SUSTAINING RURAL TECHNOLOGY TRANSFER UNDER RURAL ENTERPRISES PROJECTS (A CASE STUDY OF CASSAVA PROCESSING TECHNOLOGIES IN RURAL GHANA)

Thesis (Draft)

TECHNOLOGY AND AGRARIAN DEVELOPMENT GROUP

WAGENINGEN UNIVERSITY

©2009, Nuer Alexander (Processes of Cassava Processing by Avunu Norvisi Cassava Processing Association, Ghana)

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For quality of life

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'It takes practice and skills to live without regret'

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LIST OF ABBREVIATIONS

AfDB African Development Bank
CIDA Canadian International Development Agency
CUSO Canadian University Service Overseas
DFID Department for International development
EU European Union
FAO Food and Agriculture Organisation
GTZ German Agency for Technical Cooperation
GDS German Development Service
GoG Government of Ghana
GRATIS Foundation Ghana Regional Appropriate Technology Industrial Service
HCI Human Computer Interaction
IFAD International Federation of Agriculture Development
ISHS International Society for Horticultural Science
IITA International Institute of Tropical Agriculture
ITTU Intermediate Technology Transfer Unit
KNUST Kwame Nkrumah University of Science and Technology
MIDA Millennium Development Authority
NGO Non Governmental Organisations
REDP Rural Enterprises Development Program
REP Rural Enterprises Projects
RTTCs Rural Technology Transfer Centers
SNV Netherlands Development Organisation
TCC Technology Consultancy Centre
UNDP United Nations Development Programme
VSO Voluntary Service Overseas
ZOWFA Zoranu Fabrication

Table of Contents

ABSTRACT

Technology transfer initiatives have been prescribed as one of the main tools to improve livelihood within agrarian economies of the global world. As an engine of growth, various rural development initiatives like Intermediate Technology Transfer Initiatives, Rural Enterprises Development Program (2003 to 2006) and Rural Enterprises Projects (1993 to 2011) have been implemented in Ghana.

This thesis aimed at looking into a section of technology transfer initiatives, i.e. Rural Technology Transfer initiative within the context of the Global South. A case study of cassava Processing Technology Initiatives in rural Ghana.

Theoretically, the thesis research looked into the sustainability of two new technologies (Mobile and Fixed Processing machine units) by focusing on the theory of making, knowledge transfer and repair of the technologies. This area was relevant in the sense that it has been speculated that most rural technology transfer initiatives have failed to meet the main objectives.

The methodology for the thesis was based on Technographic Approach with a Realist view and with a focus on observation and filming of the processes in the making of a cassava by-product, specifically *gari* (a fried granulated cassava which is processed) and *agbelima* (processed cassava dough), within three rural Ghanaian communities.

A focus on the Task Groups involved in the entire technology design, manufacturing, and their interaction with the end users Task groups was covered. The rationale was to study, who made what, when and how? What makes one machine type preferred over the other and under what conditions, i.e., whether subsidies from Government, NGOs, other Donors, etc or whether individual entrepreneurs or groups had any causal influence in the type of processing plants used at the focused environment.

The findings and conclusion of the Thesis was that, Rural Technology Transfer Initiatives in Ghana had good intensions. There had not been in place mechanisms to improve on existing technologies. Wheels keep being re-invented with new initiatives instead of re-designing existing technologies. A further action for feedback mechanism from demand, technology and market perspectives is suggested to be considered and included into rural technology transfer initiatives in Ghana. The latter is expected to help sustain such technologies in Rural Ghana and other developing economies that engage in such initiatives.

The aim is to give a feedback for possible future considerations in designing, re-designing and policy decision-making in such technology transfer initiatives.

Key Words: Cassava Processing Grater, Stationary (Fixed) Processing unit, Mobile Processing unit, Rural Technology Transfer, Technography, Task Group, Sustainability, Making, Technography, Designers, Engineers, End-Users, Processors.

CHAPTER ONE: BACKGROUND

1.1 Cassava Production in Ghana

Cassava is perhaps the most important food crop in Ghana. The cassava tuber is produced in all regions, except for two in the northern part of the country. Average area cropped per year between 1999 and 2004 was about 750,000 hectares, with the primary producers being the Eastern, Brong-Ahafo, and Ashanti regions. Total annual output of cassava during the same period was about 10 million metric tons. The cassava crop is perceived to generate extensive farm and non-farm linkages for rural development, being utilized in various forms. Apart from cooking the fresh root, it can be processed into gari (fermented cassava dough), tapioca (toasted starch), and cassava flour (crude and refined). All these products are used for human consumption. Some ethnic groups also consume the cassava leaves as a vegetable. Although dried cassava chips and cassava pellets are ingredients in livestock feed in Europe, this is not yet a common practice in Ghana (http://www.ifpri.org/publication/new-challenges-cassava-transformation-nigeria-and-ghana, Accessed 30th January, 2008, Nweke, 2004a)

As a historical background, cassava (*Manihot esculenta* Crantz) was introduced from Brazil, its country of origin, to the tropical areas of Africa, the Far East and the Caribbean Islands by the Portuguese during the 16th and 17th centuries (Jones, 1959). In the Gold Coast (now Ghana), the Portuguese grew the crop around their trading ports, forts and castles and it was a principal food eaten by both the Portuguese and the slaves they bought. By the second half of the 18th century, cassava had become the most widely grown and used crop of the people of the coastal plains (Adams, 1957). The Akan name for cassava 'bankye' could perhaps be a contraction of 'Aban Kye' - Gift from the Castle (the seat of government in Ghana) (Adams, 1957).

The spread of cassava from the coast into the hinterland was very slow. It did not reach Ashanti (and Brong Ahafo) and northern Ghana, around Tamale, until about 1930. Until the early 1980s, the Akans of the forest belt preferred plantain and cocoyam, and people in the north preferred sorghum and millet. Cassava became firmly established in most areas after a serious drought in 1982/83 when most other crops failed completely (Korang-Amoakoh, Cudjoe and Adams, 1987, *in* Ministry of Agriculture, Ghana, 2004). Cassava and its various preparations, including fufu, *gari* and *konkonte*, are now very popular foods throughout Ghana, and not only in the coastal regions, as was the case some 20 years ago, but other regions of the country (FAO, 2004).

Prior to 1981, declining trends in agricultural production were correlated with the downward economic situation experienced at different times in the country. During the period, food crop production and marketing, including cassava, were marginalized relative to the production of export crops and food imports. The occasional government interventions in production and marketing of agricultural commodities under various so-called crash programmes were geared to respond to specific demands and situations.

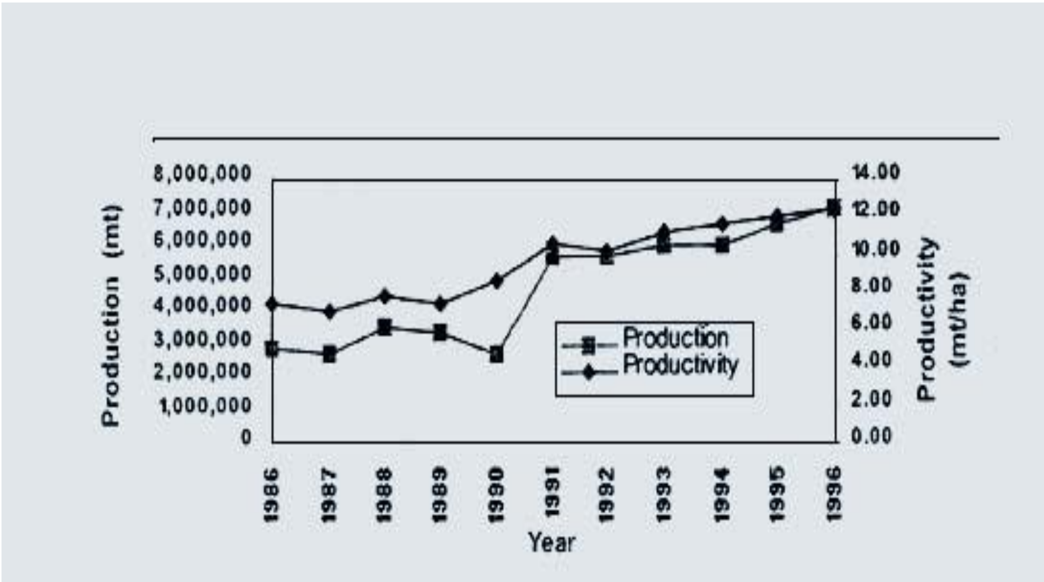

Figure 1: Trends in cassava production and productivity for ten years, 1986 -1996 (Source: *Ministry of food and Agriculture, 2004,* FAO, 2004).

The importance of cassava is confirmed in terms of crop area, total production and its contribution to Agricultural Gross Domestic Product (AGDP) and food expenditure shares (Alderman and Higgens, 1992). The average area planted to cassava - about 387 000 ha in 1986 - increased to 590 000 ha in 1996. During the same period, total cassava production increased from about 2.9 million tons to 7.11 million tons (Figure 1). Cassava is by far the largest agricultural commodity produced in Ghana and represents 22 percent of Annual Gross Domestic Product compared to 5 percent for maize, 2 percent for rice, sorghum and millet, 14 percent for cocoa, 11 percent for forestry, 7 percent for fisheries and 5 percent for livestock (Al-Hassan, 1989; Dapaah, 1996, *in Ministry of Agriculture, Ghana, 2006, FAO, 2004*)

Cassava links many farmers to the market. But it is also a domestic food security crop. It needed more public research investment than it got during that period. Policy wise, it was known that the Ghana government was more in favour of cereals promotion than cassava. Major policy changes were made from the mid 1980s, after regional droughts affecting the entire West African region from the 1970s through to the early 1980s (Ekwe et al, 2004). A major policy decision to promote cassava production and transformation came about as a result of a growing concern with the food security of rural household (Ekwe, 2004).

1.2 History of Cassava Processing in Ghana

Processing of cassava is necessary both to rid "bitter" cassavas of cyanogenic glycosides (Ekwe, 2004) and to improve taste and palatability. Processing detoxifies the highly toxic tubers of some crop varieties. Traditionally, the procedures in processing cassava depended on family labour, and are manually intensive (FAO, Ministry of Agriculture, Ghana Study, 2004-2006). The first documented cassava processing intervention (seen as a great innovation at the time) was the introduction of a medium scale motorized cassava grater in 1966 by Agriculture Engineers Ltd, a public/private enterprise in the then new Ghana (FAO, 2004). This was later followed by:

'…Several equipment manufacturers including engineering firms, research institutes, university departments, small-scale artisanal shops, blacksmiths and mechanics [who] have developed and produce various types of cassava processing equipment. Cassava processing machinery manufactured locally are drum graters, horizontal disc graters, cassava chippers, screw presses, hydraulic presses, cassava dough disintegrators, sieving machines, grading machines, plate mills, hammer mills and mechanical dryers' (FAO, 2004).

A second technology step was *'...the mechanized cassava harvester developed at the University of Leipzig, [Eastern] Germany [DDR]was tested for adaptation in Ghana by the Department of Agricultural Engineering of the Kwame Nkrumah University of Science and Technology, Kumasi. Research on manual and mechanized processing of cassava [included] power operated graters, manual screw presses and solar driers... some of which has been widely adopted by processors in the country'* (NARP, 1994;In FAO, 2004).

The background information is discussed later in the thesis. This is because written information on the history of mechanized cassava processing in the country is inadequate and inaccurate (FAO, 2004,)

1.3. Hypothesis

Rural Technology transfer initiatives have failed to meet their desired outcomes in the Ghana because of the purported distance that has existed between the end user (Task Group that use the machine/object) and the designer.

1.4. Research objective

The broad objective of this study was to ascertain the validity of the hypothesis and to make empirical debate on how rural technologies could be sustained in rural Ghana

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1.5. Specific Objectives and Questions

- To study the design methodology, formulation, use and infusion of the two technologies in place within the community.
- How the task groups within the technology transferred projects use the new knowledge acquired to meet their objectives
- Study the processes of cassava processing via the fixed and mobile technologies (in the Selected community)
- Look into the cause and effect of the entire process on the processing groups/Operators
- The repair procedure and availability of expert knowledge among the end user Task Groups

- Training and related issues on knowledge transfer to the Task Group.
- Look at the rationale behind the selected technologies and whether they met the objectives for their introduction by the implementing stakeholders

1.6. THEORETICAL FRAMEWORK

The theoretical framework make and presents a technographic analysis of what technological and knowledge transfer ought to be. This part is to help make an analysis of what has been and is on the field of this study under discussion. The section again answers the question 'What is the contribution of technology to our daily lives' (Vallema and Richards, 2009)

1.6.1 Magic/Making

Magic and craft making have been seen as some of the best ways to bring out skills and techniques in the arena of the human endeavours. The magic of medicine in the ancient ages led to the coming out of many apothecaries to help cure various sicknesses and diseases that affected the then social change and revolution (Mauss, 2006). The current global food security issues have seen a lot of 'crafts' being developed by scientists both from the south and the north to help bridge the gap of food security issues in the global south.

The concept of craft and magic making has become clear in both the mobile and stationary cassava processing technologies designed and introduced into the communities in this study. There is a causal relation within the success or not so good outcomes purported to have been realized in the infusion of such technologies (Mauss, 2006). The interaction between the end user of an artifact, to a very long extent, has a very strong causal relation to the design of the object (Artifact). The making of a thing is thus not a sure way that it is going to be used as it was made. Its interaction with the environment has a long way to be used for its intended purpose or not (Suchman, 1987). In this research, it was observed that the magic and crafting/scripting of the processing machine unit, had a strong causal relation with the end user, i.e., the processing of cassava with the machine into various end products used within the communities such as gari and agbelima.

The action of a particular mechanism brings about a change in something. The causal relation of the technology and the intervention it is expected to work on, brings out the how and why it was made and whether it met the actual objectives is mostly determined by its final use in a sustainable term or desired lifespan of the art (Sayer et al, 2000)

1.6.2 Task Groups and performance

The capacity to use technical knowledge for practical purposes depends on interpretation, negotiation and compromise by the groups involved in the making and use of such an object (Vallema 2002; pp180). The correlation between object designers and users has a very strong causal effect on the use of the artifact and the outcome of the end product being expected to meet the required objective. Rural Technology transfer initiatives is said to have failed to meet their desired outcomes in the south because of the purported distance that has existed between the end user (Task Group that use the machine/object), the designer and the unavailability of skilled personnel to sustain such commodities in terms of repair and maintenance. A performance under duress (Richards, 1993; pp74) is thus experienced when technical designers of machines , mostly based on their knowledge and understanding , design and build 'what' they may think is the best way (object) of solving particular world problems. Technology as applied science, has failed to meet their main objectives in the social context because of this. It has been realized that the science of the useful (or practical) arts has only been successful only when it has been used as designed, to achieve its main objective (van Belt, 2007).

1.6.3 Task Group interactions with Technology within the cassava processing community

There is a paradigm shift in group ordering and task activity due to introduction of new technologies and therefore a change in the social structure of the community. The task groups' ability to sustain the technology in place will help in keeping their core culture. The issue of learning by doing is therefore scripted in the interaction process (mechanism) within the use of the said technology.

Participation is a central issue in learning, the transfer of knowledge to the youth especially, young girls and boys in the cassava processing business is very paramount with their participation in the entire processes. Learning consists of 'participation in communities of practice' (Lave & Wenger 1991; pp. 49): instead of being merely a brain activity, learning and knowing are seen as processes formed by interaction with the surrounding world (consisting of other people, objects, relationships, history, culture, etc.), through bodily participation (Jaarsma, 2009; pp.15).

