achieving a desired outcome" (Rogers, 2003).

Four factors are known to influence adoption of an innovation. These include the innovation itself, the communication channels used to spread information about the innovation, time and the nature of the society to whom that particular innovation or technology is being introduced (Rogers, 1995).

Eneh (2010) identified four adoption theories of Rogers' as theories on technology adoption and diffusion, innovation decision process theory, and perceived attributes theory. The innovation-decision process theory is known to be based on time and has five distinct stages.

The first stage is knowledge; here potential adopters must first learn about the innovation, and they must act to the merits of the innovation. They must also decide to be persuaded to adopt the innovation, and finally once they adopt the innovation, they must implement it. Above all, they must confirm that their decision to adopt that innovation was appropriate. Once these stages are achieved, then diffusion is known to have successfully taken place (Rogers, 1995).

The theory of rate of adoption suggests that the adoption of innovations is best represented by an s-curve on a graph. The theory alludes that adoption of an innovation grows slowly and gradually in the early stages. This is followed by a period of rapid growth that is expected to taper off, become stable and finally decline with time (Eneh, 2010). The theory of perceived attributes is based on the notion that individuals are more to adopt an innovation if only they perceive that the innovation has the following attributes: First, the innovation must have some relative advantage over an existing innovation or the status quo. Second, the innovation must essentially be compatible with existing values and practices.

Third, the innovation must not look too complex. Fourth, the innovation must have the ability to be tried (implying, the innovation can be tested for a limited time without being adopted) and finally, the particular innovation must be able to offer observable results (Eneh, 2010; Rogers, 1995).

2.4 Technology Adoption among Farmers

Empirical studies undertaken to find the determinants of agricultural technology adoption among farmers focused on the following: risks and uncertainties according to Koundouri, Nauges and Tzouvelekas (2006), Simtowe, Mduma, Alban and Zeller (2006). Information asymmetric, institutional constraints, human capital, and access to inputs according to Feder, Just and Rosenzweig (1995), Singh and Kohli (2005) and availability of supportive infrastructure, as well as social networks and learning. These were identified as the possible predictors of adoption decisions. In a comparative study on the adoption of High Yielding Varieties (HYVs) of rice among some states in India, Singh and Kohli (2005) observed that affordability and easy access to the technology can be enhanced when the complimentary inputs are available and affordable. In another school of thought, social network and learning principles opined that adoption of technologies are influenced by the "Bayesian Learning" concept (Tenenbaum, 1999). The Bayesian Learning concept stipulates that only a handful of farmers may adopt a technology after they have experienced the technology on a very small scale. The understanding is that recipients of the technology will only adopt and use them when they realize the first positive results. In this case there is high possibility that the rate of adoption will increase in the following years.

Applying what is known as the "target-input model" transfer of new technology, Foster and Rosenzweig (1995), and Conley and Udry, (2002) obtained similar results in a study they conducted. They realised that farmers were hesitant and conservative in making the best use of inputs or innovations when they were first introduced to them. Conley and Udry (2002) undertook a study in fertilizer application on pineapples in Ghana whilst Foster and Rosenzweig (1995) undertook a study in adoption of HYVs of rice in India. Conclusions from their results indicated that initially there was low adoption of the innovations by the farmers which could possibly come as a result of poor communication and knowledge about the management and productivity of the new technology (Foster &Rosenzweig 1995; Conley & Udry, 2002). However, adoption of the technology scaled up with time as the farmers practiced farmer-to-farmer technology and also built up their individual personal experiences (Foster & Rosenzweig 1995; Conley & Udry, 2002).

Bandiera and Rasul (2006) reviewed the connection between the social networks and technology adoption in the Northern parts of Mozambique. They supported the target-input model idea from their findings and propounded that farmers who discussed agricultural practices with their neighbours have high prospects to adoption of new technologies.

2.5 Agricultural Productivity and Farmers' Livelihood

Agricultural productivity is defined through literature in several ways:

The definitions include general output per unit of input, farm yield by crop or the total output per hectare, or output per worker. According to Poulton, Kydd and Dorward (2004) agricultural productivity depends upon both technical change and the

availability of input, seasonal finance and marketing systems to increase farm production, and issue to consumers at competitive prices.

Empirical evidence from several studies conducted across rural farming communities support the assertion that growth in productivity has a direct positive influence on improvement in farmers' livelihood (Mellor, 1999). Studies conducted on small scale cassava farmers in Zambia revealed that production of cassava through traditional methods and adoption of improved varieties contributed significantly to the livelihoods of those who were located at the northern and western belts (Cadoni, 2010). According to the women groups, their belief is based on the fact that the crop is multipurpose, drought tolerant and has low inputs requirements for production (Cadoni, 2010).

Literature provides evidence that growth in agricultural productivity can improve livelihoods in several ways such as real income changes, generation of rural non-farm activities, and effects on food and cash crops (Thirtle, Lin & Piesse, 2003). Case studies review conducted in twelve countries by Byerlee, Diao and Jackson (2009), compared agricultural growth among farmers within the selected countries. The study revealed that countries with optimal agricultural growth per work exhibited the highest rate of rural livelihood improvement (Byerlee, Diao & Jackson, 2009). Fan, Hazell and Thorat, (1999) also found out that investment in road networks, agricultural research and provision of extension services had the highest impact on both productivity and livelihood improvement.

Demographic and Farm Characteristics and Productivity Extensive review of literature revealed that farmers' demographic and farm related characteristics have a significant relationship with agricultural productivity. Studies by Obasi, Henri-Ukoha, Ukewuihe

and Chidiebere-Mark (2013) among arable crop farmers in Imo State, Nigeria showed that the age, educational level, farming experience and farm sizes significantly affected agricultural productivity. Teryomenko (2008); Helfand (2003); Kausar (2011) and Gill (2011) confirmed the above assertions. Helfand however, proved further that relations between farm size and productivity is far complex than is perceived by earlier research. For example, he opined that productivity is influenced primarily by how large a farm is.

Higher household sizes promote agricultural productivity and also ensure food security. Studies such as Bassey and Okon (2008), Nandi, Gunn and Yukushi (2011) reported that larger household size impacted positively on cassava production in Nigeria. Improved Cassava Yields and Productivity According to the World Bank (2000) the global strategy to improve agricultural and rural statistics considers crop area, crop production and crop yield as three key variables that should be part of the minimum principal data set that all countries should be able to provide. It identified crop yield, as one of the important indicators for agricultural development. In effect, crop yield is defined as: CROP YIELD = Amount of harvested products ÷ Crop area. It is normally expressed in kilogramme (kg) or metric tons (World Bank, 2000).

Improved cassava yields in Sekyere South District in Ashanti Region of Ghana reported 12.1 tons per hectare in 1997 and 12.8 ton per hectare in 2008, with an average yield of 12.0 tons per hectare (MOFA, 2009). It is noted that the new cassava varieties out-yield the local without fertilizer (Owusu & Donkor, 2012). For example, two improved varieties (Nkabom and IFAD Bankye) released by KNUST in 2005 has an average yield of 48 tons per hectare (Owusu & Donkor, 2012). According to Addy, Kashaija, Moyo,

Quynh, Singh and Walekhwa's study (as cited in Sam & Dapaah, 2009), some farmers in the Brong-Ahafo and the Ashanti Regions have testified that the improved varieties yield three times more than the local varieties. Low yields in cassava are due largely to the fertility of our soils, coupled with inefficiencies in agricultural production, low adoption rates of technologies and to some extent inadequate provision of support services (Sam & Dapaah, 2009).

2.6 Some Constraints to Productivity and Livelihoods

Strangely, it is not always the case that growth in productivity translates into real farm households' income and hence improvement in livelihood unless certain conditions are met (Fan, 2004). There is the need for governments and other stakeholders to help crop farmers to address the problem of high production and transportation costs, vis-a-vis assisting to provide farmers with readily available market, favorable pricing policies and needed infrastructure for value addition (Neven, Odera, Reardon, & Wang, 2009). Agricultural based developing countries like Ghana faces challenges of postharvest losses during glut situations for some perishable staples like cassava. Without international markets and value addition for such domestic products, livelihoods are adversely affected (World Bank, 2007). Some studies were done by Diao and Pratt (2007) in Ethiopia; Minten and Barrett (2008) in Madagascar; Jayne et al. (2010) in Kenya, Malawi and Mozambique on productivity and livelihood. The results showed that agricultural productivity in staple crops have potentials of improving livelihood than any other agricultural and non-agricultural sector. In actual fact, there are some constraints to productivity which can best be described as barriers to productivity. Literature (Neven et al., 2009) has shown that some of these barriers include population growth, technology, asset and income distribution, and access to market. Productivity

can be affected by population growth, especially in sub Saharan Africa where the demographic and farm related characteristics of most countries are partially related to a poverty trap also referred to as "Malthusian trap" (Thirtle, Lin, Piesse, 2003). The Malthusian trap connotes a situation whereby population growth outpaces per capita economic growth of a country (Thirtle, Lin, Piesse, 2003). Irz and Roe (2000) proved in their multisector growth model that a minimum rate of productivity is necessary to counter population growth and avoid a possible "Malthusian trap". There a several factors that sometimes limit the resource poor when opportunities to increase productivity is based on the use of improved technology or innovation (Thirtle, Irz, Lin, McKenzie-Hill & Wiggins, 2001). These constraints limit their technology adoption and has the tendency to affect their livelihood systems (Thirtle et al., 2001).

Technology alone without infrastructure like accessible road network, and extension advice or education would be inadequate to impact livelihood (Thirtle et al., 2001). It is only when there are provision of social services and infrastructure and also initial asset and income disparities are lower, that the resource poor is able to benefit from technology generation (IFAD, 2004).