1.6.4 Material Interaction and Repair

The traditional approach to culture focuses on the symbolic meanings of objects rather than the impact that these objects have on contemporary life. Using the car as a recurring theme, Tim Dant (2006) challenges the well-established idea that consumption is the principal relationship with “things” in our lives and argues that it is through material interaction with the objects around us that we confront our society. How a material is repaired and the availability of experts’ knowledge and materials in fixing a machine is a sure way of achieving sustainability of the material concerned.

The Problem of Human-machine Communication provides intellectual foundations for the field of human computer interaction (HCI) (Suchman, 1987). The common assumptions behind the design of interactive systems with a cogent anthropological argument that human action is constantly constructed and reconstructed from dynamic interactions with the material and social worlds is challenged. The theory of situated cognition emphasizes the importance of the environment as an integral part of the cognitive process.

Interactivity is similar to the degree of responsiveness, and is examined as a communication process in which each message is related to the previous messages exchanged, and to the relation of those messages to the messages preceding them. Dant’s (2006, 2008) idea of relation to the use of ‘things’ and Suchman (1987) dynamic interactions with material and social worlds, show that a newly infused technology has a causal relation (Sayer (2000)) in changing the social structure of communities which can be a burden or a blessing.

These theoretical frameworks were used to set the validity or otherwise of cassava processing technology transfer in rural Ghana under this study.

1.7 Methodology

The following methodology was used during the research; Observation, Photo shooting and filming of cassava processing designs, manufacturing and use within three districts of Ghana. 60 respondents, including manufacturing institutions, fabricators, operators and clients of individuals and cooperatives were interviewed. The research area and methodology are explained further below.

1.7.1 Research Area

The Research took place mainly in the Ketu-North District of the Volta Region of Ghana. The communities in question have mainly processed cassava and maize as their main staple food and as such interact with technologies related to cassava as part of their daily life and livelihood. Ethnically, the area has the Ewe tribe as the dominant inhabitants and is closer to the Ghana-Togo Border. The choice of the study area culminated as a result of interaction with field staff of

Innovative Services Ltd, a consulting firm working on a Millennium Development Authority (MIDA) sponsored field training of farmers as part of the millennium development goals project implemented in Ghana.

1.7.2 Technography

A systematic study of making and performance has been used as the main definition of Technography (Richards & Vellema, 2009). According to this study, there is something social about technology and therefore, there is the need to know the contribution of technology to the performance of daily life. The main question of technography is to answer the basic question of 'whether technology could be developed or used in another way'. Technology has been defined as 'the end result of an individual (or small group) experimentation and community endorsement or rejection (Richards and Vellema, 2009). Technography therefore covers the study of the process that Task Groups relate and perform certain tasks in teams or under shared activities (Hutchins, 1995 and McFeat, 1974). It also shows how Task groups respond to a change environment (Vellema, 2002). A Group ordering activity in terms of content and task can also be termed as a technography. Again, it is the mechanism that shows the effect and structure of an activity or a set of activities that involves a process.

Technography as a methodology, tries to answer the following questions; what is made and how, what is the task and who does what (McFeat,1974), how the group is organized, what are the rules shaping behaviour and who selects what, what solution is taken and what recipe is made. Technography has thus become one of the proven methodologies used in dealing with studies that have semblances of ethnography. The research environment, having ethnographic and communitarian lineages was a very good arena to use this methodology.

1.7.3 Data Collection

Data gathered were mainly through observations and interviews which took the form of photo shooting and filming of the processes involved in the making of such technologies and how they are used. This was presumed to be the most appropriate method in the sense that the research dealt with qualitative analysis and at the same time the filming aided in the coverage of scenarios which otherwise would have been on the hind side but were observed during the review of the data and the writing of this thesis.

1.7.3.1 Unit of Analysis of Research

I followed two mobile machines for four weeks in three communities, namely Avunu, Avavlime, and Tardzewu, a distance of 50 kilometers in the Ketu North District of the Volta Region of Ghana. Two stationary Machine Units were observed for four weeks during the study period in the same area.

Secondly, a comparative and observational research was done for two weeks in the Jomoro District of the Western Region of Ghana. The purpose of this second study was to compare the use of the same technology by migrant farmers within the cassava sector, study the possibility of standardization of the technology and its parts within dominant cassava growing communities in rural Ghana.

A final Study was done in the Ashanti-Akyem district in the Ashanti Region of Ghana under the Rural Enterprises Projects (REP) funded by IFAD, the African Development Bank (AfDB) with support from the Ghana Government.

Institutionally, the Agricultural Engineering department under the Faculty of Engineering, Kwame Nkrumah University of Science and Technology was contacted. An observational study and interviews were conducted to know the perspective from experts' designers within the Research, Development and Policy dimension of the Rural Technology Initiatives run in Ghana.

A local fabricator was observed in the fabrication of the mobile cassava grating machine at Akatsi in the Volta region of Ghana. The Purpose of this aspect of the study was to study and be informed on the role of the private sector in the transfer of knowledge in the local area. The town has a distance of about twenty-five kilometers from the primary research area. Three fabricating workshops were identified. The selected workshop was done using back casting. That is, the workshop was located via its contact found on the selected mobile processing grater within the Avunu area. A benchmarking was done by locating the remaining fabricating workshops after which the latter was selected.

The GRATIS Foundation at Ho, the Volta regional capital of Ghana, was observed, to compare the role of governmental institutions and the private entrepreneur in helping to sustain the rural technologies in the communities of Ghana.

Finally, end-user processing task group (clients), represented by the Avunu Norvisi Gari Processing Group (a cassava processing cooperative of fifty members) was observed and its activities filmed. The purpose was to study possible causal effects of the processing units on end user clients.

A comparison was made with other end user task groups of the western and Ashanti regions of Ghana. The latter part was to make empirical debate that it is very possible to sustain technologies, even in the rural communities of developing economies, if local and area specific measures are taken into consideration in the entire sustainability plans of such initiatives.

CHAPTER TWO: TECHNOLOGY TRANSFER INITIATIVES IN GHANA

Rural technology transfer initiatives have been prescribed as one of the main tools to be used to improve rural livelihoods within agrarian economies of the developing world (UNDP, http://www.undp.org.cn/modules.php, Accessed, 31st May, 2010). Intermediate technology transfer initiatives (1980s-1990s), the Rural Enterprises Development Programme (2003-2006) and the Rural Enterprises Projects (1993-2011) have been implemented in Ghana. This thesis looked specifically at cassava processing technology initiatives in Ghana as an example of this activity. The thesis paid attention to a comparison of the old way of processing cassava and new ways of performing the same task. Some study time was also spent to look into the sustainability of two new technologies (Mobile and Fixed Processing machines), focusing on the making, knowledge transfer and repair of the new technologies. This area was relevant to test the speculation that most rural technology transfer initiatives in Ghana have failed to meet their main objectives. The main methodological approach was that of Technographic Approach, undertaken from a Realist standpoint. The research task groups are presented and described as follows;

2.1 Research Task Groups

Technography involves splitting out the main organizational aspects of any technology to focus analytical attention on distinct aspects – *e.g.* skill, task group organization, professional organization and the society-professional interface. Here a particular attention was given to manufacturing, processing and repair task groups.

Manufacturing task groups included IITA, KNUST, and GRATIS Foundation. Their interaction with end user was covered. The study looked into the interaction, relationships and activities involved in developing, implementing and using cassava-processing technology. The rationale was to help generate feedback for possible future consideration in the design process, and in managing technology transfer initiatives. The research appraised two main types of technologies - mobile cassava processing machines and fixed/stationary mechanized machines - as used within Avunu, Tadzewu, Xipe and Avevlime in the Ketu-North District of the Volta Region, Bompieso and Tweakor/Navrongo in the western region and Konongo in the Asante-Akyem Municipal Assembly of the Ashanti region of Ghana. A traditional (unmechanised) way of processing milled cassava dough for the end product was also covered, for comparison.

The rationale was to look into the way and manner these technologies were brought in to improve the system of processing cassava. What makes a machine type to be preferred over others, and under what conditions (i.e. whether there are subsidies from government, NGOs, other donors, etc., or whether individual entrepreneurs or groups had any causal influence over the type of processing plants being used in a specific environment)? A simple preferential analysis of two technologies was looked into, to see the strengths of each type of machine, and whether they complement each other from the end user's point of view. The research groups are elaborated below.

2.1.1 The International Institute of Tropical Agriculture (IITA)

The Institute was formed in 1967 with the support of the Consultative Group on Agriculture Research (CGIAR). It is one of the groups of institutions now known as Future Harvest Centers. It had a mandate to improve food production in lowland humid tropical Africa, and to develop sustainable agriculture systems. Located in Ibadan, Nigeria, IITA has about eighty experts (Professionals and scientists) from over thirty countries, and a supporting staff of one thousand and three hundred, located in Nigeria, Cameroon, Cote d'Ivoire, Uganda and other countries in Sub-Saharan Africa. The CGIAR, and national and private donors, comprise the main funding sources of IITA. A summary on the portal of the organization best describes the core business of IITA.

'Mission is to enhance the food security, income and well-being of resources-poor people primarily in the humid and sub-humid zones of sub-Saharan Africa by conducting research and related activities to increase agriculture production, improve food systems, and sustainably manage natural resources, in partnership with national and international stakeholders, conducts research, germaplasm conservation, training and information exchange activities in partnership with regional bodies and national programs including universities, NGOs,, and the private sector. The research agenda addresses crop improvement, plant health, and resource and crop management within a food systems framework and targeted at the identified needs of four major agro ecological zones: the dry savanna, the moist savanna, the humid forests, and the mid-altitude savanna. Research on smallholder cropping and post harvest systems on the following food crops: cassava, cowpea, maize, plantain and banana, soybean and yam' (http://www.foodnet.cgiar.org/about/about_i.htm, accessed, April 20, 2010)

2.1.2 GRATIS Foundation Ghana

The GRATIS Foundation was borne out of the then Ministry of Trade and Industry's core vision of making technological transfer readily available to micro, small and medium scale industries within the country. The foundation evolved out of the Ghana Regional Appropriate Technology Industrial Service (GRATIS) Project, a government of Ghana initiative in 1987. The institution was mandated 'to promote small-scale industrialization in Ghana. Intermediate Technology Transfer Units (ITTUs), now known as Regional Technology Transfer Centers (RTTCs) were set up 'to transfer appropriate technologies to small-scale industrialists through training, manufacturing and the supply of machine tools, plants and equipment' (GRATIS Foundation, 2010).

The foundation has the mandate of manufacturing various processing units while at the same time training local apprentices to become skilled in the repair skills associated with the trade learned. Cassava processing units are one of the many agro-processing technologies initiated within the project. Some of the units worked on include corn mills, palm oil processing units, palm kennel oil extraction units, and pineapple processing machines. Each workshop has a regional manager, engineering units, field technical experts and workshop experts.

The Government of Ghana (GoG), European Union (EU) and the Canadian International Development Agency (CIDA) provided initial funding for the activities of GRATIS and the RTTCS.

Shop floor technical assistance and funding for specific projects have been provided by the British Voluntary Service Overseas (VSO), the British Department for International development (DFID), the German Agency for Technical Cooperation (GTZ), the German Development Service (GDS), the Netherlands Development Organisation (SNV) and the Canadian University Service Overseas (CUSO). The institution was incorporated as a limited company by guarantee with the name GRATIS Foundation. This was intended to help Ghana achieve its vision 2020 ambition to attain middle-income country status. GRATIS Foundation trains in both engineering and non-engineering areas, and performs other services related to rural development and women's support services. GRATIS co-ordinates activities and provides backstopping to its network of RTTCs and also supports the activities of the pioneer ITTU established in 1980 at Suame for the Ashanti Region run by the technology Consultancy Centre (TCC) of the Kwame Nkrumah University of Science and Technology (KNUST)(GRATIS Foundation; in http://www.gratisghana.com/aboutus.htm ,Accessed 20th April, 2010, Jaarsma, 2009, pp 20-22).

The pictures below show three steps in installing and testing a new stationary cassava grater.

b. c.

Figure 2.1 Installation of cassava grater (a), fixed grater and (c) testing of the grater.

2.1.3 Faculty of Agriculture Engineering, KNUST

The Kwame Nkrumah University of Science and Technology (KNUST) is the main science and technology university of Ghana, established by Acts of Parliament in 1961 and 1998. The institution was at first a College of Technology in Kumasi, the regional capital of the Ashanti Region of Ghana. The university runs a variety of programmes, from certificate short courses to doctoral degree programmes. The School of Engineering covered in this study sits within the Agriculture Engineering faculty. The faculty teaches diplomas to doctoral degrees in various agriculture-related disciplines. There is a workshop that deals with practical research and development that concerns the faculty. The workshop has both teaching and non-teaching staffs - which comprise senior lecturers, a workshop manager, coordinator, a director, and technicians. Whilst teaching, research and development are the core mandate of the workshop, institutions and NGOs interested in post harvest technology contract the workshop to manufacture various kinds of processing units for their clients (i.e. NGO beneficiaries).

The vision and mission of KNUST is stated to be “globally recognised as the premier Centre of excellence in Africa for teaching in Science and Technology for development; producing high calibre graduates with knowledge and expertise to support the industrial and socio-economic development of Ghana communities and Africa’ (KNUST Portal, Cited April, 2010). The University has a vision ‘to provide an environment for teaching, research and entrepreneurship training in Science and Technology for development of Ghana and Africa. KNUST will also provide service to the community, be open to all the people of Ghana and positioned to attract scholars, industrialists and entrepreneurs from Africa and other international communities’ (www.knust.edu.gh, Accessed 22nd April, 2010)

2.1.4 ZOWFA Fabricating Limited

A local fabricator was observed in the fabrication process for mobile cassava grating machines at Akatsi in the Volta region of Ghana. The fabricator, David Zoranu, was an apprentice trained under a sponsored welding and fabrication technology centre in Ashiaman, in the Greater Accra Region of Ghana in the mid 1990s. He moved to Akatsi in the Volta region of Ghana after ‘graduation’ from the centre (the centre could not or would not be mentioned by local fabricator, who is informally educated). Now a master craftsman and fabricator, he had four apprentices training under his tutelage at the time of this study. The company ZOWFA Fabricating Limited had not been fully formalized under the company laws of Ghana as of the time of the research. The purpose of this aspect of the study was to study and be informed on the role of the private sector in cassava technology transfer.

2.2 Models of Cassava Graters (Mobile and Stationary)

The two main processing units of study had different make up and price tag. The differences in price and unit tons are stated below with the end users within this research preference stated;

The average costs of the mobile processing units from the two institutions were estimated at five hundred euro equivalent. This included a 3-5t diesel or petrol engine that powers the grating unit (1 GH cedi was equivalent to €0.55 as at the time of the study). The KNUST Workshop mainly produced a 1t to 5t per hour capacity mobile units. The main brands of engines used for this purpose are Nissan, Ricoh, and Yamaha, among others.

The average cost of a stationary cassava-processing unit, including a 2t diesel engine, was estimated to cost about four thousand Euros at the time of this research. This made it difficult for most rural entrepreneurs to purchase such ‘expensive’ grating units.

Local fabricators sold both processing units at about half the prices stated above. This is because they used lower quality materials (this is explained further below). According to KNUST, The manufacturing of the processing units are not commercialized because, as a research institution, the university is not mandated to manufacture or sell their products in commercial quantities. The staff of the workshop stated that business and clients are expected to take over the innovation, to manufacture or fabricate the units for sale on the commercial market. As an example, a local fabricator, SIS Engineering limited, developed a 30t-processing shaft for the Ghanaian market. SIS Engineering limited was not covered in this study because the focus was on small-scale manufacturing, fabrication and use of the processing units within a rural technology transfer context.