Rural livelihood impact normally depends on the production and consumption patterns that result from increased agricultural productivity. Situations where production resources are unequally distributed, it is the elites in society who normally benefit from the limited resources generated (Ellis & Freeman, 2004). Studies were conducted by Rios, Masters and Shively (2008) by using the World Bank Living Standard Measurement Survey (WBLSMS) data from Tanzania, Guatemala and Vietnam. The results indicated that farm households with higher productivity are more likely to access market for agricultural products but not the vice versa.

2.7 Role of Agricultural Extension Agents in Technology Transfer

Agricultural Extension Service (AES) has been identified as the important aspect of the intended transformation of the agricultural sector (Rivera, 1997, Leeuwis, 2013). For rural communities to fulfill their respective roles, they require access to productive information on inputs, new technologies, early warning systems for droughts, pests and diseases control mechanisms, credit availability as well as market prices and competitions (Kiplangat, 2003).

The role played by Agricultural Extension Agents (AEAs) in any agricultural enterprise is very critical. Their services are strategic investments because if even land, production inputs, labour, capital, planting materials, technology and favourable weather conditions are available; untrained, ill advised farmers cannot efficiently and productively use them (Dada, 1997).

The AEA also facilitates the process for small-scale farmers to organise themselves into groups. Farmer Groups (FG) are mostly able to gain access to credit and other production requirements and also market their produce through group action (MALA, 1998). The AEA acts as a link between farmers and researchers, thus providing a two-way communication flow between farmers and researchers (Leeuwis, 2013).

2.8 Background of Agricultural Extension Approaches

Extension approach means differently to different authors. For instance Rivera (1997) described it as “system”, whilst Duvel (2004) referred to it as “model”. Leeuwis (20013) also defined it as the fundamental planning philosophy that is practiced by an agricultural extension organisation.

Bergevoet and van Woerkum (2006) classified agricultural extension service delivery under four approaches as Transfer of new technology (TOT), Problem Solving, Learning and Adult Education, and Human Capacity Development. Transfer of new technology is commonly used and known to bring about behavioural change in the farmers in the form of the adoption of new technologies that are externally developed. These technologies are normally already available and tested or practiced by management through the process of information delivery, opportunity and persuasion (Coutts, 1994). It is a mono-way model developed from researchers to the field, thereby making the client a passive receiver (Coutts, 1994). In this instance knowledge is perceived as a product that is moved from science and research to the client. The TOT approach is also criticised because technology is not adapted or suitable for the specific situations that a clientele farmer is confronted with (Bergevoet et al., 2006). Some other identified disadvantages of the TOT are that the propensity of the approach to reinforce social inequalities by benefiting producers who are better resourced than their counterparts materially, intellectually, socially and economically. It also has the tendency to ignore the knowledge, skills, experiences and farmer adaptive abilities (Bergevote et al., 2006).

2.9 Problem-Solving Approach

Problem solving is an important day-to-day role played by AEAs (Madukwe, 2006). Extension communication or advice is often given based on the individual farmers' practices and information needs (Hogeveen, Dijkhuizen & Sol, 1992). As a group facilitator, problem-solving becomes an on-going and integral part of the AEAs' life as well as that of the group members (Ribori, 1997). Seven models can be applied in a problem solving situation and Ribori, (1997) explained them as follows: There is need for the problem to be defined. A good problem definition states the current and the

expected situation. The expected situation becomes an objective and should be stated in a clear, concise and concrete language, and also be realistic and feasible. The root causes of the problems also need to be identified by the group members through brainstorming. Rules of the group must be applied and when necessary gather data or other forms of analysis beyond the group's discussion.

There is need for alternative solutions to be generated from the group members through brainstorming. Evaluation and criticism of other group members should be avoided. The alternative solutions must be evaluated. The group must establish criteria for judging the solutions. Emotional reactions and unnecessary criticisms must be avoided. In the process best solutions must be agreed upon either by voting or criterion evaluation. When used constructively, controversies and disagreements can help select the best solutions (Ribori, 1997).

Finally, the people must be involved to develop an action plan. Their commitments must be built, as well as effective and timely implementation of the solutions must also be ensured. Solutions must be implemented according to planned action and also be evaluated. Possibly, AEAs must add regular and routine check for group progress to their meeting agenda (Ribori, 1997).

2.10 Learning and Adult Education Approach

Teaching farmers in groups is a means of proactive informal education that aims at assisting individual farmers to better understand their situations (Coutts 1994; Madukwe, 2006). The techniques of learning cycles and styles in agriculture that is helpful as conceptual framework in adult learning include concrete experience,

observation and reflection, the formation of abstract concepts and generations, and hypothesis for future testing which leads to new experiences. The learning process is a continuous recurring or cycle coupled with the understanding that the individual develop his own learning cycles. Kolb (1984) identified four learning styles as being associated with the different stages of the learning cycle, namely; assimilative, accommodative, convergent and divergent learning styles. The assimilative learning style is characterized by the ability to reason inductively. It is concerned with ideas and abstract concepts rather than people and social interactions (Kolb, 1984). The accommodative learning style is characterized by ability to solve problems in an intuitive trial- and- error manner rather than through careful examination of facts. It relies heavily on other people for information rather than on its own analytic ability (Kolb, 1984).

The convergent learning style is characterized by the ability to efficiently solve problems, make decisions and apply practical ideas to solve problems. It deals with technical tasks and challenges rather than interpersonal and social interactive issues (Kolb, 1984). The divergent learning style is characterized by the ability to identify concrete examples of a concept and to generate various qualities about the concepts from various perspectives.

It is brainstorming in nature, and individuals with such qualities are very creative, emotionally oriented and prefer to observe rather than act (Kolb, 1984).

2.11 Human Capacity Development Approach

Extension in relation to human development is a means to facilitate and support individuals or groups to take initiatives to identify and access their needs and problems. Extension also seeks to guide individuals and groups to acquire knowledge and skills

required to cope effectively with their situations (Coutts, 1994; Madukwe, 2006). The human development in extension involves a participating approach that applies the principle of participation, adult and action research and learning. The compounding complexities of agricultural and environmental issues make it more ideal to encourage farmers to adopt participatory technology development (PTD) approach to finding solutions to their problems. The advantages of the human capacity approach include promoting the recognition of local ways of knowing, supporting local innovation and adaptation of technologies. Also involving stakeholders in research that has social and/or financial impact on the farming community, and acknowledging the value of sharing information and ideas among the farmers. Finally, encouraging stakeholder ownership of both problems and solutions, and making use of group processes and learning (Coutts, 1994; Madukwe, 2006).

These approaches have been however criticized on grounds that farmer's may lack the expertise to identify problems because the problems may be new to them (an example is environmental issues) and knowledge developed among the farmers are likely to be limited only to that group of farmers (Black, 2000).

Swanson (2010) also summarized agricultural extension delivery under four paradigms as technology transfer, advisory services, non-formal education, and facilitation extension. The technology transfer paradigm generally, uses persuasive methods for telling farmers which varieties and production practices they should use to increase their agricultural productivity and thereby maintain national food security for both the rural and urban populations of the country. With the advisory services, farmers in most cases are "advised" to use a specific practice or technology to solve persuasive advisory techniques when recommending specific technical inputs to farmers who want to solve a particular problem and / or maintain their productivity (Swanson (2010).

The non-formal education (NFE) paradigm continues to be used in most extension systems however, the focus is shifting more toward training farmers on how to utilize specific management skills and technical knowledge to increase their production efficiency. In other words, to utilize management practices, such as integrated pest management (IPM), as taught through Farmer Based School (FBS). With regards to facilitation extension, front–line extension agents primarily work as "knowledge brokers" in facilitating the teaching and learning processes among all types of farmers (including women) and rural young people. Under this extension paradigm, the field staff first works with different groups of farmers (small-scale, men and women farmers, landless farmers) to identify their specific needs and interests. Once their specific needs and interests have been determined, then the next step is to identify the best services of expertise that can help these different groups address specific issues and/ or opportunities (Swanson, 2010).

2.12 Working with Farmer Groups

Organizing individual farmers who have common objectives (or problems to solve) into one force is generally known as farmer- based organizations (FBOs) but this can include all types of farmer groupings such as Farmer Co-oporative (FC), Farmer Interest Groups (FIGs), Producer Groups (PGs), and Farmer Associations (FAs) and /or Self Help Groups (SHGs) (Swanson, 2010). FBOs have the potential to strengthen the bargaining power of farmers in the marketplace, both in inputs supply and in market supply (Swanson, 2010). FBOs can provide a wide range of extension and advisory services (Diaz, Le Coq, Merccoiret & Pesche, 2004). For instance, they may be organized around clientele groups, and specific interest or larger commercial farmers; or group of farmers who are exporting high value crops. They may also carry out

specific functions and different economic activities ranging from input supply co-oporatives to packaging and marketing of high-value products for export. Organizing farmers into groups can increase the efficiency and effectiveness in supplying the needed extension and advisory service to various classes of farmers. Group formation can facilitate the dissemination of agricultural technology, and help to transform farming systems among various farm households and communities. It can also encourage farmers to adopt environmentally friendly farming practices. FBOs can also influence government policies and programmes that are targeted towards increasing farm income and thereby improve rural livelihoods (Chamala & Shingi, 1997). Group formation is ideally done by farmers themselves. This process can be facilitated by locally identified and specially trained Group Promoters (GPs) or AEAs, who assist the group development process and act as intermediaries (Diaz, Le Coq, Merccoiret & Pesche, 2004).

2.13 Some Benefits of Working with Farmer Groups

Farmers coming together to form working groups has enormous benefits and these can be described mainly as benefits to the individual farmers and also benefits to the government (FAO, 1996). According to Benard and Spielman (2009), and Kruijssen, Keizer and Giuliani (2009) farmer groups are regarded as potentially effective mechanisms to increase farmers' livelihood by reducing information distortions and transaction costs. Small-holders can pool resources and market their products collectively particularly, overcoming the high transaction costs that they incur as a result of their small individual sizes as they maintain their membership in their farmer groups.