2.3 Additional Cassava Processing Equipment Units

For a cassava processing unit to be completed, the following equipment is needed to process harvested and peeled cassava into its end product. A parching pan made of clay and silver, aluminum and galvanized metals, a press, a frying ladle, and cutlass/ knifes are needed to complete the set up. For the purpose of this study Agbelima and Gari - two end products of processed cassava - will be commented upon. The items or equipment below are necessary when dealing with gari processing.

i. **Weighing Balance**
   This is used to measure the processed product of cassava (Gari and Agbelima).
ii. **Washing machine**
   This is not very popular among end user cassava processors; this is used to wash peeled cassava before the cassava grater does grating.
iii. **Presser**
   Mainly a screw press, it is used to drain water content of grated cassava dough (it is estimated that only one-third of grated cassava is food, the rest is water and thus ought to be expressed; toxic matter, as earlier stated, is drained away in the water from the cassava dough).
iv. **Grater**
   This is fully described later, as a focus of this thesis
v. **Sieves**
   A metal or rubber sieve is used to sieve pressed and dried cassava dough; the purpose is to make the dough granulated for frying into gari, or tapioca, among others.
vi. **Fryers/Rotary Dryer**
   The fryers are mechanized units used mainly by medium scale processors to fry pressed and dried cassava dough. Small scale and micro cassava processors mainly use Frying/ parching pans.
vii. **Sealer**
   This is needed to seal bagged gari (processed and fried cassava granules).

CHAPTER THREE: DESIGN PROCESS AND ANALYSIS

There are currently several new rural technology initiatives in Ghana. The aim of these initiatives was mainly to improve sustainable development in various ways. Former initiatives have become ‘White Elephants’. An aim of this study was to find out what works and why, in order to avoid further “white elephant” projects. This chapter covers the design, manufacture and related issues associated with cassava processing initiatives in Ghana.

3.1 The Cassava Grating Unit

The cassava processing grater and other components (referred to here as processing units) have been in existence for many years. Some designs may date back as much as fifty years. The design processes have however been modified from an ordinary perforated tin/sheet punched with nails (mainly from beverage containers) to machine drilled graters configured and standardized under initiatives within the last thirty years. The process of designing the grater and its components is poorly documented. This study could obtain no relevant historical literature from the institutions and stakeholders covered in this study. Consequently, it was very difficult to trace the actual origin of the current design of cassava-processing mill. One possible source is IITA, but a request for background information was responded with not much information than earlier stated on the organizations official web portal.

3.2 Design Process

The KNUST-ITTU processing manual (Appendix 1) and interviews conducted with some staff and experts of KNUST revealed that a team of engineers and experts from Germany and Ghana worked together on the design of the cassava processing mill and its components, using the IITA model 202 as a starting point. The aim of the design-modification cycle was to make the eventual machine suitable for Ghanaian cassava processing conditions, focused on both the household level and commercial use. In making the design, a bigger wooden miller was built after drawings had been made, ‘to test how to transpose it into a working mill’ (researcher interaction with Agriculture Engineering Workshop Manager, KNUST, 2009). The team then reduced the prototype wooden grating drums ‘to make it look smaller and workable’. This, according to the workshop manager of the agriculture-engineering faculty, was to ensure the grater was capable of being fed with the smaller sizes of the cassava (cassava tubers are not uniform in size). Two lecturers interviewed at KNUST made similar statements. A hopper is designed on top of the grating drum, to be filled with peeled cassava for grinding. There is an outlet for the grated cassava to come out of an exit chute of the grating drum after grinding.

Figure: prototype rolling grater Figure: A chute of wooden cassava grater Figure: Prototype cassava grater Figure: Cylindrical grater

A wooden board is made to serve as an adjusting board and a pressure plate within the hopper and the grating drum. After normal chain sawing of the wood, a bar machine is used to get the required dimensions. A machine press is used on the wooden block before cutting. This is to get the required radius.

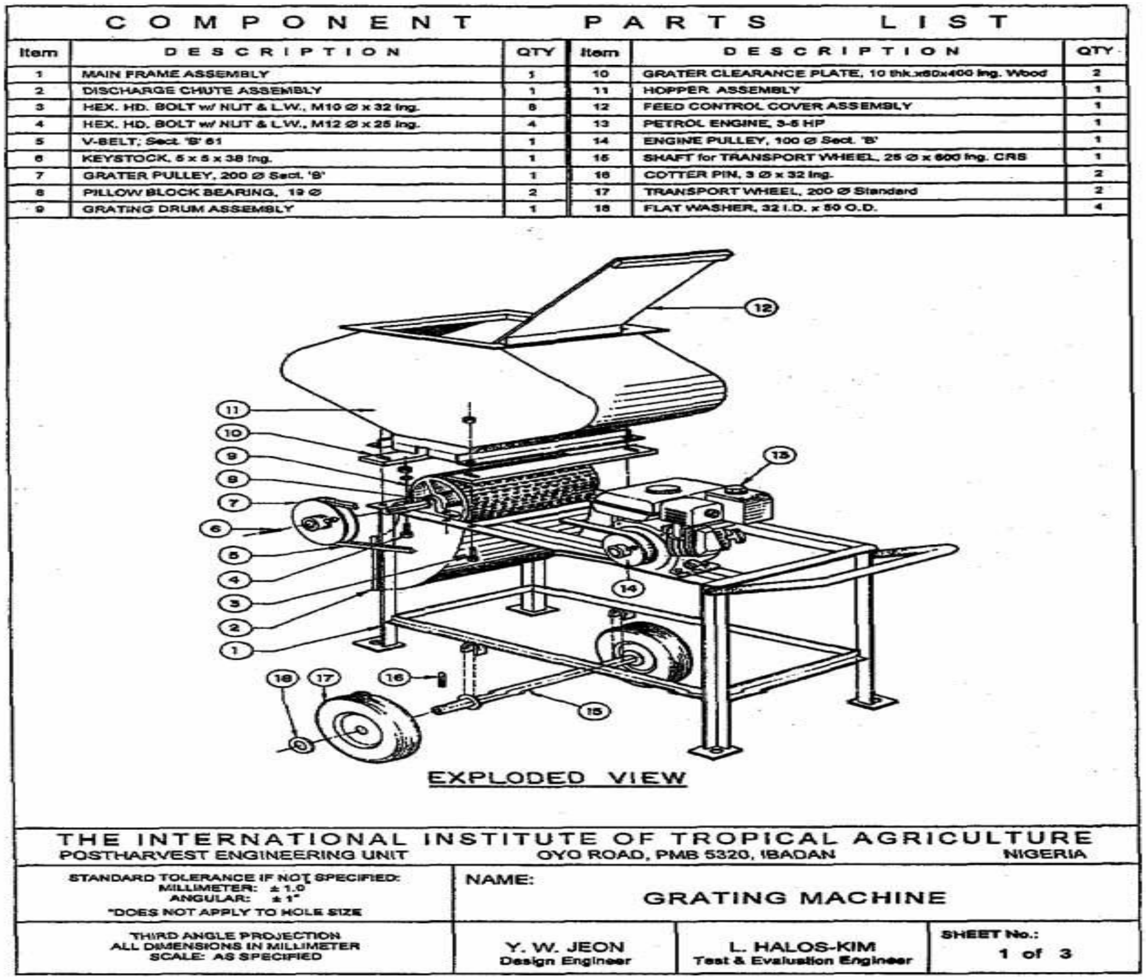
On the part of the grater, hopper, grating drum and chute, the main metals used are mild, galvanized, or stainless steels. Bend shears are needed to bend the metals to fit into the size needed for the components of the grater. A shaft is used to drill and cut some parts of the metal being used. After cutting and drilling, a centre or combine lathe is used to machine metal and its components to size, prepare the drum and cut the metal to the circumference preferred or needed by the designer. The cut drum is then rolled using a rolling machine, to get the size for the grater in a cylinder shape (the same design could be flat or round in shape). The grater is then rolled to the required size by the manufacturer and knotted to keep it in a cone or cylindrical shape. The cut shape is perforated using a machine or nails. The perforated roller is drilled to keep the shape at the desired diameter and size. On the part of the chute, a metal is cut and shaped to allow the grated cassava dough to be discharged at the exit from the grater. This is done when the cassava is pressed via the grinding processes of the rolling drum. The size of the chute is designed to fit the entrance of the rolling grater.

The designed components (grater, hopper, grating drum, chute and pulley) are fitted together and assembled to comprise the total cassava-grating machine. Depending on the taste and location of the client, the grating machine can be made stationary, i.e. it is fitted on site under a processing shed. If the machine is to be moved around, then the manufacturer configures it into a mobile machine, with wheels to allow it to be wheeled around. The experts do onsite training. No operating manual is given to clients.

a. b. c.

Figure 3.1 Different prototypes of cassava chippers (a) round chipper, (b) shaft in a flat chipper and (c) complete grater without an engine

However, there are scripted drawings for the manufacturing of the machine (Drawings 1, 2 and3). What is noteworthy here is that the machine is simple to vary by type, size and model, mainly depending on the client's preferences and location (the manufacturer may advise, but mostly will build the machine to suit the specification of the client). The present study confirmed that the grating units configured by both KNUST and GRATIS are all basically variants on the IITA 202 Model. The basic drawing for this model is reproduced below; with IITA origins clearly stated (the design engineer was Y. W. Jeon).



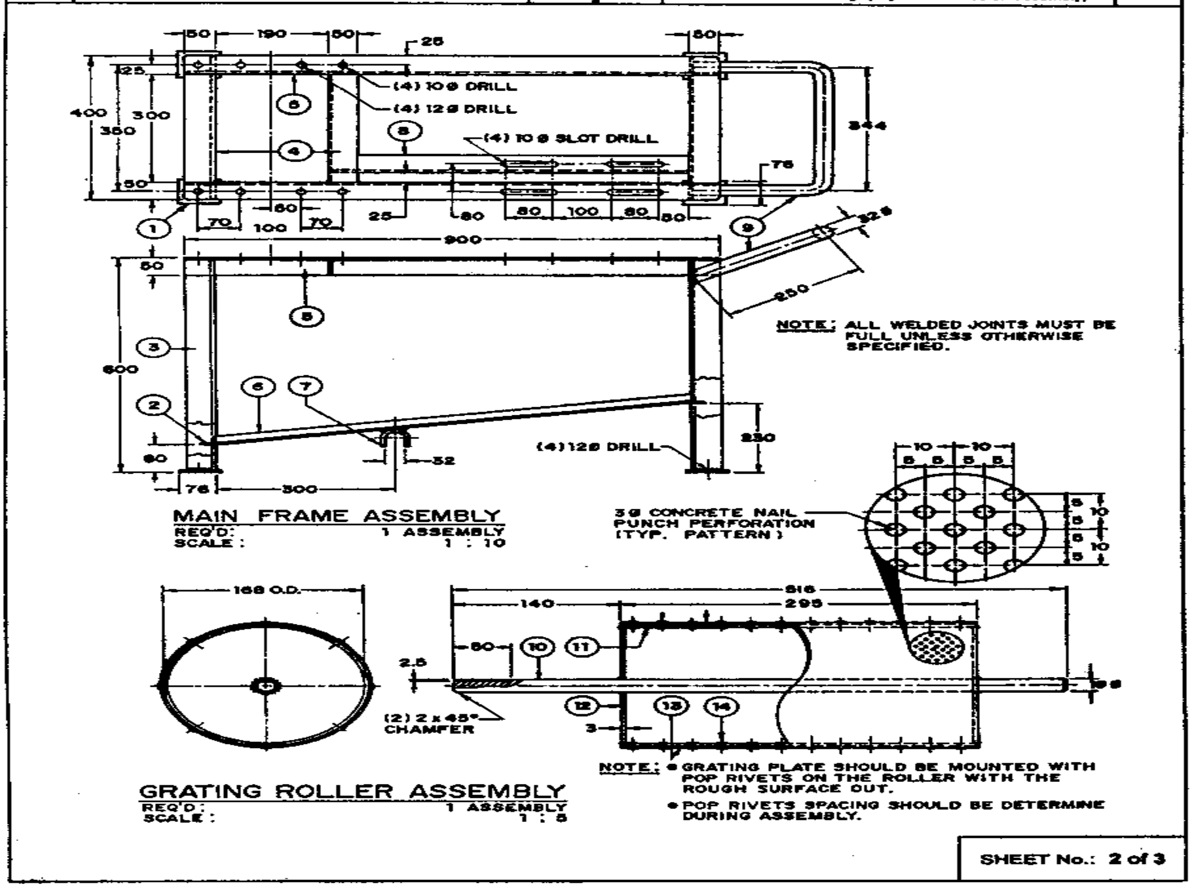
COMPONENT PARTS LIST					
Item	DESCRIPTION	QTY	Item	DESCRIPTION	QTY
1	MAIN FRAME ASSEMBLY	1	10	GRATER CLEARANCE PLATE, 10 thk.x60x400 lng. Wood	2
2	DISCHARGE CHUTE ASSEMBLY	1	11	HOPPER ASSEMBLY	1
3	HEX. HD. BOLT w/ NUT & L.W., M10 Ø x 32 lng.	8	12	FEED CONTROL COVER ASSEMBLY	1
4	HEX. HD. BOLT w/ NUT & L.W., M12 Ø x 25 lng.	4	13	PETROL ENGINE, 3-5 HP	1
5	V-BELT; Sect. 'B' 61	1	14	ENGINE PULLEY, 100 Ø Sect. 'B'	1
6	KEYSTOCK, 5 x 5 x 38 lng.	1	15	SHAFT for TRANSPORT WHEEL, 25 Ø x 600 lng. CRS	1
7	GRATER PULLEY, 200 Ø Sect. 'B'	1	16	COTTER PIN, 3 Ø x 32 lng.	2
8	PILLOW BLOCK BEARING, 19 Ø	2	17	TRANSPORT WHEEL, 200 Ø Standard	2
9	GRATING DRUM ASSEMBLY	1	18	FLAT WASHER, 32 I.D. x 50 O.D.	4

(Source: Figure 1: IITA Postharvest Engineering Unit- Portal, copied April, 2010)

The above drawings represent the main prototype IITA 202 cassava grater used to train the workshop Team of The Agriculture Engineering Faculty of KNUST and the GRATIS foundation in Ghana. It is known from the drawings that a Design Engineer (Y.W. Jeon) and Test and Evaluation Engineer (L. Halob-Kim) were the main designers of the above processing machine. These were part of the main project team from the IITA that worked and tested the efficacy of the cassava grater in Ibadan, Nigeria, The seat of IITA. Sheet number 1 of 3, shows the exploded view of the unit component. The team of engineers are said to have disengaged after the design of the grater. This is in line with the IITA policy on Project Management that states that this should be the case after success of projects. It is again in line with standard Donor driven technology transfer projects.