Farmer groups are able to improve their members' access to resources such as inputs, credit, training, transport and information and also increase their bargaining power, and in some cases facilitate certification and labelling of their products (Bosc et al., 2002). Collective action when taken by farmer groups can reduce the individual's farmer risks with long term investments such as those required for perennial crops (e.g. cassava) and capital-intensive processing technologies. Di Gregorio et al., (2004) also observed that organised farmer groups can be supported and promoted as useful avenues for increasing farmer productivity and also for the implementation of food security and other developmental projects.

2.14 Groups' Sustainability and Self-reliance Mentality

For the benefits of group action to continue even after outside assistance ceases, the groups must become self-reliant and cohesive units. This requires adherence to the following suggested thematic points (Di Gregoria et al, 2004): A group should not depend too much on a single individual. Regular group savings are essential and should be encouraged. The members' contributions to group activities can help them build a sense of group ownership and solidarity. Records keeping should be encouraged because it helps the group to remember what has been decided at meetings and keep track of contributions, income and expenses. Records keeping are also essential for monitoring group business activities. Small groups have their limits, and it is encouraging for small groups to link up into larger inter-group to have favorable policy environments. Farmer groups are best promoted where legal and policy conditions favor such forms of co-operation, and when the government confines its role to that of a facilitator rather than a controller. The legal and policy environment should encourage rural participation and the formation of informal self-help groups. Meanwhile, rural

people should be allowed to organize their own group businesses and concerns. What the government need to do is to encourage the development of rural communication systems that facilitate information exchange and networking. Also assistance programs should aim at developing group self-help capacities since too much financial assistance can create over dependencies.

2.15 Cassava Farmer Field School (CFFS)

The provision of knowledge to traditional farmers to improve their ecological literacy was a major concern for many organizations including the Food and Agricultural Organization (FAO, 2013). It is in this direction that an educational approach which was called the farmer field school (FFS) was developed in 1989 in Indonesia as part of an FAO Integrated Pest Management (IPM) programmed; initially to address crop health problems on rice (FAO, 2013).

The application of FFS to cassava began in Africa in the late 1990s. The idea of the Cassava Farmer Field School (CFFS) came about as an intervention to address the spread of strains of the viruses causing cassava mosaic virus disease and, more recently, cassava brown streak disease at the time. The main objective was to promote IPM and ecologically friendly cassava production (FAO, 2013). CFFS were established to link up with programmes that distributed disease-tolerant cassava varieties and which they have tested in multiplication fields. The main goal of this learning-by-doing approach was to provide the opportunity for farmers to develop strategies to manage disease problems more effectively, while improving their cassava production practices (FAO, 2013).

CFFSs help farmers to validate and test local knowledge, as well as scientific knowledge generated outside their communities. A process of sharing and critical analysis helps farmers to adapt new information and technologies to their local situation. The CFFS approach (group work) aims to strengthen collaboration within and between groups. It focuses on interaction with farmers, extension services and research. It also helps farmers to improve their knowledge and skills in field management, leading to improved production of cassava. They also help farmers to become better organized and to network with peers and other groups effectively (FAO, 2013).

The basic principle and concept of the CFFS is that, it is a participatory approach for learning that builds on principles of non-formal education. It is a "school without wall" that takes place in a field where the crop (cassava) is grown. The farmers meet regularly in that field to develop their capacities to analyze and solve their individual and shared challenges. The Root and Tuber Improvement and Marketing Programme (RTIMP) adopted a similar training for their participating farmers which were called Farmer Field Fora [FFF] (MOFA, 2010).

2.16 Elements of Sustainable Livelihoods Approach

Livelihood approach is the manner in which thoughts and ideas are directed towards the objectives, scope, and priorities that lead to development (DFID, 2000). The Sustainable Livelihood Approach (SLA) is a general principle or idea adopted by the Department for International Development (DFID) in the late 1990s (DFID, 2000). The SLA concept has been adopted by various organisations like Oxfam, Institute of Development Studies (IDS); which they modified in their specific contexts, priorities, and applications in their work (DFID, 2000).

The combination of the resources (both material and social), and the activities being undertaken by an individual or household for the material provision of its members, comprises their livelihood (Chambers & Conway, 1992). Livelihoods however, go beyond material and monetary rewards.

According to DFID (2000) a livelihood is said to be sustainable when it can cope with and recover from stress and shock, and maintain or enhance its capabilities and assets both now and in future, while not undermining the natural resource base. As a concept, livelihood can impact to less tangible benefits among the clientele farmers such as a sense of greater social acceptance or of being more empowered (Braun, Thiele, Femandez, 2000). Livelihood systems adequately cover the dynamics of household decision-making and actions. In other words, clientele farmers can take the production of their crop as part of a livelihood diversification strategy for better risk management and income generation. What this means is that for cassava production to remain an attractive option of households, it has to maintain its comparative advantage over on-farm and off-farm livelihoods. This can be achieved by possibly increasing productivity and value addition of the crop (Braun et al., 2000).

According to Farrington, Carney, Ashley and Turton (1999), a focus on livelihood should focus on three main characteristics which are people and their activities, the holistic nature of people's activities and the link between the micro and the macro enterprises of the people. Chambers and Conway (1992) also reiterated that livelihoods conceptual framework looks at the interaction between people, their capabilities different types of assets or resources that they have access to, and the activities through which they gain their livelihood.

2.17 Livelihoods Conceptual Framework

A conceptual framework is a set of ideas that are put together in order to provide a coherent approach to analysing and understanding an issue or problem. The framework organises, clarifies and defines terms and concepts. It also spells out the assumptions and values which underlie the concepts. According to Mills and Huberman (1994), and Robson (2011) the conceptual framework of a study is the system of concepts, assumptions, expectations, beliefs and theories that support and inform the research work, and is a key part to the research design.

The livelihoods framework examines the different elements that contribute to people's livelihood strategies. It analyses how forces outside the household or community in 'the external environment' affect them (Brocklesby & Fisher, 2003). According to Brocklesby & Fisher, various livelihoods frameworks, including the ones used by Department for International Development (DFID), Corporative for Assistance and Relief Everywhere (CARE), Oxfam and United Nations Development Programme (UNDP) use similar concepts, but there are differences in how they organize and describe them. However, all these different livelihood frameworks have several things in common as in the following:

1. People are the starting point or the 'center of development'
2. There are important differences among communities, among families and between members of the same family or household and that means no single 'solution' will benefit all households equally.
3. The poor increasingly depend on multiple sources of livelihood.
4. Strengthening livelihood security involves building on the assets, capabilities, and the activities which are the basis of household livelihoods.

5. Links must be made between micro (local) and macro (larger than local) levels. Holistic analysis involves seeing the 'big picture' that links people and their livelihoods, the natural environment and the structures, policies and systems which impact on them. Understanding key links between these elements makes it possible to target interventions to achieve the best effect.
6. Participatory analysis and planning is a way of understanding the livelihood priorities of the poor and the relative importance of the assets on which their livelihoods depend.

The DFID framework employs the various concepts namely; vulnerability context, livelihood assets, structures and processes, livelihood strategies and livelihood outcomes as the basic principles on which it operates. It demonstrates how these concepts are interconnected to provide livelihood for the individuals. The five livelihood capitals (natural, social, physical, financial and human) are provided by the available governments (public), private sectors, laws, policies and institutions. Meanwhile the vulnerability context affects these capitals either positively or negatively (DFID, 1999). Structures are important because they make processes work. If structures can be likened to "hardware", then processes can be the "software". Absence of appropriate structures, especially in the rural areas retards development because many services (public and private) go undelivered. Thus, making such people vulnerable and affect their livelihood (DFID, 1999).

2.18 Livelihood Assets

Assets form a very important component in a livelihood of people. They are the different types of resources that together help people build their livelihood. The types and combinations of assets that people have, enable them to execute their planned

livelihood strategies successfully (Chambers & Conway, 1992; Scoones, 1998). Assets are interdependent and relate with each other. For example, a cassava farmer's access to productive land (natural capital) can be used to produce cassava for income (financial capital), at the same time serve as security collateral to access agricultural credit. Again the income from sale of cassava or credit from the bank (financial capital) can be used to purchase agricultural equipment (physical capital). As people are the foremost consideration in livelihood approach, it is necessary to accept that they require an array of assets to enable them to achieve positive livelihood assets. Carney (1998) therefore identified five core categories of livelihood capitals; natural, financial, social, human and physical. Natural capital entails the resources from which useful resources for livelihoods are derived. They include the stock of natural resources around us (land, clean air, trees, and water bodies) which people rely on for their livelihood. Financial capital entails the resources that people use to achieve their livelihood objectives (DFID, 1999). These include savings (cash, bank deposits or liquid assets such as livestock, and jewelry), sources of credit, and remittances from relations abroad. Social capital entails the networks, as well as shared norms, values and understandings that foster cooperation within or among groups. These include the various social resources (formal and informal relationships), interactions that promote people's ability to work together, membership of formalized organization that are governed by accepted rules and norms, relations of trust that facilitates cooperation (Healy & Cote, 2001).

Human capital comprises the skills, knowledge, and capacity to work and good health that enables people to undertake different livelihood strategies in order to achieve livelihood outcomes. It assists in the achievement of the other five capitals (DFID, 1999). Physical capital includes the basic infrastructure, physical goods and facilities

(both public and private) that people use in support of livelihood strategies. Examples of the public facilities are access to information, water and sanitation, affordable transport service and examples of the private facilities are shelter, agricultural equipment and vehicles, and household goods (DFID, 1999).