COMPONENT PARTS LIST

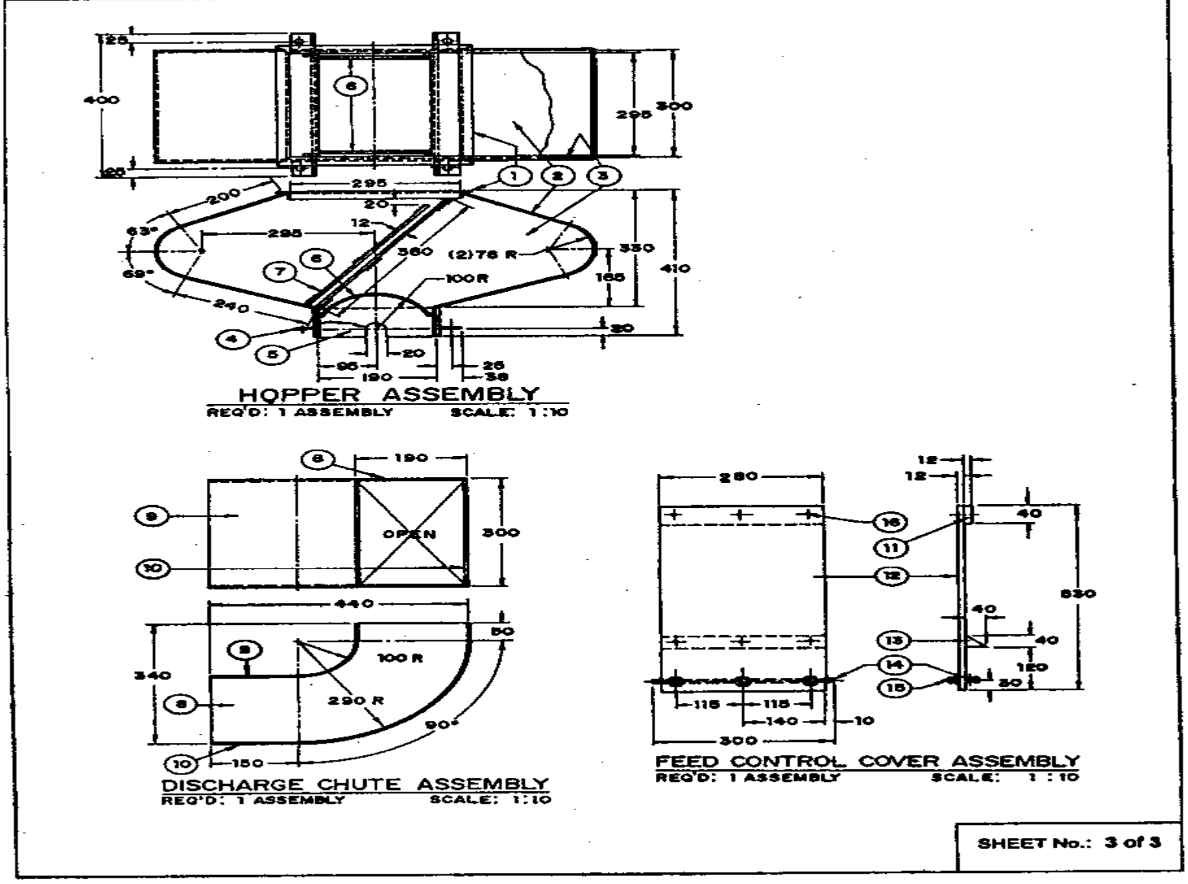
Item	DESCRIPTION	QTY	Item	DESCRIPTION	QTY
1	BASE PLATE, 6 thk. x 76 x 76 M.S. Plate	4	8	HOR'Z. FRAME, 5 thk. x 50 x 300 lng. M. S. ∠- Bar	1
2	CONNECTING BAR, 5 thk. x 25 x 300 lng. M. S. ∠- Bar	2	9	HANDLE, 32 Ø B.I. Pipe	1
3	VERT. FRAME, 5 thk. x 50 x 600 lng. M. S. ∠- Bar	4	10	SHAFT, 19 Ø CRS	1
4	HOR'Z FRAME, 5 thk. x 50 x 400 lng. M. S. ∠- Bar	3	11	ROLLER, 168 O.D. B.I. Pipe	1
5	HOR'Z FRAME, 5 thk. x 50 x 800 lng. M. S. ∠- Bar	2	12	FLANGE, 3 thk. M.S. Plate	2
6	CONNECTING BAR, 5 thk. x 25 x 800 lng. M. S. ∠- Bar	2	13	GRATING PLATE, Ga. 18 G.I. Sheet	1
7	GUIDE BRACKET, 3 thk. x 25 M.S. Flat Bar	2	14	POP RIVET, 3 Ø x 10 lng. (Qty. determined on assembly)	



(Source: Figure 2: IITA Postharvest Engineering Unit portal, copied online March 2010)

Sheet 2 of 3, of the drawings describes the component parts of the grater and dimensions to be used in manufacturing the IITA 202 cassava grater. The sheet explains how the grating plate should be mounted. It however gives flexibility by stating that Pop Rivet Spacing should be determined during Assembly. The drawings again caution how welded joints of components should be done.

COMPONENT PARTS LIST					
Item	DESCRIPTION	QTY	Item	DESCRIPTION	QTY
1	TOP FRAME, 3 thk. x 12 M.S. ∠ - Bar	4	9	CHUTE UPPER WALL, Ga. 18 G.I. Sheet	1
2	HOPPER WALL, Ga. 18 G.I. Sheet	2	10	CHUTE LOWER WALL, Ga. 18 G.I. Sheet	1
3	HOPPER WALL, Ga. 18 G.I. Sheet	2	11	HANDLE, 12 thk. x 40 x 280 lng. Wood	1
4	MOUNTING FRAME, 5 thk. x 38 x 400 lng. M.S. ∠ - Bar	2	12	COVER, 12 thk. x 280 x 530 Plywood	1
5	MOUNTING FRAME, 5 thk. M.S. Flat Bar	2	13	STOPPER, 40 x 40 x 280 lng. Wood	1
6	ROLLER GUARD, 3 thk. x 12 M.S. Flat Bar	2	14	SLIDE BAR, 6 Ø x 300 lng. M.S. Round Bar	1
7	GUIDE BAR, 6 Ø M.S. Round Bar	4	15	HEX. HD. BOLT w/ NUT & F.W., M6 Ø x 19 lng	3
8	CHUTE SIDE WALL, Ga. 18 G.I. Sheet	2	16	NAIL, 1" CWN	8

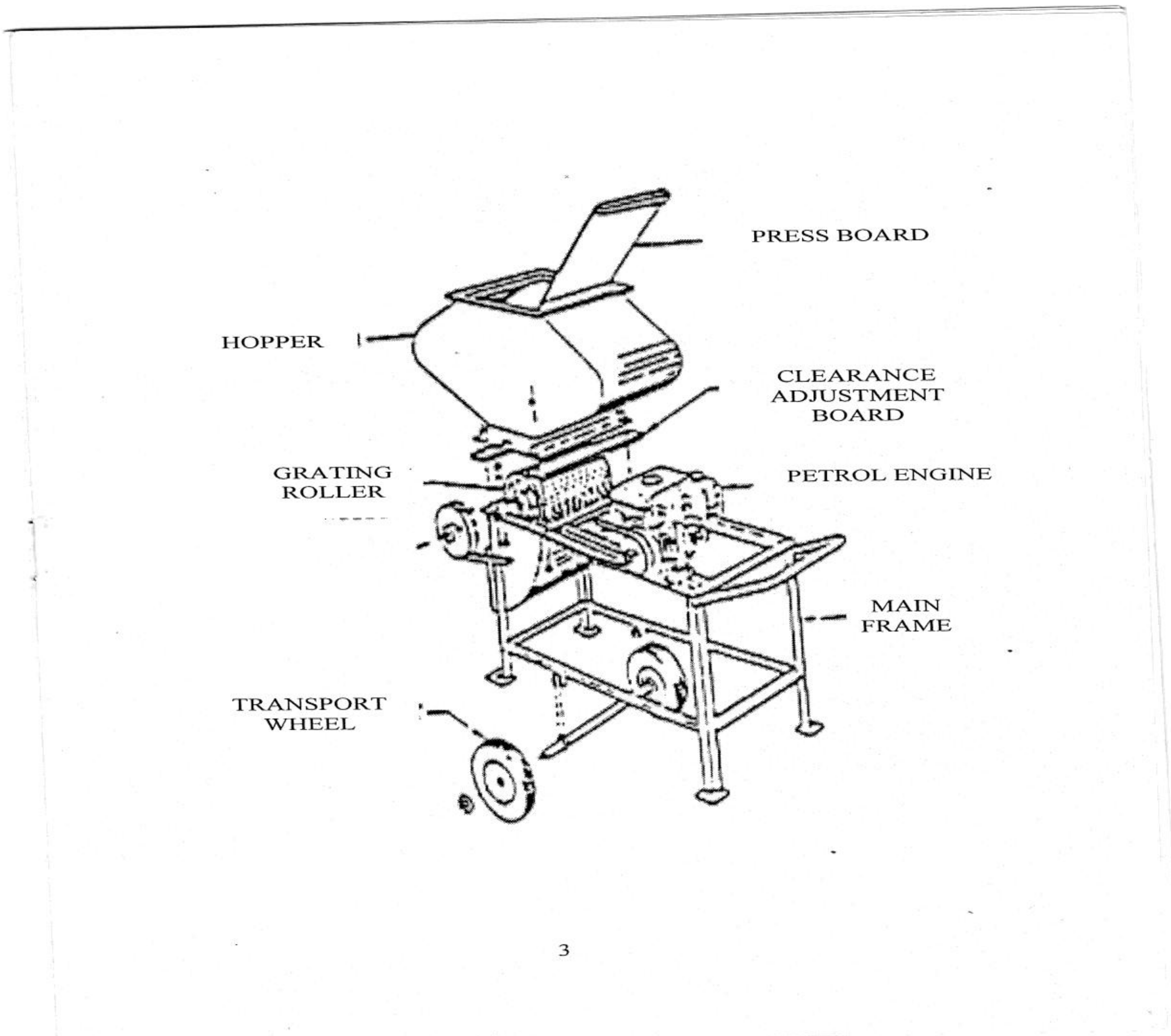


(Source: Figure 3: IITA Postharvest Engineering Unit portal, copied March 2010)

Sheet 3 of 3 describes typical assembly processes to be carried out when fixing the components. (Hopper, Discharge Chute and Feed Control Cover). The dimensions are clearly stated and manufacturers of the cassava grater readily follow the plans

The design process of the IITA Model Manual as modified by the KNUST and GRATIS Foundation (GRATIS Foundation's GF IITA 202) is not very different from the manual stated and described above (a few modifications are described below). The model grater was designed more as a mobile processing machine than a stationary one. According to interviews conducted among the manufacturing institutions and local fabricators, the original design (as seen in the

IITA 202 drawings) is quite handy for moving between one processing space and another. The mobile unit solves an initial problem whereby processors carried peeled cassava long distances (an average of three kilometers was witnessed within the communities in which this research took place). Nevertheless, KNUST and the foundation have also configured the design for stationary applications, upon the request of clients and for exhibition purposes such as annual open day ceremonies at institutions, e.g. the National Farmers Days that are held in the month of December, trade fairs, and others. The main components of the grating unit remain as follows; a pressing board, hopper, clearance adjustment board, grating roller, mainframe, transport wheel and an engine - mainly a petrol engine (Appendix I).



The main description (Appendix, 2) is summed as follows; the grating machine is mobile with a removable two wheel assembly, an oval shaped hopper with an aim of reducing spillage of grated cassava dough, a hand held press board to make the operator use less effort and which again increases the contact of the cassava and the grating roller during the grinding process. The grating drum, also called 'rasper', is a perforated or 'punched' metal (mainly galvanized or stainless steel) rolled and 'riveted' on a wooden cylinder or galvanized steel pipe. The ends of the grating drum running centrally are housed in 'pillow block' bearings. On the part of a pipe being used, the ends of the pipes are closed and holes 'drilled in the covers to take the rod' (Appendix 2). The rod takes a pulley, which is connected to an engine (mostly petrol engine but diesel engines are used sometimes) through a vee belt.

The clearance adjustment boards 'slides' through a slot in between two bolts loosen to fit the board. The rigidity and design of the board enables 'uniform size of cassava mash to be obtained'.

Figure: workshop entrance without wheel and Engine

Figure: Combine lathe

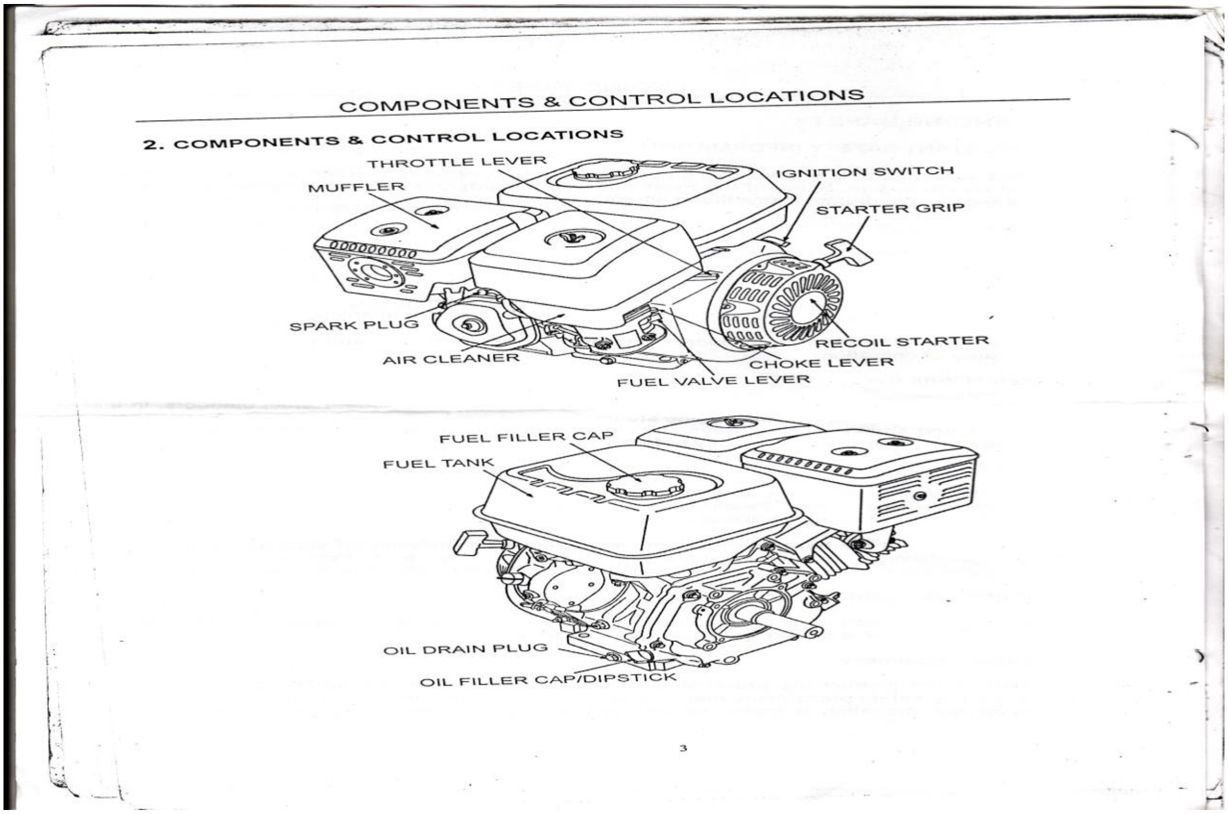
Figure: Manufactured Grater

3.3 Processing Unit Power Engines

The cassava processing units are powered by diesel and petrol engines with average of three tons capacity in the research area. The general components are described as follows:

3.3.1 The Mobile Processing Unit Power Engines

The owner's manual for the engine has the following components and control locations; Throttle Lever, Muffler, Spark Plug, Air Cleaner, Fuel Valve Lever, Choke Lever, Recoil Starter, Starter Grip, Ignition Switch, Fuel Filler Cap, Fuel Tank, Oil Drain Plug, Engine Switch and Oil Filler/ Dipstick. The description of a typical engine component is presented below in a manual.



Fuel Valve Lever: the fuel valve lever serves as the entry and exit of the passage between the fuel tank and the carburetor of the engine. The runs when the valve is in the ON. The OFF position is to be in place when the engine is not into use. This is to prevent carburetor flooding and possibly reduce fuel leakage.

Throttle Lever: The lever speed is responsible for controlling the speed of the engine. The throttle lever is moved to slow or make the engine run faster.