The extent to which people are able to access these assets to provide their livelihoods are strongly affected by their "vulnerability context" and also their "livelihood strategies" (DFID, 1999). Livelihood strategies are the various activities and decisions that people take to achieve their livelihood outcomes and goals. They emanate from happenings and realities that the individual or society find from the immediate surroundings or the environment (DFID, 2000). It is a constant process of decision-making and activities that take diverse forms. Vulnerability context or livelihood insecurity on the other hand are the shocks, seasonality and trends that affect livelihoods. The shocks are sudden unexpected events that have significant and negative impact on livelihoods. They are irregular, and differ in intensity and events such as; natural disaster, civil conflicts, and collapse of crop prices or ill-heath of livestock for farmers. Some shocks can look like trends, for example increase infection rate for Human Immune Virus (HIV)/Acquired Immune Deficiency Syndrome (AIDS) and malaria can have negative impact on livelihood at national or regional levels leading to death of family members (DFID, 1999).

Seasonality are seasonal changes that affect assets, activities, prices, productions, employment opportunities and health of the vulnerable. The poor tend to be more vulnerable to the adverse effects of seasonality than the rich in society. It can also affect the poor in the urban areas especially, those who spend large proportions of their

income on food (DFID, 1999). Trends are forces or changes that take place over a longer period of time than those of the shocks and seasonality. They have either positive or negative effects on livelihoods. The effects of trend can be described as Economical (declining food crop prices that affect the farmers, and development of new markets); Population related (increasing population pressure); and Resources related (soil erosion and deforestation). Livelihood outcomes are achievements or outputs of an individual's livelihood strategies. The DFID's Sustainable Livelihood Framework (SLF) identified "five" types of livelihood outcomes. These are more income, increased well-being, reduced vulnerability, improved food security, and more sustainable use of the natural resources (DFID, 2000).

2.19 Principles of Perception

Perception, according to Van den Ban and Hawkins (1996), can be defined as a process by which an individual receives information or stimuli from an environment, and transforms them into psychological awareness. Gamble and Gamble (2002) defined perception as a process whereby an individual selects, organises and subjectively interprets sensory data in a way that enables him or her to make sense of the world. It can therefore be deduced from the definitions above that perception as a process involves the application of the senses of an individual to interpret the "world" or the environment in which he or she finds itself. However, there is a school of thought that perception transcends beyond application of the senses alone by an individual. For example, Gamble and Gamble 2002 reposed that what happens in the real world may not necessary be the same as an individual perceives a particular situation to be. In other words, an individual's interpretation of events may significantly not be the same as that of other people. In principle, perception is governed by relativity, selectivity, organisation, direction, and cognitive style.

2.19.1 Relativity

Van den Ban and Hawkins (1996) maintained that an individual's perception about an issue or object is not obsolete but rather relative. For example, an individual may not be able to judge the height of a standing tree but may be able to describe whether it is longer or shorter than another one.

Therefore, in the course of designing a message, an individual perception of any part of the message is influenced by the context that precedes the message. Therefore, perception in effect is influenced by an individual's surroundings.

2.19.2 Selectivity

According to Van den Ban and Hawkins (1996) an individual's perception is selective, in that at any point in time one's senses receive a host of stimuli from the environment around him or her. As the nervous system cannot sensitise all the available stimuli, the individual responds only to a selection of those stimuli. One's choice of selection for an experience is reinforced by existing attitude, beliefs and values. Those experiences that are not significantly consistent to his or her existing attitudes, beliefs and values are ignored (Gamble & Gamble, 2002). In effect, capacity building and past experience of persons can also influence their perception.

2.19.3 Organisation

A person's perception can be described as organised in the direction that he or she can structure the sensory experience in a manner that makes sense to him or her. In a twinkle of an eye, an individual's senses process visual and aural stimuli into figures. A figure is easily attracted to a designer who wishes to incorporate that "figure" into a particular part of a message, depending on how "good" that figure is. "Closure" is another term

used to describe perceptual organization (whereby an individual perceiver tends to close what he or she perceives to be an open or incomplete figure).

2.19.4 Direction

An individual perceives what he or she is "set" to perceive. What an individual selects, organizes or interprets is influenced by his or her mental set. An important perceptual concept mostly used by communication designers to limit the amount of alternative interpretations given to a stimulus is called "set". According to Van den Ban and Hawkins (1996), one set-back that affects communicators when expecting their audience to understand a situation in a new way is the audience's "perceptual set". The age, motivation, past experience and educational level of a person influences his or her perceptual set (Gamble & Gamble, 2002). The authors however, reposed it that once past experience differs even among people of the same age, it implies then that experience affects the manner in which stimuli is perceived by an individual. In respect to education, Gamble and Gamble (1996) reported that it can be a barrier to communication instead of facilitating it. The implications are that individuals learn lesson in life differently from one another and in effect can perceive the same stimuli differently.

2.19.5 Cognitive Style

Due to the differences in cognitive style of individuals, their perceptions differ significantly from one another (Van den Ban & Hawkins, 1996). A person's mental process works remarkably in different ways depending on personality factors such as a tolerance for ambiguity, degree of "close" and "open" mindedness and authoritarianisms. Once it is not practicably possible for an individual to design

different messages by combining all cognitive styles among his audience, "message redundancy" is recommended. This is a term that is used to describe how an individual should adopt a strategy by which the same idea is presented in a number of different ways which will appeal to most cognitive styles (Van den Ban & Hawkins, 1996).

2.20 Evaluation in Agricultural Programmes

Evaluation is a system of judging, appraising, determining the worth, value or quality of a project, or activity in terms of its relevance, efficiency, effectiveness and impact. Simply put, evaluation is a systematic process to determine what a programme is and how well the programme does it (Patton, 1990). Evaluation is used in many programme contexts and across many different disciplines. Even within one project there may be several evaluations initiatives underway. For this reason, in "good" evaluations the choice of evaluation approach needs to be context specific and take into consideration the purpose for which the study is being undertaken (Christie, Ross & Klein, 2004; Worthen, Sanders & James, 1997). Most evaluations are carried out for two main purposes: improve programme design and implementation, and demonstrate programme impact. For improvement of programme design and implementation, it is important for project evaluators to periodically assess and adapt their activities to ensure that they are as effective as they can be. Evaluation can help them identify areas for improvement and ultimately help them realize their goals more efficiently (Hornik, 2002; Noar, 2006). Evaluation also enables project evaluators to demonstrate their programmer's success or progress. The information that they collect allows them to better communicate their programme's impact to others, which is critical for public relations, staff morale, and attracting and retaining support from current and potential funders (Hornik & Yanovitzky, 2003).

There are various types of evaluation, but two main philosophical approaches are generally used; formative and summative evaluation. Formative evaluation is an on-going process that allows for feedback to be implemented during a programme cycle whereas summative evaluation is used at the end of a programme cycle so that it can provide an overall description of programme effectiveness. It enables stakeholders to make decisions regarding specific services and the future direction of the programme that cannot be made during the middle of the programme cycle (Scriven, 1967). Although there is a necessity for both formative and summative evaluation approaches, modern literature on programme evaluation tends to promote formative approach: that is, evaluation which is concerned with the process of programme development or improvement (Scriven, 1967).

However, Voichick (1991) reports that many extension educators may place more emphasis on the summative evaluation due to the need for impact data to address accountability and progress. Chambers (1994) reiterates that it is not the timing that distinguishes formative from summative but the use of the evaluation data.

According to Pefile (2007) an impact-assessment study aims to determine causality and to establish the extent of improvement for the intended beneficiaries. Impact assessments are time sensitive and, therefore, there is the need for studies to be conducted periodically throughout the duration of the project that is being assessed (Pefile, 2007).

2.20.1 Principles of Basic Impact Evaluation Designs

There is no one straight jacket rule for conducting a good evaluation in agricultural extension. The term evaluation is subject to different interpretations and various

individuals and organisations define it in various contexts. Agricultural extension officers and organisations adopt on-going and informal processes to evaluate their agricultural programmes and activities through casual feedbacks and observations. Useful results are obtained for relevant and efficient operation of the programme. On the other hand, researchers can enhance the value of evaluation results by devoting sufficient, forethought and planning to the evaluation process (Lewis, Ritchie, Nicholls & Ormston, 20013).

Formal evaluation therefore refers to thoughtful process of emphasising questions and topics of concern, collecting relevant information and further analysing and interpreting the information for what it is designed and proposed for. In effect, evaluating agricultural programmes will require the researcher's fore knowledge of the programme and the types of questions to be answered (Lewis, Ritchie, Nicholls & Ormston, 20013). Bennettt's Hierarchy in Extension Programme Evaluation For extension programme evaluators to be able to successfully measure incremental changes, Bennett (1979) developed what has been commonly named as "Bennetts's hierarchy" that showed the causal links between the steps from inputs to outcome. It is such that stakeholders can follow the developments that take place in the cause of the funded life of extension programmes. Seven steps were identified: Inputs (staff time, costs, and resources used); Activities (newspapers or newsletters, articles, discussions groups, and workshops); People's involvement (number of people reached, characteristics of people, frequency and intensity of contact); Reactions (the degree of interest, like or dislike for activities, and the perception of projects); KASA (Knowledge-what the people know, Attitudes-how the people feel, Skills-what the people can do, and Aspirations-what the people desire); Practice (adoption and application of knowledge, attitudes, skills, or

aspirations); End results (the social, economic, environmental and individual consequences of the programme).

The Rockwell and Bennett Model of Extension Programe Evaluation also called the Targeting Outcomes of Programmes (TOP) programme planning and evaluation was developed from Bennett's hierarchy in 1975 and reviewed by Rockwell and Bennett in 2004. The model purported to focus on encouraging extension programme planners to consider the outcomes they intended to achieve at each step of their programme planning process. The TOP model explains that programme planning and programme performances are mirror images of each other (Rockwell & Bennett, 2004); that separates the model from other development models such as the Logic Model. The TOP model also has seven levels, namely; Resources, Activities, Participation, Reactions, KASA (Knowledge, Attitude, Skills, Aspirations) Practices and Social-Economic-Environmental conditions. Feedback is encouraged at each level of the divide; which is programme development on one side and programme planning on the other side. The TOP model uses two types of evaluation techniques to determine programme performance; process and outcome evaluation (Rockwell & Bennett, 2004). Process evaluation measures the resources used, activities held, participation and participant's reaction. The first four levels (inputs, activities, people's involvement and reactions) evaluate implementation, and they are the easiest part of the programme evaluation process. Process evaluation results provide feedback needed by programme implementers to improve the mechanics of their programmes. Outcome evaluation measures changes in participants' knowledge, attitudes, skills and aspirations (KASA), participants' behaviour; and social, economic, environmental outcomes. The last three levels (KASA, practice and end results) measures outcomes and focuses on the

immediate, medium as well as long term benefits of the programme for individuals and communities. Incidentally, the outcome evaluation is progressively more difficult to conduct than the process evaluation (Rockwell & Bennett, 2004). This is because, in most cases extension evaluators develop the highest interest to assess the effect a programme has on changing practices and improvement in the social, economic and environmental conditions. However, the observed outcomes might have been contributed by other factors rather than the programme intervention. Using the TOP model to measure programme performance does not guarantee that an implemented programme was the sole cause of any programme outcomes, except that there is high likely association between programme and outcomes (Rockwell & Bennett, 2004).

2.20.2 Context, Input, Process and Product Evaluation Model

According to Stufflebeam and Shinkfield (2007) there are about 26 approaches that are normally employed to evaluate projects. These 26 may be grouped into five categories: Pseudo evaluation, quasi evaluation studies, improvement- and- accountability oriented evaluation, social agenda and advocacy, and eclectic evaluation. Stuffflebeam and Shinkfield (2007) explained that when compared with professional standards for project evaluation and also rating by utility, feasibility, propriety and accuracy, the best evaluation approach that has emerged is the Context, Input, Process and Product (CIPP) evaluation model.

The CIPP model of evaluation is identified under the improvement- and- accountability category and known to be one of the most widely used evaluation models (Stuflebeam & Shinkfield, 2007).

The CIPP evaluation model is an elaborate framework developed by Stufflebeam for conducting formative and summative evaluations. It is a framework for guiding evaluation of programmes, projects, personnel, products, institutions and evaluation systems (Stufflebeam, 2003). The CIPP model of evaluation is based on two major assumptions:

1. Evaluation plays an important role in initiating and bringing about change.

2. Evaluation forms a pivotal aspect of routine agricultural programmes. In effect evaluation should not be regarded as special activity conducted only when agricultural projects are introduced (Stufflebeam, 2003).

According to Stufflebeam (2003) evaluation is a process of explaining, assessing and providing needed information to judge alternative decisions. The CIPP is conducted as a process and each element represents a type of evaluation undertaken independently or as an integrated event (Gredler, 1996).

In summary, the context evaluation represents planning decisions; input valuation represents structuring decisions; process evaluation represents implementing decisions or recycling decisions to judge; and product evaluation represents reaction to programme achievements.

Context evaluation is a type of situational analysis undertaken by an evaluator. Based on the prevailing realities, an assessment is made with regards to what need to be done. It is a form of baseline information that leads to the operations and accomplishment of a whole system. The main purpose of context evaluation is to define the environment. This is to, identify the relevant conditions related to a particular environment, and then direct attention to unachieved activities, and lost opportunities in other to determine

what need to be achieved (Sufflebeam, 2003). The identified "gap (s)" forms the objectives of the evaluation.

Input evaluation forms the next stage of the model designed to provide information on how to use resources to achieve expected goals. Input evaluates specific areas of the programme by ensuring the following: that the programme objectives are met appropriately and the objectives are in line with expected outcomes. Again, the contents are in agreement with the goals and objectives of the programme and the various steps put in place to undertake the activities are appropriate. Above all, there are other activities that can help achieve planned objectives and also there are enough reasons to believe that the contents and steps chosen will successfully produce expected results. In effect, one of the main purposes of input evaluation is to assist clients to develop a workable plan based on their particular needs and circumstances (Stufflebeam, 2003). According to Stufflebeam 2003, there are three stages involved in process evaluation. The first is to predict possible shortcomings during programme implementation stage, and then provide information for decision making and finally keep records of occurrences as they unfold. The main purpose of process evaluation is to provide feedback about needed changes that may come about if implementation is inadequate. Stufflebeam, (2003) indicated that process evaluation also ensures whether activities are on schedule; activities are implemented as planned; available resources are being used efficiently; and programme participants are comfortable with their assigned roles. Process evaluation also provides information to stakeholders who want to learn about the programme and also assist stakeholders to interpret programme outcomes (Gredler, 1996). Product evaluation is identified as an important segment of "accountability report" for evaluators (Stufflebeam and Shikfield, 2007). This evaluation is primarily

used to determine whether an ongoing programme need to be continued, repeated and /or extended to other parts of the localities (Stufflebeam, 2003). The primary function of the product evaluation is to measure, interpret and judge achievements. It also provides directions for improving programmes to better serve the interest of beneficiaries so as to beat down cost.

2.21 Input and Credit Support to Farmers

Availability of credit and /or input is a very important factor in the successful adoption and utilization of technology (Baryeh, Ntifo-Siaw, Baryeh, 2000). Once most cassava cultivation practices are done under rain fed conditions, it will be appropriate that farm inputs are made available to farmers on time and at reasonable prices (Baryeh et al., 2000). Farmers can thus take advantage and use the resources for their productive farming enterprise.

A study conducted in Sekyere South District in the Ashanti Region of Ghana on improved cassava variety "Bankyehemaa," revealed that farmers' access to input had significant impact on area of cassava cultivated (Owusu & Donkor, 2012). Studies have also shown that when rural farmers have adequate credit to access inputs such as improved cassava planting materials, agrochemicals and hire labour, adoption of technology is enhanced and area under cultivation subsequently increases. Demographic and Farm Related Characteristics of Cassava Farmers The demographic and farm related characteristics of the cassava farmers is reviewed in terms of sex, educational background, family size, age and farming experience.

2.22 Sex of Cassava Farmers

Studies have shown that in sub-Saharan Africa women constitute between 60 and 80 percent of the labour for food production, both for household consumption and market (FAO, 1994). Predominantly, agriculture is being managed by women due to the fast out-migration by men (FAO, 1998).

The FAO (1985) asserted that women play a significant role in agriculture as they constitute two-thirds of the work force in agricultural production in Africa. This was supported by Sabo (2008) that about 70 percent of rural women constitute the total agricultural workers, 80 percent of food producers and over 90 percent of those who process basic food stuff are women, and they undertake 60 to 90 percent of rural marketing. The traditional roles of men farmers are changing. For example, in Kenya about 86 percent of farmers are women, 44 percent of whom represent their husbands in their absence (Saito, Mekonnen & Spurling, 1994). According to Prah (1996), Ghanaian women constitute about 52 percent of the agricultural labour force and produce about 70 percent of the total crop. Cassava is labelled “woman’s crop”. This is evident from the fact that women undertake most of the processing activities (Nweke, Spencer & Lymann, 2002). Studies have shown that women are increasingly providing labour in the production of cassava (Nweke, 2002). Although men are still playing a central role in land preparation, women play a major role in the post-harvest activities in the commercial production of cassava (Saito et al., 1994). Adewale, Oladejo and Ogunnyi (2003) opined that gender should not be hindrance to farmers in cassava production, however Oledeji, Oyedekun,

Bankole (2001) observed that there is the general belief that men are naturally stronger than women and so the men are more qualified to accept energy demanding jobs such as cassava farming than the women.

2.23 Educational Background of Small-holder Cassava Farmers

Anyanwu, Kalio, Manila and Ojumba (2012) observed that when there is an increase in the educational levels of cassava farmers there comes an equal resultant increase in their orientation towards cassava production for the market. In that effect, poorly educated farmers tend to be conservative and are mostly found to resist new innovations. Another effect of poor level of education is the continuous use of traditional farming practices which normally lead to the vicious cycle of low productivity. It can be accepted that acquisition of education is a measure of skills that promotes the individuals' chances of success in any given task or activity.

Education thus, can positively influence clients' accessibility to extension services. Nzeulor (2002) however, begged to differ from the above assertion. He reported that when people attain higher levels of education, they accord low participation to farming. Challenges that illiterate cassava farmers who cannot read and write encounter are widespread and there is high possibility that their understanding about information concerning the prospects of the improved cassava varieties can easily be hindered (Nwabueze & Odunsi, 2007). Research suggests that the area cultivated under improved cassava varieties increases as the number of years of schooling of the farmer increases. Thus, education improves the managerial skills and human capital of farmers. It enlightens and imparts the necessary knowledge on new technological packages and provides skills and understanding on how to use the new technologies efficiently.

An individual's exposure to education tends to increase his/her ability to access, process and utilise information relevant to his/her technological needs (Kudi, Bolaji, Akinola & Nasal, 2001). When farmers are able to access information on improved technologies they become better sensitised and that leads to changing their attitudes towards adoption of recommended improved technologies (Caviglia & Kahn, 2001). Education has a positive influence on farm productivity by improving the quality of labour and the probability to adopt agricultural innovations successfully in a rapidly changing environment (Feder, Murgai & Quizon, 2003; Knight, Weir & Woldehana, 2003).