Engine Switch: The ignition system enables or disables the ignition system of the engine. This is controlled by an ON and OFF position

Choke Lever: The choke lever enriches the fuel mixture for starting a cold engine when in the Close position. The Open position helps get the correct fuel mixture for operation when the engine is started or re-started.

Recoil Starter Grip: This helps in the cranking of the engine by pulling the starter grip**.**

The components described aid in the use of the processing grater. The engine is fixed to the fun belt and connected to the cassava grater to power it into motion.

3.3.2 Stationery Processing Power Engines

The types of engines are mainly diesel or petrol powered and tied to the cassava grater. The main components are a belt linking the grater to the engine, tapper rollers, connecting rods with gun mesh bushings, and gears made of cast iron with take off from a flywheel, and a starting wheel, among others. The engines are mainly four-stroke vertical single or double cylinder and water-cooled. The working parts are enclosed with compression ignition.

Below is a type of engine used by manufacturers, local fabricators and local cassava processing operators

Source: Based on design from Agro Equipment Industries (India) an ISO 9001:2000. (Accessed, 20th April, 2010)

Most of the engines observed on site have trademarks such as ONDO, Agro Food Limited, Rex, and Nissan,

Figure 3: Agro Diesel Engine (Peter Type)

3.4 Analysis

The study has described how basic engineering principles were used to modify an IITA design (expressed in manufacturing and operational drawings) and procedures to make the processing unit operational (described in Figures 1, 2 and 3). What this study may consider as a possible problem with the design process is that the engineers who comprised the primary task group for design and modification dispersed after the initiative that brought them together ended. This ended their mandate to designing, introduce and further adapt processing units in the market concerned. According to information on the portal of IITA, such teams are decommissioned after evaluations on their assigned tasks, which mainly fall under projects that have fixed timelines (IITA, 2005). Similar scenarios were reported for the group undertaking the modifications of the basic IITA design in Ghana. A manager of an ITTU workshop, who pleaded anonymity, mentioned that '*when the project ended, the engineers also left and since the government does not have any money to help us to continue with further studies, our workers are also relaxed.*

This is so because we lack the capacity and funds to improve on what was started by them' (Anonymous, October, 2009). This lack of continuing capacity to modify and improve designs is a second major finding of technographic study.

What was realized from the studies for this thesis, based on examining engineering drawings supplied by institutions visited, is that the current cassava-processing grater used in most part of rural Ghana originates in Nigeria, and resembles one designed or disseminated by the International Institute of Tropical Agriculture (IITA). This much is evident from the plans consulted. How this model is configured in the Ghanaian context is described below. Drawing for the "IITA" machine are the main ones used by the GRATIS Foundation, under the Ghana government's Intermediate Technology Transfer Unit (ITTU). This unit had German and Canadian government donor support during the period of the initiative, and these donors may have helped acquire the design from IITA. That the machine has no clear provenance or history is one of the first important findings of the current technography. Things would be very different in Europe where mechanical designs are carefully documented, both as part of a patenting process, and then often for historical purposes (by enthusiasts and/or museum curators).

Agriculture Engineering Experts interviewed from the Kwame Nkrumah University of Science and Technology's (KNUST) Agriculture Engineering Faculty mentioned that, a German and Ghanaian collaboration resulted in the design of some prototypes and components of the processing mill at the University in the mid 1980s to 1990s (the study found about three different types of processing grater which comprised of large, medium and small scale units). What is evidently clear from this study is that, the agriculture engineering workshop manager and coordinator mentioned that some staff of the faculty had been trained in Nigeria at the Intermediate Technology Transfer Unit (ITTU) in Ibadan, Nigeria. The training, according to the Workshop manager of KNUST, who was himself a trained participant, covered the design methodology and processes of the cassava-processing mill. A manual for a model known as IITA type 202 (Appendix III) was used for the training.

From the point of view of experts from KNUST and the GRATIS Foundation, IITA engineers must have mechanized various components of the cassava processing units. According to expert informants, the main mechanical parts are, in sequence, as follows; cassava grater and its unit, cassava pressing machine, cassava chopper and frying pans. The design and fabrication of the cassava grater, the main focus of the study, is described below.

The study found that follow-up mechanisms to check the efficacy of the designed units were not put in place either by the teams mentioned or government agencies and the donor partners who initiated these projects. In effect, little or no effort has been made to explore outcomes of possible use of grating units, once donor and expertise support was ended. Follow up on the processing machines would have helped generate valuable knowledge on how the prototype machines fared within the targeted areas, and possible feedbacks could have led to continuing improvement of the processing mill. This study therefore points to a situation that could be improved. In most industrialized countries, designers and companies maintain on on-going interest in prototype machines, and the most important improvements often come with Mark II models and beyond. The fixed life of the design cycle – with engineers moving to new assignments in other parts of the globe, and with no systematic follow-up, is a major reason why machine technologies for rural development in Africa remain backward, unless modification is within the scope of local repairers and service personnel.

This study realized that while there has been the call to sustain rural technologies such as the cassava processing units within the targeted areas, mechanisms to check whether what was designed and manufactured have been used in its scripted way, or whether modification is needed have not been put in place. Technographic study points to one very specific feature of the Ghanaian case. Modification has taken place, but it has not been fully documented. The stationary grating design unit, it was observed, has gone through a lot of modifications 'to suit the taste of clients' but these have not been included in the drawings available to fabricators drawings (at least from the interviews conducted on site). Again, the mobile unit has gone through various designs by wayside fabricators who do not use any manual to make their units. Finally, the study also determined that the primary annotated manuals and engineering drawings have been archived in an old faculty library at the KNUST, and as such are not readily accessible to students or researchers to study the history of the machine or the modification cycles through which it has passed (and lessons learnt). This seems in part a failing of engineering culture in Ghana. The drawings are not seen as having intrinsic interest. An expert within the University put it 'people don't know how to put things in places', and as such lack a maintenance culture or orientation (anonymous, 2009).

Basic drawings of manufacturing manuals are however with various instructors and lecturers who use them to 'teach' apprentices and students at their levels. The archives storing these manuscripts at the faculty of Agriculture Engineering of KNUST have been relocated and as such are not traceable, and due diligence has not been done to retrieve such information for further study. On the part of the foundation (GRATIS), the study observed and realized that manufacturing manuals are shelved and shielded from the public domain and at the same time operating manuals are difficult to be acquired by and from clients, interested persons and institutions that deal with such processing units.

There is even an air of secrecy about these arrangements. An official of a rural technology facility, who again pleaded anonymity, stated that he got his drawings on 'a governmental agreement' with his organization. He could therefore not give to the public or interested persons a drawing manual of the cassava grater. This means that clients, fabricators and local operators have to improvise in the use, repair and maintenance of the processing units' on site. The specifications of the grating units are therefore shrouded in these inaccessible manuals, hidden from both the researcher and local fabricator.

Nor is there any other kind of support relationship between the design at the research centre and the fabrication workshops covered by the present study. Nor is there any relationship between the operator of the machine on site, the designer and the fabricator. With the exception of SIS Engineering Company (Small, Medium and Large-Scale fabricator not focused on in this study) and ZOWFA Fabrication Company (Small Scale), both of which have their contact details on all processing units sold, none of the other units observed during field work had any details to lead the client back to the manufacturer for help.

Unfortunately, the rural technology facility is yet to think of having an operating manual written for its future clients. There is the assumption by the interviewees that, to protect their designs, such institutions should protect their drawings from being duplicated by the fabricators. Fabricators likewise protect their modified designs from competitors (and researchers) who undercut designs by using cheaper and inferior materials.

In standard industrialized country practice, the foundation, rural technology facility, local fabricator, local operator and purchasing client would have easy access to each other. There is a strong relationship between, research and development, market, and clients in advanced industrialized countries. In the Ghanaian context this has not been realized, in the context of rural technology design. To quote an expert in cassava post-harvest engineering, it is expected that '*Collaboration among the Manufacturers, Businesses, Research Institutions, Extension Staff/Enterprise Developers and Farmers/End User Task Groups is the only thing that will go a long way to help sustain the transfer of rural technologies'* (Dr. Darko, School of Engineering, KNUST). However, the intellectual property laws in Ghana are not very well developed, or actively applied, and arguably this lack of protection for designs is as much a reason as any for the attitude of secrecy and discreet encountered among the design and fabrication task groups.

With the above analysis, it is anticipated that future users may not be adequately enough informed about the processing units being designed, in terms of how or where to direct feedback for redesign purposes. A case in point was observed when a local operator suggested on site, the increase of a space within a clearance adjustment board and the rolling grater. This, he mentioned, will allow the wooden boards not be easily scraped during the milling processes and thus prevent the mixing of the scrapings with the cassava dough during the milling processes. According to the operator, having used the processing unit for five years, he realized that the space between adjustment board and roller was too small. This leads to the board being too easily in contact with the roller, which is perforated scraping part, and thus wood mixes with the cassava dough.

In observing the materials used to make the processing units, types of materials specified in the design (in this case mild, galvanized, or stainless steels) are not always used, and the actual materials used on site may differ 'due to the high cost of making these materials and the overhead cost of transporting them to the workshop from the market' (Anonymous, 2009). Within the primary design centres (the Science and Technology University and the GRATIS foundation), use of specified metals makes the final product expensive to local clients. On the part of the local fabricators, it was realized that ordinary metals from tin, containers and scrap can often be joined together, welded, cut, re-shaped and moulded into various components of the unit, to offer a "below spec" machine affordable by smaller households and groups.

Local fabricators of the cassava grating units are mainly former apprentices who have gone through a number of required years of training under senior and master craftsmen trained by GRATIS or former ITTUs located throughout the country from the mid 1970s through to later part of the 1990s. Some of these fabricators 'inherited' their businesses from the fathers and relatives who were blacksmiths. The price of these processing units was estimated to be about half the cost of the same units manufactured by KNUST or GRATIS Foundation. In the 2005 annual report of IITA, The following was stated 'The constraints identified in our study were mainly the sourcing of raw material and the establishment of functional organizational structures both among the farmers as well as at the processing plants, which underlines the necessity for research in this field to make sure that business opportunities are properly identified and described before being introduced to the private sector' (IITA, 2005, pp29). Thus technography reveals a gap between formal solutions and what local fabricators actually do, driven by consumer pressure for cheaper machines. But again there seems no suitable forum in which this lesson can be debated and absorbed.

The lack of specification affects local debate about performance criteria by end user task groups. Consumers and manufacturers cannot dirve up quality where market and technical signals do not mix. The above observation shows that Ghana may be worse off than Nigeria, where apparently the number of standardized units built to specification and widely used helps to convey a standard in the absence initial records to provide a baseline for quality control. IITA especially provides a portal through which local appreciation of high standard equipment can be appreciated (http://www.foodnet.cgiar.org/agro_ent/process/Process.htm; in FAO, 2005. Accessed 5th March-26th April, 2010)

Statements based on anonymity of some experts and officials interviewed revealed that donor and international institutions often end or decommission projects with a stalemate over how activities are to be continued. Donor funds and institutional assistance do not meet long-term objectives, but only satisfy short-term outcomes, as seen under this particular study. The standard intellectual property rights regimes do not seem to work in the case discussed, and a culture of poor records, gaps and silences hinders technological development. Maybe new efforts are needed to create longer-term linkages among stakeholders, in the absence or infancy of intellectual property drivers to improve machine design? According to the anonymous experts consulted, design initiatives are purely for research purposes and as such are within the public domain. There is no need therefore to protect any intellectual rights, as the units were made with donor funding or state support. New technology initiatives, especially with a rural focus, in Ghana, tend therefore to keep on re-inventing wheels, rather than improving an existing vehicle. What is now needed is a system for learning from mistakes under the existing designed units or technologies. Donors and stakeholders of rural technology transfer initiatives need to re-consider introducing new technologies into existing cultural environments without studying if there has been a history of similar initiatives and if there has been, finding possible ways of improving on the said technologies. A starting point for a better approach, it is here suggested, is the technography of the design task group. Having revealed gaps and discontinuities in the design and fabrication process through this means steps must now be taken to create specific feedback linkages for continuous design improvement.

CHAPTER FOUR: END USER TASK GROUP

The end user task groups within the cassava processing industry are placed into two types. That is, small-scale (local) fabricators who mainly rely on available metals to make the processing machines for the local market. The clients of these end-user task groups are small groups and individuals within the rural communities around the location of such workshops. What is noteworthy here is that most of these end- user task groups mainly do not have any contact with research and manufacturing institutions mentioned above. They learnt how to manufacture the prototyped processing plants through apprenticeship programs under both public and private initiatives within the country. The second group under this definition comprises operators and processors of the cassava processing plant onsite (these are mainly within household and group arena). Detailed functions and roles of this task group category are described in this chapter.

4.1 Small-scale (Local) Fabricator:

The local fabricator makes the cassava grater within the group arena. The grating unit is built without any manual. As stated earlier, the design process of the cassava grater was not really different from that of the manual from IITA, KNUST or GRATIS Foundation. What was different here is that, the fabricators use simple tools (e.g. hammer, hacksaw blade, nails, among others) and improvised raw materials to make the cassava grater.

The process of making the machine by the local fabricator is summarily described below and pictorially presented.

To begin with, the fabricator makes the same components. That is, Press Board, Hopper, Clearance Adjustment Board, Grating roller, Chute, Main Frame to sit both the grater and the engine. There were no transporting wheels under the mobile processing machine units observed under this study. The process of making a mobile cassava grater is described below in the pictures (the study did not find a local fabricator who was engaged in the making or building of a stationary grating unit within the research area):

					
001	Apprentices working	**002**	Designing a rolling grater	**003**	Oval grater
					
004	Shaft to be fixed on mill	**005**	Master craftsman and apprentice interaction	**006**	Welding to fit joints together
					
007	Checking on specifications by master craftsman	**008**	Putting hopper on stand	**009**	Fixing bolts and nuts
					
010	Grater ready for spraying	**011**	Finished cassava processing mill	**012**	Some tools at the workshop

In pictures 01, 02 and 03, the rolling grater is designed by the fabricator to suit the specification of the master craftsman in this case. A shaft (04) is made to fit in two bolts. This is to fix the grating roller and pulley at the same time on the main frame, or stand in this case. Sequences 05 to 10 show the welding, scrapping and fitting of all the components of the cassava grater. Sequence 11 represents a typical finished grater, ready for the market. Sequence 12 shows two of the type of tools used at the workshop. A number of apprentices perform series of activities in the entire processes of the processing plant. There was no manual found at the workshop of the fabricator as stated earlier. Pictures of old machines made when the master craftsman was an apprentice and previous machine units, served as the main 'manual' on-site.

4.2 End User Operator

On the part of the operators' use of the processing mill onsite, four of such processing units were followed within a period of eight weeks (Two Mobile and two Stationary units described earlier). The following observations were made and described below:

4.2.1 Mobile Processing Units

A typical day of an operator of the mobile processing unit started early dawn (about 06.00 hours) with the servicing of the entire component of the unit. The main set of tools used comprised a small hammer to push the wooden components, hacksaw blades or knifes to cut, shape, and press the clearance adjustment boards. A set of pliers, spanners, and screw or bolt drivers are used to tighten the screwed parts of the unit. The various joints of the processing units are inspected to see if bolts are tightened well, shafts are intact, hopper is fitted well, and grating rollers turn well. Fan belts and pulleys are inspected to see if they fit well and no cuts are seen on the belts that connect to the engine of the unit.

When defects are observed, the necessary repair action is done. A clearance adjustment or pressboard is re-shaped by the use of the hacksaw blade or knife to re-fit in the hopper. A broken bolt is replaced; a bent hopper is re-adjusted by the use of a hammer at the observed faulty area. These, among others, are the typical repair and maintenance procedure of the cassava grater performed by the end user operator.