2.24 Farm Sizes of Cassava Farmers

Ojukaiye (2001) and Olayide, Ogunfowora, Essang and Idachaba (1984) classified farm sizes ranging from 0.1 to 5.9 hectares as small farm holdings and indicated that such farms would not allow for meaningful investment and returns such that it can scale on food security. Report has also shown that increase in farm sizes had led to increase in gross income of cassava farmers (Anyanwu, 2009; Obasi, 2005). Meanwhile, Strong (1989) also opined that the average land holdings of small scale cassava farmers are often too small to provide efficient outputs. Implications from the relationship between farm sizes and gross incomes are that naturally, small farm sizes will lead to low outputs and consequently low productivity According to Alao (1971), a farmer may possess positive behaviour towards a new technology, however he might have limitations in respect to insufficient or non-availability of farm land. Rogers and Shoemaker (1997) suggest that when behavior, attitude and consistency are discussed, farm land is identified as one of the eight variables that are mostly necessary for determining the extent to which farmers perceive the acceptability of new agricultural intervention. If farmers in the community's desire to increase their productivity of the improved

cassava varieties yet has the limitation of availability of land, little can be done apart from cultivating on subsistence which can also affect their incomes and livelihoods.

2.25 Household Sizes of Cassava Farmers

As reported by Ani (2004) and Nani (2005) household size in traditional farming community guarantees the accessibility of labour and possible increase in productivity. It therefore means that the higher the farm size, the higher also it is to source labour from within the household.

Notwithstanding the fact that, an increased household size implies an increase in cost of feeding, Effiong (2005) believes that large household sizes enhance the availability of family labour so that there is reduction in labour cost for agricultural production. Omonona, Oni and Uwagboe (2006) asserted that larger household sizes tend to increase the area cultivated under improved cassava varieties.

In effect, higher household sizes promote agricultural productivity and also ensure food security. Studies such as Bassey and Okon (2008), Nandi, Gunn and Yukushi (2011) reported that larger household size impacted positively on cassava production in Nigeria.

2.26 Age of Cassava Farmers

Ogundari and Ojo (2006) reported that cassava outputs decrease with correspondent increase in age of the farmers, indicating that farmers' age impacted negatively on cassava output. This is expected, considering the rigorous and traditional nature of cassava production in our part of the world. The practice is such that aged farmers cannot cope, aside knowing them as risk averse, conservative and as such unproductive. Research has shown that the age of a farmer plays a pivotal role in informing his

adoption decisions, and more youth respond to innovations than older ones (KSADP, 1997). Onu and Madukwe (2002) asserted that the youth are more likely to accept and serve better as technology transfer in cassava production. Age is a factor in delivery and adoption of agricultural technology (Oluyole, Ogunlade, Agbeniyi, 2011). The younger the farmer, the higher his aspirations to accept new technologies than the conservative farmer. The conservation farmer in most cases seems to be more complacent with his or her traditional methods (Tsosho, 2004). Theories have suggested that adult learners seek information that meet their production needs and societal roles, hence they go to places where they feel comfortable, places that are non-intimidating and user friendly, and above all places that speak their language (Cerf & Hemidy, 1999).

2.27 Cassava Farmers' Working Experience

According to Bassey and Okon (2008), Gbigbi, Bassey and Okon (2010), when farmers have many years of experience they tend to have accumulated enough knowledge through several years of trial and error and this makes them more productive. Akorede (2004) reported that farming experiences between seven and twelve years is encouraging enough to increase production of cassava.

2.28 Conceptual Framework

The conceptual framework of the cassava farmers' perception of impact of the West Africa Agricultural Productivity Programme on their livelihood systems consists of five parameters. These are, perceived effectiveness of the WAAPP components; perceived effectiveness of the farmer groups; extension services delivery; and farmers' demographic and farm related characteristics. Extensive review of literature revealed

that farmers' demographic and farm related characteristics have a significant relationship with agricultural productivity. Studies by Obasi, Henri-Ukoha, Ukewuihe and Chidiebere-Mark (2013) among arable crop farmers in Imo State, Nigeria showed that the age, educational level, farming experience and farm sizes significantly affect agricultural productivity. Several authors (Teryomenko, 2008; Helfand, 2003; Yasmeen, Abbasian & Hussain, 2011; Gill, 2000) confirmed the ascertion. The primary objective of WAAPP's intervention is to increase productivity of cassava, and that is evident in the main components (provision of improved planting materials, training and inputs support). Successful extension delivery in terms of technologies and processes are channeled through effective decision-making and behavioral change processes of the target clients (Rogers, 1995). These are expected to bring about optimal-level performance that should have positive influence on productivity (Wu, 2005).

The farmer groups play very useful complimentary roles to augment the technology delivery with respect to access to resources, improved technologies, market information and empowerment of farmer groups (Bosc et. al., 2002). The expected outcome is to increase the productivity of improved cassava. The ability of the main components of the interventions to effectively increase productivity is determined from the view point of the beneficiary farmers.

The overall expected results are the achievement of the desired positive impact points of the programme's interventions on the livelihood systems of the cassava farmers. These include improved production of quality planting materials, ownership of mobile phones, decrease in debts owed to service providers, ability to pay wards' school fees, and improved access to extension services (DFID, 2000; Norton, 2004). There is

significant and positive relationship between real impact and productivity. For instant, financial capital acquired can be invested back into the beneficiary farmers' farming enterprise.

CHAPTER THREE

METHODOLOGY

3.1 Description of the Cassava Grater

The machine is made up major components; The main frame, the hopper, Petrol engine, the grating unit and the main shaft.

The main frame /table:

This is part of the machine that carries the total load of the assembly. The material for the frame is angle iron. The frame is to be joined by welding. The main frame will be constructed with angle iron. The angle iron is welded together to form the frame work. The welding provides very rigid joints.

This in line with the modern trend of providing rigid frames, this provides the strength and rigidity for the overall machine.

The hopper

The hopper is the receptacle through which cassava is admitted into the machine for grating. It has a rectangular plan which tapers gradually.

The grating unit

This unit consist of the shaft, perforated mesh, rolled sheet circular disc and rivet pins. The drum will be formed by the shaft passing through the rolled cylindrical sheet and it will be welded in place by a circular disc. This drum is then wrapped with the perforated mesh and it is attached by riveting.

The discharge unit

This is the continuation of the hopper below the machine that allows the flow of the grated cassava to a storage pit or receptacle

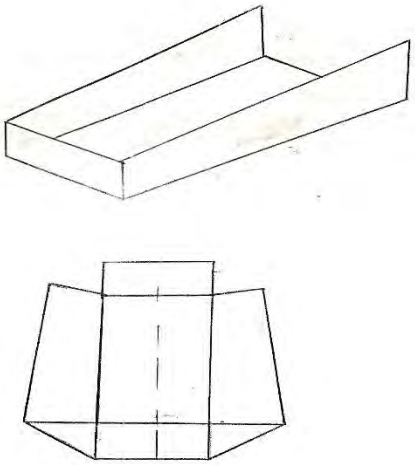

Figure 3.1: The Discharge

Bearings

Pillow bearings are used in this machine. They are located at both ends of the main shaft in order to reduce friction between the contacting parts and increase shaft speed.

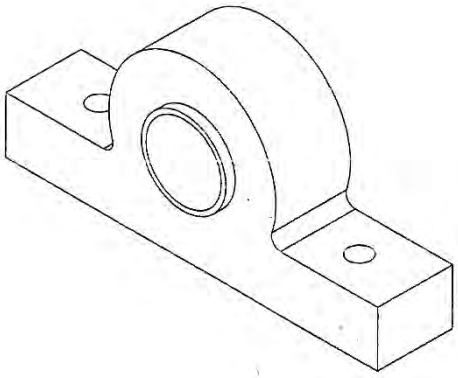

Figure 3.2: The bearing

3.1.1 Materials

In this section, the materials used and the methods used in the fabrication of the mobile cassava grater machine is discussed.

Table 3.1: Materials used for the fabrication of the cassava grater

S/no	Name	Material used
1	Hopper	2mm mild steel plate
2	Table/frame	40mm by 40mm angle iron
3	Grating drum	6mm thickness mild steel
4	Grating plat	1mm galvanize plate
5	Shaft	30mm diameter shaft
	Pulley	Cast iron
	Bolt and nut	Mild steel
6	Bearing	Cast iron
	Revit pins	Stainless steel
	Belt	Alloy rubber

Table 3.2: The summary of the choice of equipment selected

Part	Equipment choice	Justification
Power source	5.5HP petrol engine	• Less fuel consumption • Cost effective • Availability of parts

3.2 Methods

The following methods were adopted in this project work.

3.2.1 Design consideration

The following factors were considered while designing the machine

- Material properties
- Load capacity
- Maintenance strategy
- reliability of the machine

3.2.2 Design determination

According to Osoiro & Udu (2013), having considered the primitive method of digestion and mechanized rotary action of the oil palm fruit grater, a lot was taken to determine the development of the machine.

- Higher capacity compared to the traditional/primitive method of the palm fruit grater.
- Reduction in drudgery associated with the traditional/primitive method.
- Strength of material should withstand the force acting on the various components of the rotary palm fruit grater.
- Simplicity and complexity of the grater should suit the intended user(s) and has no side effect on him and his environment
- The general configuration of the machine and the factors of safety administered for effectiveness and efficiency.
- The power ratings of the engine to be used.
- The configuration and operation techniques of the machine when in operation.
- Ease of operation, choice of material and machine affordability.