The engine part of the machine unit was inspected to see if there were leakages. Fuel and lubricating oil levels are checked. When this is done, the components are re-fueled or 'greased'. The main tool used here were rugged cloths to wipe the oily parts. Pliers and drivers are used to tighten parts that require such an action. A broom is used as a brush, sweep, and a rugged cloth serve as a duster to clean the dirt from the engine. The grating unit is washed with water to remove dirt accumulated previously and particles of grinded cassava evidenced from previous use of the machine.

The complete machine unit, that is the grating and engine parts, is brought to the open space for a 'test start'. Lifting is made from opposite side that carries the component. Two or more people perform this task. More water is poured into the hopper when the engine is 'heating'. This helped to remove leftover dirt that had been left during the first 'cleaning' of the machine. The process takes about twenty minutes. What was observed was that, whenever there was 'more work to be done', for example, during harvest time, part of this process was skipped 'to make time for the clients'.

a. b. c.

Figure 4.1 Mobile units in an open space (a), fixing a bolt on an engine (b), testing the unit before use in the open (c).

The mobile unit was carried by head pottage, carted on a hand pulled truck by the operator, clients (mostly women) and youth. It could be moved on a motorbike to the farm, community or market centers during market days at a fee negotiated between the client, operator and a motorbike rider on commercial purposes. Milling at the farm level was at request of the farmer, an individual or cooperative/ association, who had 'bought a cassava farm'. Similar process of transporting the unit went for 'milling' within the communities. On market days however, the unit was sent by the operator and or his apprentice who supported and performed assigned tasks such as operating the machine 'when the master/ parent is tired' or filling the hopper with peeled and washed cassava. This task was performed with the full participation of the 'client' who had come to process his or her cassava. It was observed again that most of the milling was done during the late afternoon till 'when the market ended' (between 14.00 to 18.00 hours).

The grating unit was washed with water at the processing space/ area. This was followed by the mentioned mode of transportation of the processing unit back to the operators' compound. That is, head pottage, pulling on a truck or on a motorbike. This was a typical day of the end user processor of the mobile cassava-grating unit.

a. b. c.

Figure 4.2 Operator adjusting a Mobile Unit on-site (a), Women helping in processing cassava (b) and Operator concentrating on milling (c).

In Figure 4.2a, the operator is seen using a coconut husk to ‘adjust’ the mobile processing unit to maintain balance. This was done whilst the grater is in motion; Figure 4.2b depicted the interaction among the operator, women and the machine unit. Whilst one person washed the peeled cassava onsite, another poured it into the hopper/grating drum with the support of the operator. A third person used the hand to scoop the processed dough from the chute. Figure 4.3c shows the operator using both hands in a bending posture to ‘press’ the cassava whilst grating. Another person uses a stick to bring the dough from within to the entrance of the chute. The hand is then used to scoop the dough into waiting pans for other members to carry the dough for bagging before pressing is done.

4.2.2 Stationary Processing Unit

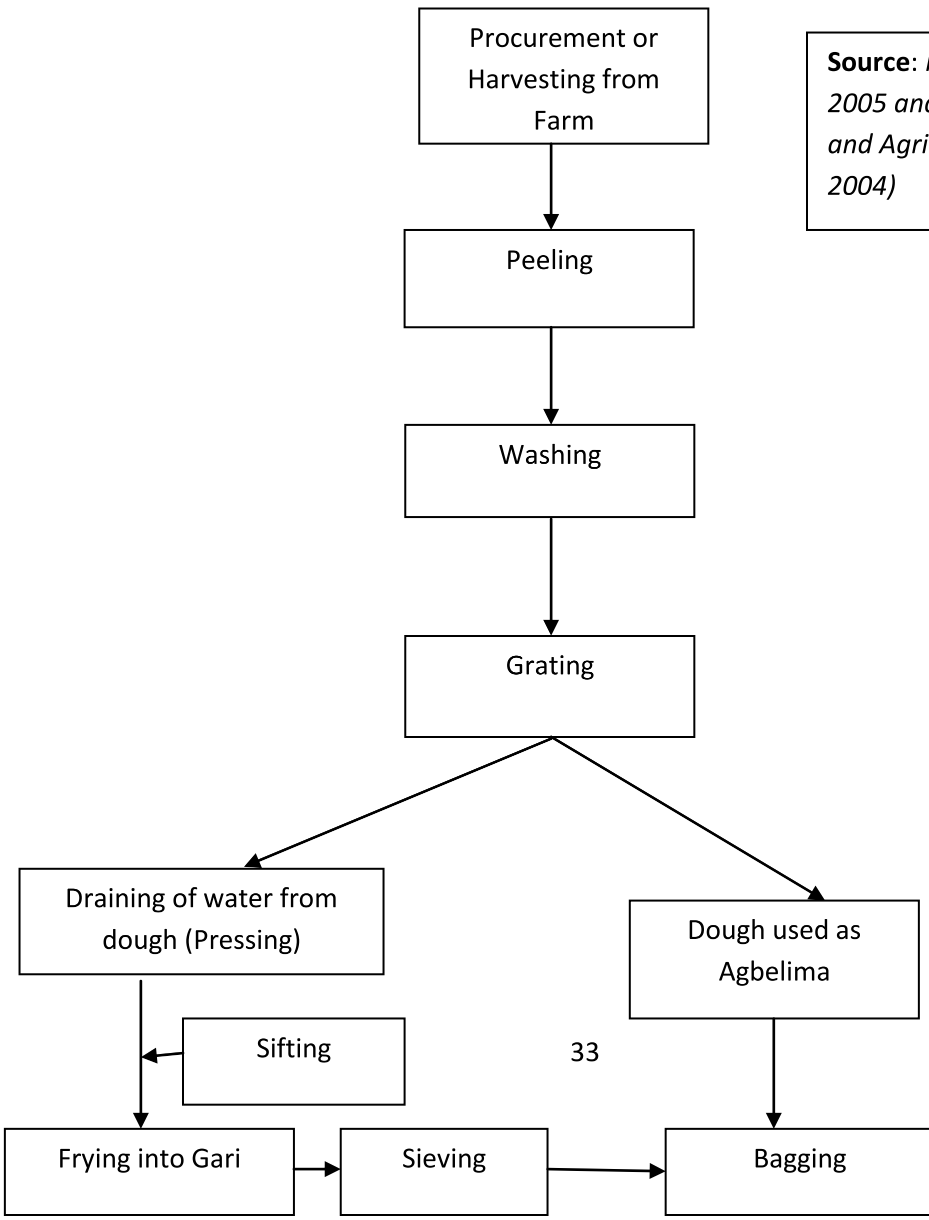
The operation of a stationary processing unit is not too different from that of the mobile unit. What was different is that, the grating unit is fixed and located mainly in the household compound of the ‘owner’ of the machine unit. There is attached the rolling grater, a handle that is used to push and pull the adjustment board. When it is a group or community based unit, the machine unit was located on group land or communal space (mainly at the outskirt of the community). This was to facilitate and reduce the transportation time of carrying the cassava tubers from farm to the milling shed.

The day of an operator is described as follows; the grating unit is inspected and ‘cleaned’ as done within the mobile unit. The same tools are also used and the same process is taken. That is, checking on sharpness of rolling grater, shaping boards to fit into hopper/ drum, tightening bolts, ‘greasing of nuts and lubricating of engine components, among others. This process took about twenty-five minutes if the unit is small scale and about forty minutes if a medium scale unit. The machine unit is ‘tested’ by using a sparking handle that turned a wheel along the pulley.

On a typical day of an operator of the processing unit, work mostly started around 12.00 hours in the daytime, ‘when farmers return from the farm’. Most of the cassava is peeled on farm or at the household compound by the clients (individuals or women groups) or at the group fire shed. The peeled cassava was carried in pans on head pottage, bagged in sacks or carted to the processing sheds. When the unit was located within the fire space of a group, cooperative, association or community arena, the cassava is peeled onsite, washed and carried straight for milling. The operator pushes and pulls the handle of the grater, this allowed the cassava be grinded as the tubers fall within a space created during the push-pull activity within the hopper and rolling grater. Apprentices and women throughout the milling process support the operator in the performance of this task. A typical day ends around 20.00 hours with the cleaning of the grating unit. During bumper harvest time, milling could go on till 24.00 hours.

4.3 End user processor

The end user processors are herein referred to as 'client'. A day's activity of a client followed a procedure that was synonymous to local cassava processing on-site. This is described below using a flow chart and pictures in an order that corresponded with 'standard procedure' within the rural cassava processing industry.



Source: *Modified from FAO, 2005 and Ministry of Food and Agriculture (Ghana), 2004)*

The production procedure of the processed cassava has the above diagram as the most common procedure in the research areas. Each member of the harvesting or processing of the cassava tuber knew what his or her task was. The task is not written but communicated orally among members. The Task Group involved in the business (that is, women, men and youth), either harvested the tuber from their own farms or that of their family members. Tubers could be bought from neighbors, towns and villages in and around the production area. Young men hired by an individual person performed the harvesting, peeling, bagging and transporting the tubers to the processing shed. An entire family performed this task if the processor was from the household perspective. If the ‘client’ was an association or cooperatives (this was the case in the research area), members’ aged between ages sixteen to forty-five performed this task. The cassava was then uprooted, peeled on the farm to be processed (Peeling was done by elderly members with an average age of forty-five). All the members performed the task at one time or another) or carried on head pans or jute/poly sacks to group shed or members’ compound for processing. The peeled cassava was washed in basins with water (depending on the locality and group taste, washing could be done two times or more with available water within the vicinity). Grating was done after the washing of the cassava by either the traditional method (this is done with the perforating of any lead or flexible matter with a nail or any sharp pointed edge to make it porous to scrape the cassava into soft dough) or the use of the processing machine, which is the focus of this research. The cassava dough is then placed into sacks and tied very hard for the water substance to be drained; this then is put under a press for a number of days (two to four days, depending on the locality and style of the processor). The dried cassava dough is taken from the press to a fire shed where frying takes place to produce gari. Sifting was done using a locally made sieve which had a pan under it or a sieve that directly gets to a box beneath it. Conversely, the cassava dough is used as agbelima (cassava dough) and used to mix corn dough to prepare various local foods (such as Banku, Akple, Wopkle, etc).

Pictorial presentation of processors daily activities

							
001	Weeding around the root		002	Sending root home		003	Harvested cassava

					
004	Packed pan of cassava	005	Head potting of tubers	006	Uprooted tubers for peeling on farm
					
007	Peeling cassava on farm	008	Heading to shed	009	Peeling arena near shed
					
010	Men, last to come from farm	011	Washing peeled cassava	012	Ready for milling

4.3.1 Harvesting from Farm

Again the way and manner cassava is uprooted from the soil follows a skill in order not to destroy the cassava tuber during the process of uprooting. Members rely on experienced colleagues to uproot the tubers whilst the not so good members cut the uprooted cassava sticks. Packing is done into sacks or woven baskets and then carried to an agreed upon place for peeling. The group knew among themselves who was more skillful to do what, when and how (e.g. harvesting the tubers). To perform this task, the 'harvester' bends and gauges the possible locations of the tubers underground. The cutlass (machete) or hoe is used as the main tool to uproot the tubers. The average age category of these persons was between the ages of twenty-five to thirty-five.

4.3.2 Peeling

Peeling is done using a traditional method, a simple knife or machete is used by the group to peel the cassava, a new skill is exhibited in the process of peeling, there is caution in the entire peeling process, this, it was observed and confirmed by the group that, the style of peeling aids in removing the cassava covering and not the edible part of the tuber. The advantage was that washing the tubers required limited use of water (which was mainly scarce and costly) before grating is done.

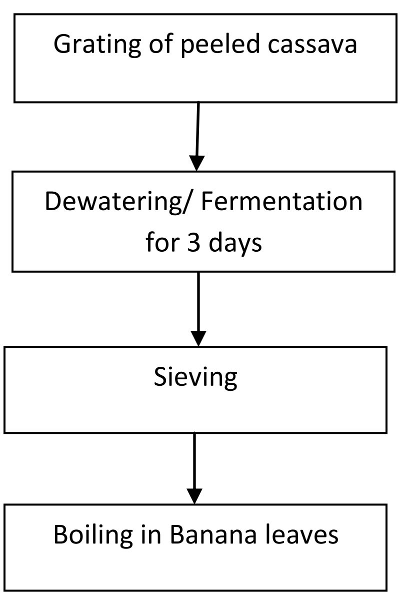
4.3.3 Washing

The peeled cassava is placed in large bowls and then washed with water. This was thoroughly done to remove traces of dirt before grating. The washing of the peeled cassava is expected to clean the dirt and reduce the possible infestation of pathogens comprising of fungal, viral, and bacterial pathogens, insects, and nematodes (IITA, 2005). The washed cassava is then ready for grating using various methods from traditional to modern rural and appropriate technologies available.

4.3.4 Grating

Traditionally the cassava grater was made by perforating any metal-like tin to grate the peeled cassava. However, with the advent of intermediate technologies, various methods have been improved and used by processors at the household level. The mobile and stationery-grating units have taking over the grating of peeled cassava at this level. Grating is done by powering the grater with a horsepower diesel or petrol engine, which is controlled by a steering wheel at the right side of the grater by turning to push the cassava tuber in the hopper (as described earlier).

4.3.5 Making cassava dough (Agbelima)



(Source: ISHS Cassava Processing Flow Chart (Demonstration of Cassava Processing Technologies, Accessed, 20th February,2009)

The finished grinded or grated cassava dough is scooped and placed into a sack for the market. That is, if the cassava is milled as Agbelima. In this case, the cassava dough became the end product and bagging for the market is done.

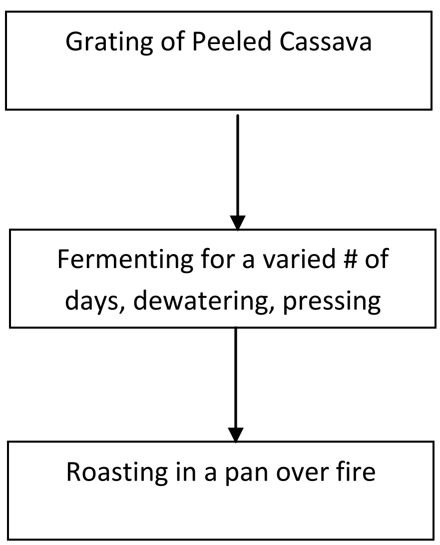
4.3.6 Pressing (Draining of water from grated dough)

The bagged cassava dough is pressed, if the dough is for the making of gari. The grated dough is put in sacks and tightened hard under a specially made press. The aim is to squeeze and drain liquid matter in the dough. The clients, using their hands, bend and put the bagged dough on the press. To be able to drain the water, the press is periodically tightened ‘as and when the water is reduced’. It could take an average of three days to dry and finish pressing the cassava dough. This depended on the type of press being used by the client.

4.3.7 Sifting (sieving dried dough)

After the water has been pressed and the water squeezed, the grated cassava become compact or hard. The compact matter is then sifted by the use of a sieve that is made of palm branches or metal that is perforated. This is done when a fire shed was ready and large frying pans, which could be clay made or metal prepared for frying the cassava granules. The older members of the Task group performed this activity. The youth (mostly teenage girls) assisted in performing this activity. In this way, they are initiated to cassava processing business.

4.3.8 Frying (Gari making)



(**Source**: **ISHS** Cassava Processing Flow Chart- Accessed 20th February, 2009**)**

The sifted cassava dough is the ready for drying through a frying/roasting process that could take thirty minutes to two hours (even more time) depending on the hotness of the frying pans, the quantity of the dried cassava being fried, the skills and techniques being used and members performing the frying. This was another avenue whereby young members take their turns concurrently with the old and experienced members of the group. The transfer of knowledge became very evident at this point of processing the cassava into its finished product (Gari in this case)

4.3.9 Sieving

Fried cassava was sieved using metal sieve and a collecting box beneath it. This is part of the unit set of the processing mills sent to communities as interventions or bought by family holdings, individuals or processing associations. The old method of this was done by the use of palm branches, or sieves with pans placed below them.