3.2.3 Theoretical analysis

Force Exerted on Shafts (Vertical Force)

The machine element that exerts force on the shaft is the belt pulley driven electric motor and grating drum:

Weight of Pulley, $W_p = M_p g$ (i)

Where M_p = Mass of the pulley in Kg = 1.5kg

g = Acceleration due to gravity = 9.81m/s

$W_p = 9.81 \times 1.5kg = 14.715N$

Weight of Drum, Wd =ρ V g (ii)

= ρ V g of [Volume of the two Circular plates + Volume of the Rolled Steel Sheet + Volume of Perforated Mesh]

Where ρ = Density of the Material

For Stainless steel = 7930kg/m3

For Mild steel, = 7860kg/m3

V = Volume of the Material Volume of pipe = πΔr2 h = π (0.25″ x 0.245)2 x 0.35 = 4.1251 x 10-3 m 3 Volume of Circular Plate = 5.94x 10-5 m 3

g= Acceleration due to gravity

Point Loading of Shaft Due to Drum,

Wd = 9.81[({4.125 + 0.0594}10-3 x7860) + (7930 x 4.125 x 10-)] = 643.56N

Distributed Loading Due to Drum = 643.56/350 = 1.839N/mm

Power Transmission

The ratio between the velocities of the electric motor pulley/driver pulley and the drum pulley/ driven pulley is calculated mathematically, as follows:

Let Ne = Speed of the driver in r.p.m. = 1440rpm

Nd = Speed of the driven in r.p.m. = 1440rpm

Length of the belt that passes over the driver, in one minute = π De Ne

= 332.5m

Similarly, length of the belt that passes over the follower, in one minute = π Dd Nd

=332.5m

Since the length of belt that passes over the driver in one minute is equal to the length of belt that passes over the follower in one minute,

therefore, De Ne = ɳ Dd Nd (x)

Therefore, De = 0.0735m = 3″

3.2.4 Machinery and machining processes used

- **Drilling machine:** it was used to create holes on the machine table for bolts and nuts
- **Milling machine:** was used to create keyway on the machine shaft
- **Centre lathe machine:** was used to turn the shaft
- **Welding machine:** was used weld components together
- **Bending machine:** was used to bend the plate whiles forming the hopper
- **Table shear:** was used to cut the plates
- **Pedestal grinding machine:** was used to grind the welded joints

3.2.5 Fabrication location (Gratis Foundation-Bolgatanga)

The place of fabrication is GRATI FOUNDATIO BOLGATANGA U/E REGION is a mechanical workshop in the Bolgatanga municipality in the upper east region of Ghana, the workshop is situated in near the brewing company in Bolgatanga central. GRATIS FOUNDATION could be described as an engineering workshop which is equipped with metal working machines for fabrication, welding, drilling, bending, cutting, of various components in the various areas, and for supporting the scale enterprise (SME) in the municipality

3.2.6 Fabrication process

The fabrication process involves using the selected materials and constructing the product based on the design and the desired dimension. The various methods used during the fabrication of the machine from start to finish include; measuring, marking, cutting, joining, drilling and finishing.

This was done part by part before assembly of each component.

Fabrication of the table.

The table serves as the main frame of the cassava grater. It is the table that carries the hopper the grating unit and the bearing. Because of the work it does, it has to be robust to avoid any failure of the machine, because of that the materials used were carefully selected.

The table has a rectangular shape of the size 620mm x 290mm and a height of 390mm.

Below are the materials selected for the fabrication table/frame of the machine

- 40mm x 40mm angle iron
- G-10 Electrodes
- Hacksaw blade
- Angle grinder
- Grinding disc.
- Try square
- Scriber
- Tape measure

The following steps were followed in fabricating the table /frame

- The tape measure was used to measure the length of the material to be cut for the fabrication of the table.
- The try square in conjunction with the scriber was used. Both tools were used to mark the mitre, that is an angle of 45 degrees.

  The table has four legs and the height is 390mm so following the same procedure, the four legs were marked and cut with the hacksaw blade.

The top of the table is rectangular in shape measuring 620mm x 290mm. two pieces the measures 620mm were measured and cut and other two pieces which measures 290mm were also measured and cut.

- With the use of the electric arc welding machine, the table was assembled
- To make the table more robust, an angle was welded at two opposite sides of the legs and then another is welded to join the two.

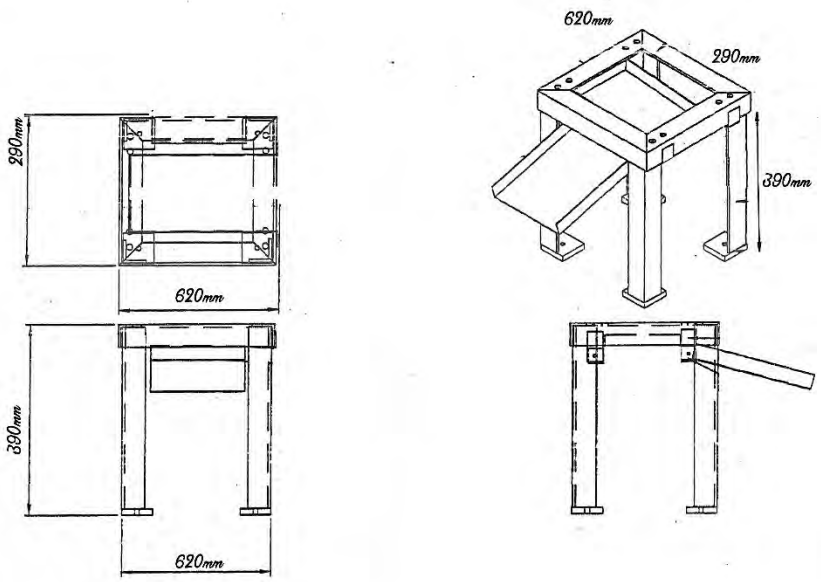

Figure 3.3: The Table

The hopper fabrication

The hopper is the receptacle through which cassava is admitted into the machine for grating. It has a rectangular plan which tapers gradually.

In fabricating the hopper, one need to make available the following tools and materials;

- 2mm mild steel plate
- Angle grinder
- Grinding disc.
- Long rule
- Scriber
- Tape measure

The main material used for the hopper is the 2mm mild steel plate. It has a square plan and a rectangular base the size of the one of the square plan is 280mm. the base has a size of 170mm x 200mm. The reason why one side is longer than the other side is to make space to accommodate the grating drum since it has a length of 190mm, while the shorter part will only make way for the shaft and the diameter of the rating drum.

The following steps were followed in the fabrication process;

- The tape measure was used to measure 360mmx200mm.
- The rule and the scriber were then used to do the marking out
- The shears were then used
- The shears were then used to cut off the mark portion of the plate
- First worked of the site that has a base of 200mm.In realizing the shape of the base, from the end of the base of the plate, then measure 40mmand from the other end too, measure 40mm leaving the inside measurement to be 200mm. A scriber is use to mark from the edge of the top to joined the marked portion of the base and the same is use to the other end.
- The shear is then used to cut off the unwanted portion leaving the correct shape.
- The same procedures are followed to realize the other parts
- A space is then created at the middle of the two parts that measure 170mm to make way for the bearing shaft which is part of the grating unit.
- Welding machine and G-10 electrode ware used to assemble the parts to form the hopper.

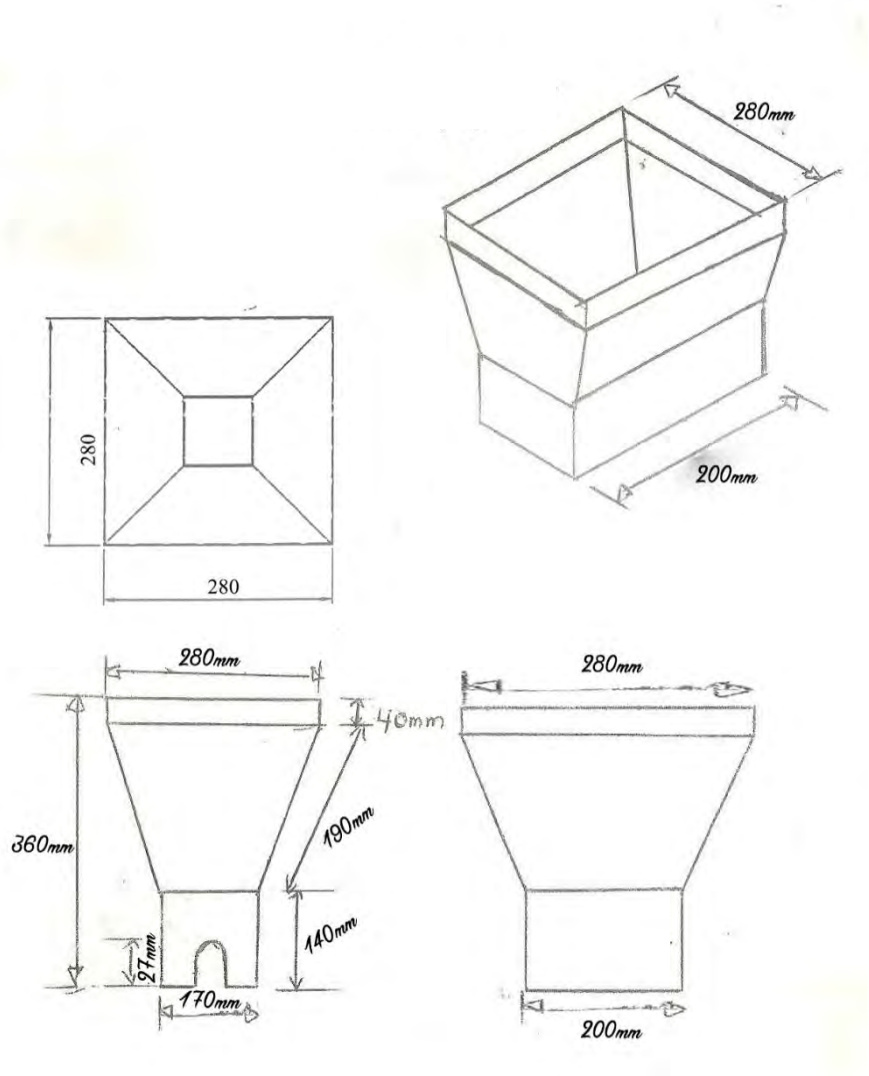

Figure 3.4: The Hopper

Grating Unit

The grating unit is made up of the shaft, the grating drum, and the grating plate.

It is the unit that does the grating of the cassava tubes into a cassava past before the water is squeezed from it. Before the grating unit is assumed, the other components that form the unit are to be worked on.

We then start with the shaft, the drum and the grating plate.

The shaft

A shaft of diameter 30mm was purchased, with a length of 450mm, since the bearing to be used is 205, it calls for a shaft of diameter 25mm.

A lathe machine was use to form down the parts of the shaft that will take the two bearing and the pulley.

After the diameter of 25mm attained, a file was use to chafer it so that it can pass through the bearing.

The grating drum

A pipe of diameter 150mm and length 195mm and 6mm thickness was purchase from the market.

Since a shaft of 30mm diameter would pass through the center, a drill of diameter of 30mm was used to create a hole in the center of the plate after it has been machined. The machine plate is now welded to close the open end of the pipe.

The grating plate

1mm galvanized plate was purchased from the local market to produce the grating plate, to get the actual size of the plate to be folded ΠD was used for the calculation

3.143 ×200

3.143×200= 628mm.

The plate was cut at a measurement of 628mm×195mm.

The plate is then perforated using a punch tip. The grating plate is then fitted to the drum by means of riveting.

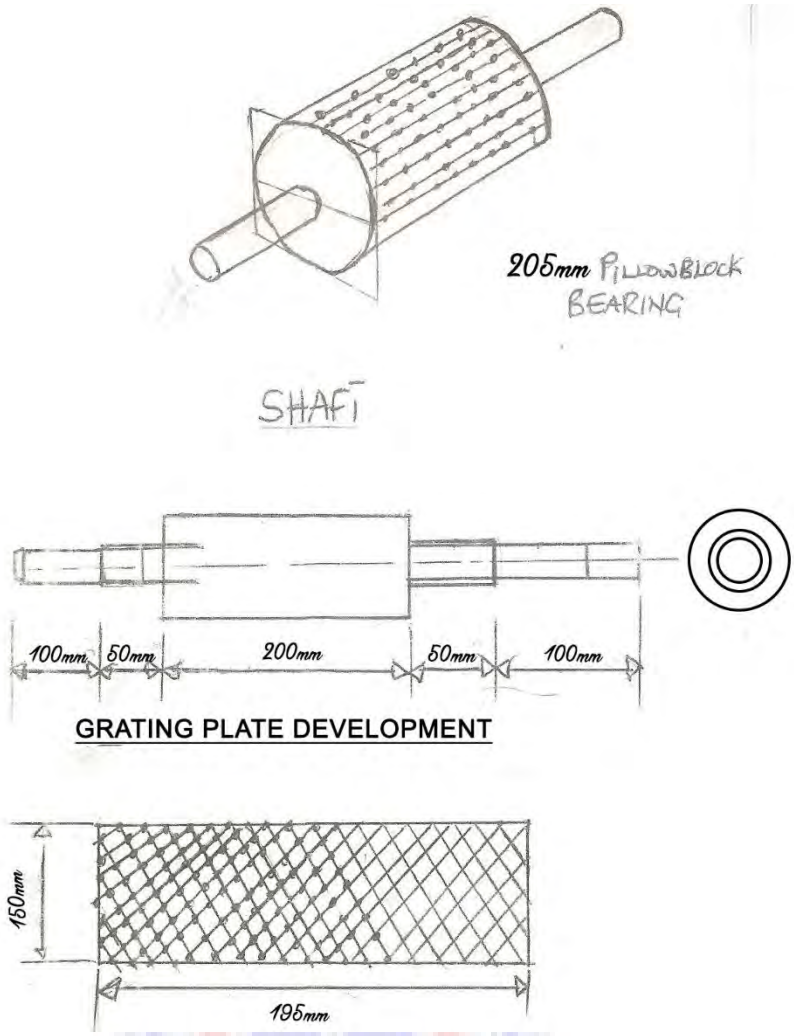

Figure 3.5: The Grating Unit

3.2.7 Assembling of the shaft, drum unit, and the grating plate

The perforated 1mm galvanized was rolled around the drum and riveted to the drum.

The bur is allowed to project outward since that is what does the grating.

The shaft is well placed in the drum and welded by using the welding machine.

Figure 3.6: Complete cassava grater

3.2.8 Assorted component

Bearing is fitted on the frame to allow the shaft to pass through to provide revolution of the grating unit

Belt and pulley these parts transmit power from the engine to the machine

Bolt and nut these are used to fasten two or more parts together.

3.2.9 Assembling of various components

After the 205 pillow bearing were correctly positioned on the grating unit, bolt and nuts were used to tighten to the frame to holes that has been created.

The hopper is then placed on the grater to the frame, the space provided at the two ends of the base of the hopper, makes a way for the shaft to pass through it. The bolt and nuts are used to hold the hopper to the frame.

Since the frame is going to carry the petrol engine, slots were created on the frame for the positioning of the engine.

The engine is then mounted to the main machine through the bolt and nuts. There are two pulleys one is on one end of the grater and the other on the other end of the petrol engine. The pulleys are well aligned.

3.2.10 The working principle of the machine

Cassava grater is one of the key equipment used in garri production. It is used to processed cassava into mash before fermentation.

Usually peeled cassava is first served in to the hopper that is the upper part of the machine, then to the second part that is the grating drum which rotates at constant speed. Then the cylinder is made up of horizontal axis with serration, the abrasion of the cylinder surface crushed against the cassava root and reduced them to mash.

Finally, starch water will be separated from the cassava mash. After the cassava is mashed it passes through the discharge unit then collected with either basin or bucket.

So the working principle of cassava grater is that, by taking, using of the extrusion force between the toothed roller and grater part to break cassava into mash/ the two-layer grating can effectively improve the breaking rate so as to increase the garri yield.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

The power and the speed from the petrol engine is transmitted to the belt drive, then further transmitted to the grater through the pulley. The cassava grater begins to grate after the petrol engine has been started. It makes use of both gravitational movement of the cassava as well as gradual loading during grating.

Therefore, it does not require the cassava to be hand- pressed as done on the conventional graters. Also, to avoid bearing breakage and other related problems, the drum shaft doing the work was made parallel between the adjacent bearings using spirit level for its alignment.

There are several methods of testing for the output capacity of machines but with respect to this small-scale cassava grater, the output capacity of the cassava grater was examined as follows:

Forty-five kilogrammes was used for ten different input values of mass. The time taken for each input was checked and recorded. Each tuber was weighed and the weight of the whole input of cassava obtained, the following measuring parameters were obtained:

Table 4.1: Number of cassava loading and time taken to grate

Number of loading	Mass of cassava (kg)	Time taken to grate(sec)
1	2	30
2	2.5	62
3	3	91
4	3.5	119
5	4	149
6	4.5	180
7	5	213
8	5.5	241
9	6	272
10	6.5	359
Total	**42.5**	**1716**

The output of the machine

Therefore, for test machine;

Output capacity = (mass of cassava(kg))/(time taken in sec.)

= 42.5x3600(kg)/1716(hrs)

= 89.16kg/h

With an average machine throughput capacity of 89.16kg/h, the machine performance is satisfactory.

Routine maintenance

1. Check bolts and nuts on pulley and bearing for looseness and tighten if necessary.
2. Check engine soundness using the manufacturer's recommendations as specified in the operator's manual
3. Clean grating machine before and after work every day.
4. Check engine oil before the engine is started.

5. Wash the hopper and the grating compartment thoroughly with water.
6. Check the belt tension for looseness and adjust if necessary. Loose and floppy belts reduces efficiency of the machine and can cause serious injury when they fly out.
7. Grease all moving part that required greasing in order to reduced friction to enhance it efficiency.

Table 4.2: Cost analysis of the cassava grater

Item description	Unit price (GHC)	Qty	Amount (GHC)
2mm steel plate	300	½	150
40x40mm angle iron	80	1	80
3mm steel plate	400	¼	100
Diameter 30mm shaft	100	1	100
205 bearing	40	2	80
1mm galv. plate	120	¼	30
G-10 electrode	50	1	50
paint	80	½	40
Thinner	80	½	40
Pulley	50	1	50
V-belt	30	1	30
Grinding disc	30	1	30
Hacksaw blade	6	1	6
Petrol engine	450	1	450
Total			1236.00

Based on the construction material selection and quality of fabrication work, the machine is durable and it is easy to operate. It is cost effective considering the amount involved in fabricating the machine.

CHAPTER FIVE

SUMMARY CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

A mobile cassava grater was designed, fabricated and performance evaluation carried out. The test result revealed that the machine has a capacity of 89.16/hr. The machine is made up of simple components that can be easily assembled. It is designed so that local users can purchase and easily carry out maintenance and at the same time operate the machine with ease for cassava processing.

5.2 Conclusions

A small-scale petrol engine powered mobile cassava grating machine designed, fabricated and tested. It was found to be effective and efficient enough and could grate about 89.16k of cassava tuber per hour.

This machine can be used at home -scale for domestic application and it affordable since the cost of production is low compared to other ones.

The machine is also economically viable. Thus, it can be used in small-scale production especially in the rural settlements and for subsistence farmers.

5.3 Recommendations

- Efforts should be made to adopt and popularize this design, especially for the benefits of the rural people who make up a greater percentage of the nation's population.
- The machine should be mass produced since this will lead to lower unit cost

- To develop the area of agriculture and industrial raw material development as well as food security and employment, government should take advantage of this innovation.
- Short- and medium-term loans should be granted to farmers to enable them adopt this important innovation for mass production of cassava products in other to meet the growing demand of the nation's industry, local consumption and for export.
- Cassava processors and local cassava processing industries are encouraged to patronize this innovation and to increase their profit.
- The use of this innovation other than the commonly used manual type will attract youths and more investors in this sector as drudgery and tedium has been removed.

Since the efficiency is above average, thus, the mobile cassava grating machine is highly recommended for cassava processors.

5.4 Suggestions for Future Research

There are a number of ways in which this study can be extended. This study only focused on the grating of the cassava. However, a comparative project could be done to add screw press to eliminate the traditional way of dewatering, that is loading it into sack and putting heavy stones on it for the water to drain. In addition, future study should examine the economic efficiency in the small-scale cassava processing industry.

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