4.4 Discussion

The following comment made by an expert on the study under discussion start the subject under review, 'when the Germans and Canadians ended these projects, there were no funds to continue working on these projects, staffs were not again motivated and therefore the workshops collapsed' (italics added). Again, another official stated that 'a pilot project has been initiated at an area (name withheld) because there has been a donor support for this project (italics added). The above comments show the need to look into the way and manner rural technology initiatives have been and are perceived within the beneficiary countries. The issue of sustainability of these technologies thus becomes questionable.

To comment on local fabricators and operators of the processing unit, the study observed that, these groups have little or no formal education and limited managerial skills. This affected their operations within the cassava processing industry. It must be said that most of these task groups have gone through either formal apprenticeship or informal apprenticeship trainings. With formal apprenticeships, meaning, a technical and or vocational institute, such as the GRATIS Foundation, or other ITTU affiliated institutions had trained them. Informally, they would have 'studied' under master craftsmen or from relatives who owned such processing units

Commenting on the use of the machine, the end user operator (mostly men and youth) and clients (mostly women and youth) carry by head pottage, the mobile grating unit. The practice does not correspond with the purported primary idea of designing and prototyping a 'mobile' grating unit. Even though the grating unit is 'mobile', the prototypes do not have to use wheels as per the original drawings in the manual developed by IITA and prototyped by GRATIS, KNUST and ZOWFA Fabrication. This 'hard' task of transportation, performed by the end user is thus something that could be fed into a feedback mechanism to a design team to consider in solving. A case in point was seen in the use of wheel barrel-like tires for some mobile units in the Nigerian cassava processing industry (http://www.fao.org/inpho/content/fpt/Roots/cyanide.htm, Accessed 5th-29th April, 2010)

Again, the performance of the above task meant that the core activity of men was a bit digressed or diverted by spending some time of farming and hunting tasks, to dealing with processing cassava. A performance under duress (Richards, 2006) is experienced in this case. Another important issue in relation to the point raised is that, almost all the operators covered in the study own cassava farms and thus the processing unit is an alternative income generation for their household and livelihood enhancement.

On the other hand, the emergence of the mobile processing unit served as alternative livelihood income generation activity for many operators who once used the engine attached to the cassava-processing unit to support chain-saw operation in Ghana's timber industry in the 1980s to 1990s. A ban on chain-saw operation by Ghana's government, made most of the operators lose their livelihood. The influx of the mobile cassava grating units was thus a good omen for this category of persons within the communities studied.

To comment on the role of women within the end user paradigm, the study observed that more time was spent in the harvesting of the cassava tubers on farm. The process involved weeding, uprooting, head pottage and peeling of the cassava tuber to the processing unit. Time spent performing these activities takes an average of about ten hours a day. This affected the household core activities of the married ones among this category of task group. The cassava transformation task is done by bending and squatting throughout the duration. The women again carry either the raw tubers in sacks from an average 'long' distances of about five kilometers. This affected their health. The use of the hand to scoop cassava dough from the processing chute is again risky. This is because; the rolling grater could pick the fingers if care was not taken and thus causing injury. The bending and squatting make these women develop long-term waist problem in their prime age of thirty years. Discussion with the women revealed that the most common side effect of their task was having waist problems.

The youth in this study have a unique role to play within the cassava processing industry. That is, learning the entire cassava processing techniques from the older groups (that is, Fabricators, operators and processors). This role has been undermined due to the Ghana government's new policy of free compulsory basic education (FCUBE) and youth in employment programs currently underway in Ghana. Whilst the study observed that the new government policy is good for the wellbeing of the young generation, a gap could be created within the transfer of local knowledge. This is especially related to the secondary activities performed by the youth in the area of assisting the parents, to process the cassava tuber and add value for the market.

CHAPTER FIVE: CONCLUSION

The following conclusions are made with further actions that could be taken to possibly improve on sustaining rural technology transfer initiatives in Ghana.

5.1. Technography of Design

The cassava processing technologies described have been motivated and initiated by designers and experts with a very good intension. That is, to help improve the way and manner cassava is processed within the local and rural communities in Ghana. What was revealing, the study has observed, is that, there has seen the lack of the culture of keeping records of the design mechanisms developed by the primary and manufacturing task group. The study realized that, if there had been a good archival systems put in place for the primary manuscripts of the processing units, that is; Press Board, Hopper, Clearance Adjustment Board, Grating roller, Chute, Main Frame, Grater and the engine, there would have been in place a good processes of learning from mistakes made on existing machines. The latter would have helped to improve them by new initiatives, researches, and or institutional bodies that may have interest in the promotion and production of such technologies. Whilst it could be said that industrialized countries keep to good records and archiving systems (including patenting and other intellectual property rights), the Ghanaian case study did not have such a mechanism put in place to improve on existing technological transfer initiatives. What was very revealing from this study was that these statements were made by experts and caretakers within the cassava processing facilities centers and have played certain key roles in the design, manufacturing or implementation of old machinery units used from previously designed cassava processing units.

In comparing with Nigeria that has a lot of cassava processing technologies made available onsite, the designed manuals and drawings in Ghana's institutions are archived and not readily available for research and businesses to build on that. Referring to the history of the emergence of the cassava rolling grater and other units, it was realized that some Ghanaian experts were trained by IITA in Ibadan, Nigeria, and experts from the University of Leipzig (Germany), to acquire the necessary knowledge to design similar machine units for the Ghanaian processing environment. Nothing of that information was found to exist under the study under review. This was because of limited information given to the researcher onsite by the institutions covered. Again, whilst small and medium-scale fabricators are linked to the primary designers of the manuals in Nigeria (e.g. IITA), this was not the case of Ghana. Each task group performed its task separately. There was no feedback mechanism to enable the designer to be able to study and understand the causal effect of the technology introduced within the targeted environment in rural Ghana. In Nigeria, the various models of cassava processing units are available and one can easily get to know of the types, use and possible preferences by clients.

5.2. Design Task Group

Ghana, and for that matter engineers need to know the history of the various types of cassava processing units available. Again, there is the need to know the different models, specifications and clients' preferences of the units available and in use. This will go a long way to help engineers to configure what type of processing units are preferred as per a location of the cassava processing units in use. For example, during interactions with different cassava processing operators and the women processors, it was realized that, whilst processors and operators within village communities preferred to use the mobile processing units, most of the groups and operators in towns and with access to electricity, preferred the stationery processing units. Designer task groups therefore need to put their task and purpose of re-designing and improving on the design and use of the processing units into local context and not wholesale design for the entire country. There is the need to implement within local demand so that the end user task groups may not use the units in different ways within the local environment. Consideration of how the local people or end user task groups differently prototype the units could be taken into consideration.

A possible patent rights and regulations may have to be put in place to maintain industrial secrets of designers and manufacturers. Even though donor funding may have contributed very much to the possible establishment of technological units like the cassava grater, mechanisms to promote and protect intellectual properties of designers (corporate or individual legal persons), could lead to the security of technological innovations and possibly encourage re-designing of existing technologies like the cassava grater which was the focus of this study. The latter may lead to possible feedback mechanisms from end user task groups to designer task groups, thus, improving and sustaining the technology transfer initiatives in Ghana and other developing economies that face similar challenges.

5.3. Sustaining Rural Technologies in Ghana

Technology Transfer should not be a push but demand expectant. The end user should demand for the technology and not vice versa. In the rural settings of developing economies, the old ways of doing things always has a causal relation with the culture and community cohesion. It demands that, when a technology is being infused into the set community, there is the need to factor in the ethno-cultural system in the said community (Mauss, 2006). The technology transferred becomes unsustainable when what is given a community is something they already have and or not wanted, taking into account the family system through demand process.

In sustaining rural technology initiatives within an environment such as rural Ghana, there is the need to re-write the design team of such initiatives as the cassava processing units. A possible dream team made up of local and foreign experts with core knowledge in processing technology is required. The ideas of both task groups are needed (this was seen in the actual initiatives that brought in the standardization of the processing units). There is however the need to keep proper records of the drawings and manuals for future improvement of the existing processing units by new experts and help to conform to new findings of the use of the units by the end user task groups (operators and processors). If this is taking into consideration, there could be a break in re-inventing the wheel of importing new technologies that may not be sustainable like the existing units studied.

The availability of and use of operating manuals will go a long way to help sustain various technologies infused or transferred into the rural communities. (Manuals need not follow the traditional ways but could be scripted with pictorial processes to make it easier for end users who are mostly illiterate and thus may not be able to read and understand the writings of the said manuals) The availability of knowledge and skill to operate the said machine is another way of making technologies transferred with a specific community sustainable.

Manufacturers and businesses should be able to adequately transfer the skills and knowledge to the end user to enable him/her to be abreast with the functions, management and maintenance of the said machine. Training is needed to be given to the end user operator to facilitate early detection of faults and the fixing of parts that become faulty.

Maintenance is very important in sustaining a transferred technology. A top-down and bottom-up approach of maintaining a machine is very necessary to make a machine last longer or meet its lifelong timeline.

For the above to be achieved in sustaining the technological knowledge transferred, there should be the need for both the designer and end user task groups to form coalitions. The former, it is hoped could put in place a feedback mechanism to take these feedback from the end user and therefore help to improve on the existing technology. As a case in point, a local fabricator of mobile processing grater, ZOWFA, has given a name to each mobile unit fabricated. He has his contact cell phone number on each unit sold out to the clients. This method helped him to track how the machine is used onsite. Again, this helped in getting quick solutions in fixing and repairing the said machine unit should there be any defects or breaks. An appropriate action could be taken to rectify the said fault encountered by the operator on the use of the technology and the machine unit as the end user on the field improvises it.

Possibly, issues on intellectual property and patency could be looked into. The fact that most technology institutions in Ghana may not be fully or willing to give out information about their prototype technologies to researchers and 'outsiders', could be seen in relation to how unsecure most of them might have felt in the arena of duplication of knowledge from primary task groups by end users who may not pay back any royalties to such technology innovators (corporate or individuals).

In having a very sustainable technology use on site, the dream team, it would be expected, to re-include within the new technology that would come out of the feedback loop, a tracking method of improvising made by end users on the field during the use of the processing unit. As an example, the use of coconut husk or tubes of tires cut by operators of both the stationery and mobile units, to keep the unit balanced on the open field, could be re-modified by designer task groups during the re-design process.

The socio-cultural effects of the units would need to be further looked into. This will help in getting to know whether the new way of doing things have any causal effects on the social ordering in relation to the use of the unit re-sent into the community. The involvement of youth in the entire processing units, to some extent, meant these youth would have to divide their time of, going to school and working on the farm with operating machines units. Again, with the call for a free compulsory basic education program in these rural communities, a study on the effect on how these youth reform to the new changes in relation to working on the units after school could be very good information for social and technical workers.

The Ghana government could start a process of advocating for a percentage of total project cost of initiating or re-designing rural technologies in the country. Again, a fund could be set up through the state's financial allocations for such actions to be carried within and among designers, manufacturers, fabricators, operators and user clients within the rural processing task group chain. Such an action could help in the collection of feedback from end-users of such technologies transferred. This fund could be used to engage engineering consultants who would have been locally trained with designer task groups during project designs, planning, implementation, management and evaluation processes.

Donor organisations and partners who promote technology transfer initiatives should consider 'conditionalities' placed in such contract for state governments to sign. When conditions specified do not aid in expert designers and consultants going back to study and take feedbacks from end-users to improve on existing technologies, technology transfer initiatives could not be sustained in the long term.

The private (business) sector could take the initiatives of professionally connecting with design engineers, research and policy to get work done in making sustainable business of existing and future technologies that would be designed. This could go for other value addition processing units in Ghana and related countries involved in rural technology transfer initiatives.

Environmental issue (not covered in this study) could be looked into for further action. This could, especially be concentrated, in and around the transformation spaces of the processing units of end user task groups. The study observed on the field that the outcomes of peeling, washing and pressing of the cassava dough in and around the processing area could generate environmental challenges and interesting issues. This is because the water from the washed cassava may contain unwanted and harmful toxic materials like cyanide, among others that may have environmental effects in and around such community spaces and food safety.

Further study on the effect of the machine units directly on gender issues within the cassava-processing sector could again be an area that could be of sustainable interest for further research. This study, due to its time frame, could not deal much with this and as such further study is therefore suggested.

To conclude, rural technology transfer initiatives have come a long way in Ghana to help improve the living condition of the local person. However, 'it is sometimes necessary to take one or two steps back and to think about what we are doing' (Oskam, 2009). There is the need to help sustain existing technology transferred into developing economies like Ghana for future use. A Technography with a realist standpoint, as a methodology, could continually be used to unravel and suggest possibilities of sustainability issues within this sector.

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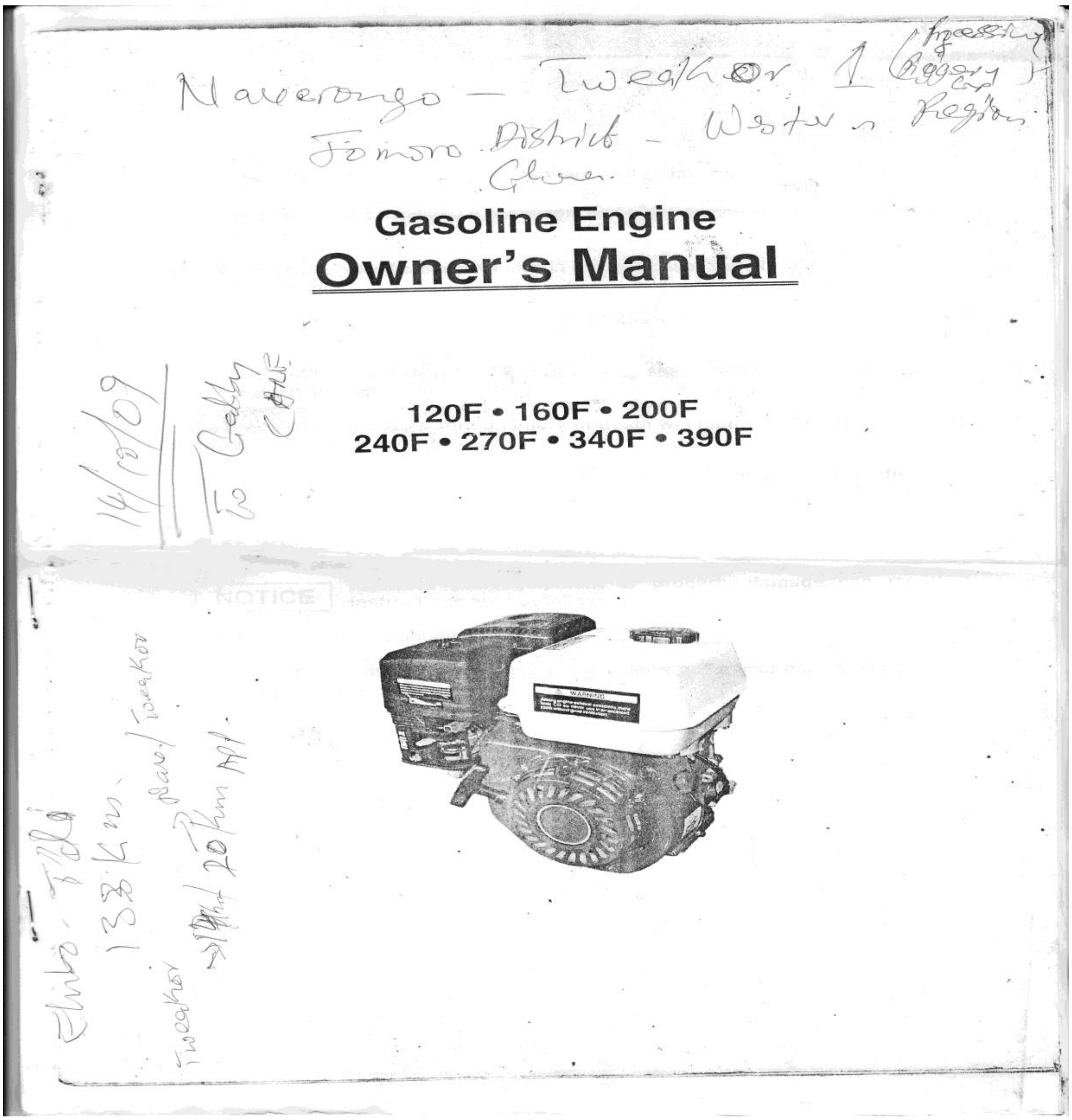
APPENDICES

Appendix I

A Typical Engine Used to run the Cassava Grater (Mobile unit)



Gasoline Engine

Owner's Manual

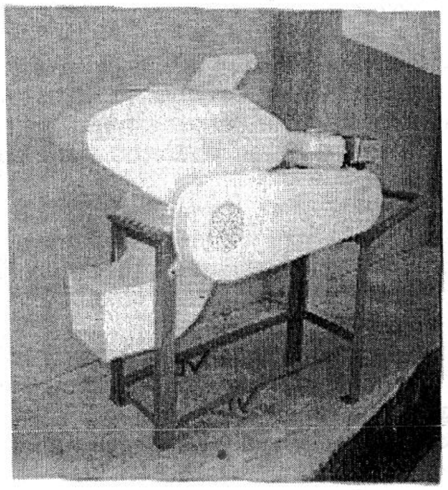
120F • 160F • 200F

240F • 270F • 340F • 390F

Appendix II

A Typical Manual from GRATIS Foundation to be given out to Buyers of Processing Plants

OPERATION AND MAINTENANCE MANUAL



CASSAVA GRATER
(GF IITA-202)

GRATIS FOUNDATION RTTCS

OPERATION AND MAINTENANCE MANUAL
CASSAVA GRATER (GF-IITA)

1. DESCRIPTION

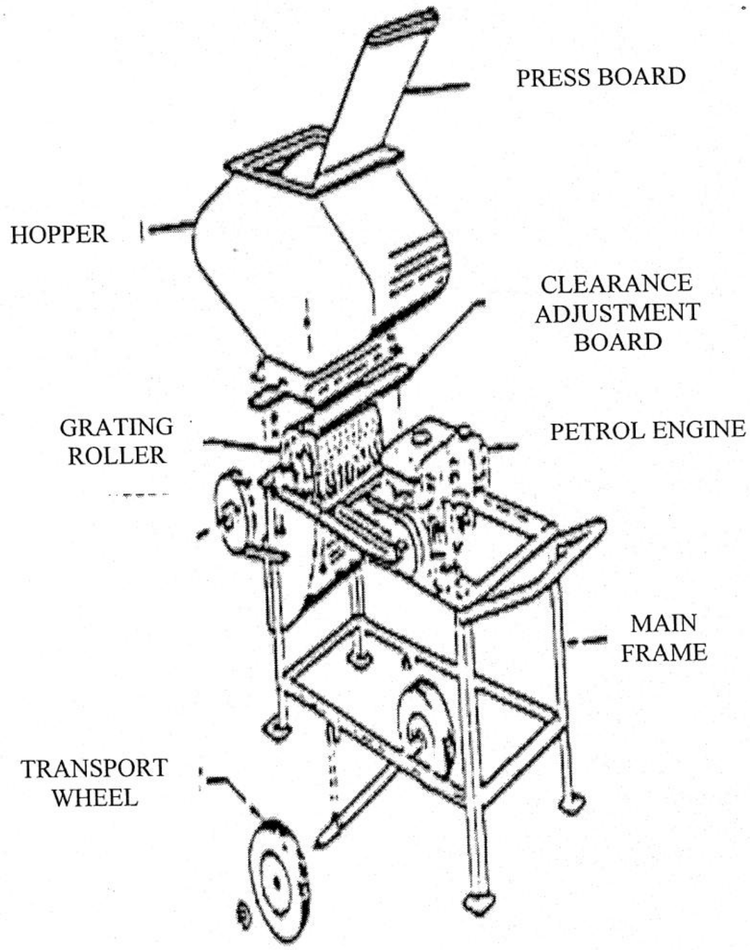
The **GF- IITA Cassava Grater** is light in weight and mobile by means of removable two-wheel assembly. Its oval shaped hopper reduces spillage and the use of a hand held press board reduces the effort needed by an operator and increases cassava-grating roller contact.

The grating roller or grating drum, also known as rasper, is a punched galvanised or stainless steel sheet rolled and rivetted on a wooden cylinder or galvanised steel pipe.

The ends of the rod running centrally through the grating roller are housed in pillow block bearings. If a pipe is used, the ends are closed and holes drilled in the covers to take the rod. An attached pulley connects the rod to the pulley on the petrol engine through a Vee belt.

The clearance adjustment board of the grater slides in a slot when two bolts are loosened. The design of the clearance adjustment board and its rigidity due to the fastening enables uniform size of cassava mash to be obtained.

If the hopper, the discharge chute and the grating roller are made of stainless steel, the GF-IITA Cassava Grater can be used in grating fruits such as pineapple, watermelon, for juice extraction.


PRESS BOARD
HOPPER
CLEARANCE
ADJUSTMENT
BOARD
GRATING
ROLLER
PETROL ENGINE
MAIN
FRAME
TRANSPORT
WHEEL

2. INSTALLATION

Holes are provided in the legs of the GF-IITA cassava grater for bolting on a concrete foundation. However, as it is frequently used on-farm or on-site, it is provided with wheels and installation to enable operation only requires securing petrol engine to an in-built stand.

3. OPERATION

3.1 GRATER

- adjust clearance (gap) between adjustment board and grating roller by loosening the two fasteners (bolts) and sliding the board in the slot.
- feed peeled cassava into the hopper of the grater.
- push peeled cassava into contact with grating roller using the hand-held press board.
- examine grated cassava mash for finess.
- if finess is not what is desired, vary clearance between adjustment board and grating roller.

3.2 PETROL ENGINE

- check level of lubricating (engine) oil and fuel and top up if necessary.
- open fuel line
- open “CHOKE if engine is being run for the first time in a day

- turn "ON" engine with switch
- pull cranking rope, slowly at first, then briskly once or twice, till engine starts.
- close "CHOKE" immediately engine is in full throttle.
- increase or decrease speed with throttle lever.

To Stop engine

- reduce speed
- turn "OFF" engine with switch
- close fuel line if no more grating is to be done

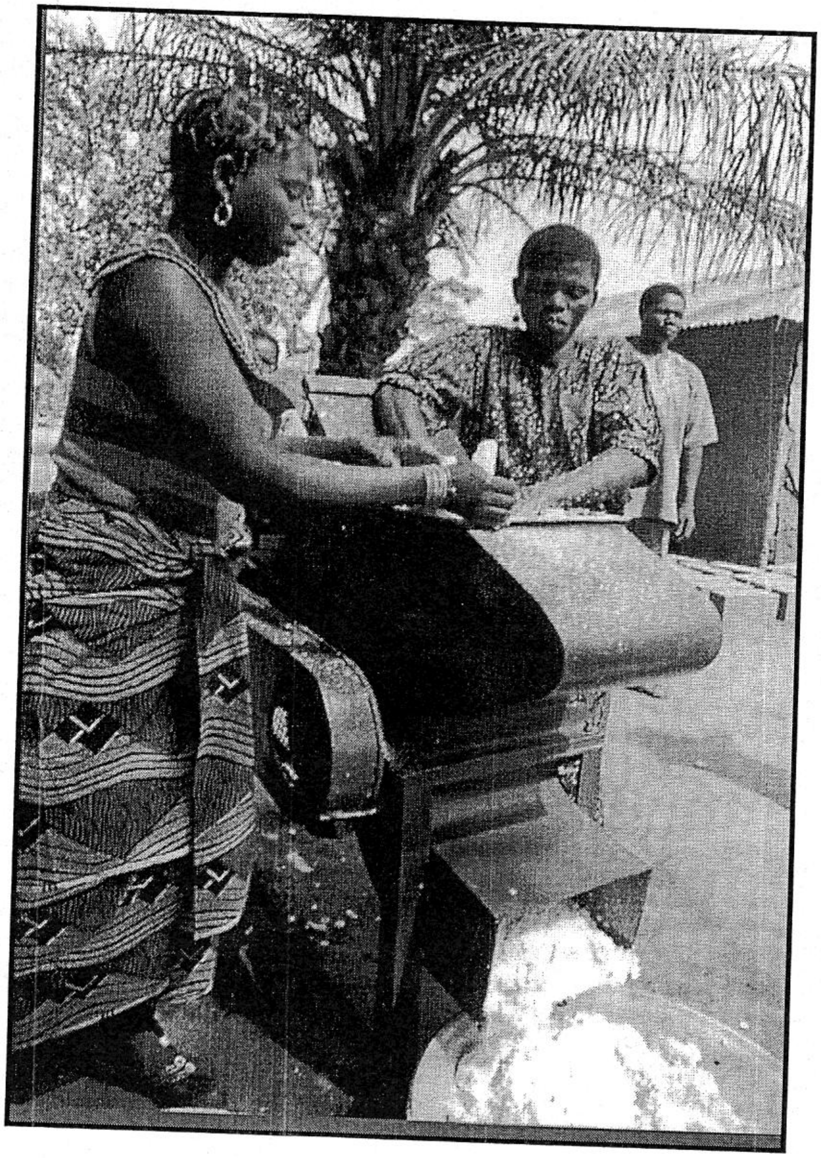
4. MAINTENANCE

4.1 GRATER

- after a day's work clean, thoroughly with water and wipe body.
- grease bearings at 3-month intervals and replace if they emit unusual noise.
- replace pulleys if wear is excessive.
- change drive belt if frayed or cracked.
- scrape and repaint grater if it is corroded.
- with use, clearance adjustment board wears - replace board when wear is such that needed gap is obtained by sliding and fastening board at the end of the slot.

4.2 PETROL ENGINE

Daily preventive maintenance checks are given in 3.2. Refer to manufacturer's manual and carry out the normal periodic maintenance of petrol engine including change of lubricating (engine) oil, fuel, oil and air filters. If equipment is used continuously for 8 hours a day, this must be done monthly.

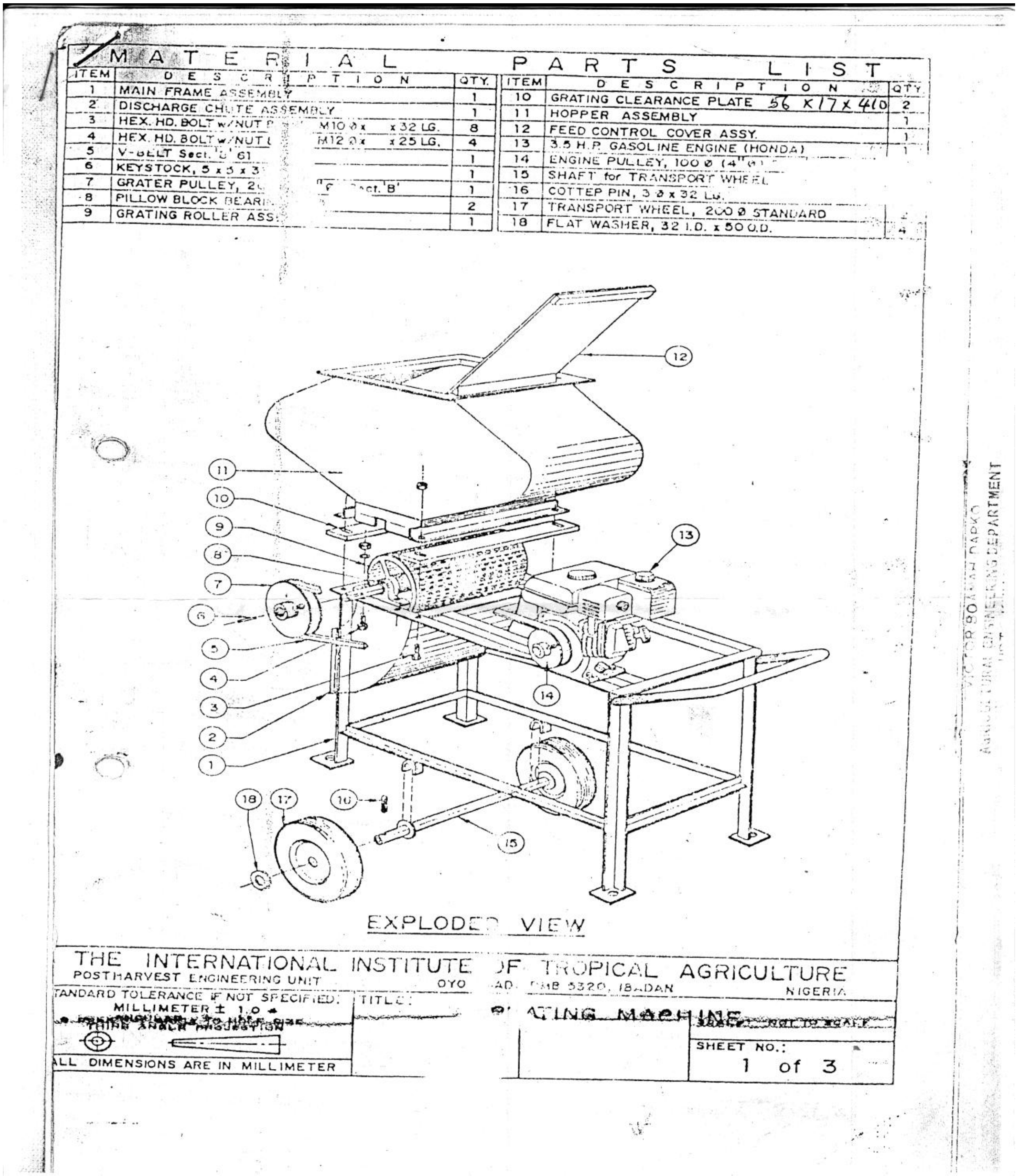


6

5. SPECIFICATION

Capacity	:	1000kg/h
Prime Mover	:	4hp, 3600 rpm petrol engine
	:	110mm dia pulley
Speed	:	1000rpm
Pulley (grater)	:	200mm dia
Drive Belt	:	V, B60
Bearing	:	Pillow Block, P205/206

Appendix III: Manual from KNUST- Agricultural Engineering Faculty (Based on IITA Type 202 Model)



MATERIAL PARTS LIST

ITEM	DESCRIPTION	QTY.	ITEM	DESCRIPTION	QTY.
1	MAIN FRAME ASSEMBLY	1	10	GRATING CLEARANCE PLATE 56 x 17 x 410	2
2	DISCHARGE CHUTE ASSEMBLY	1	11	HOPPER ASSEMBLY	1
3	HEX. HD. BOLT w/NUT [illegible] M10 Ø x x 32 LG.	8	12	FEED CONTROL COVER ASSY.	1
4	HEX. HD. BOLT w/NUT [illegible] M12 Ø x x 25 LG.	4	13	3.5 H.P. GASOLINE ENGINE (HONDA)	1
5	V-BELT Sect. 'B' 61	1	14	ENGINE PULLEY, 100 Ø (4") [illegible]	[illegible]
6	KEYSTOCK, 5 x 5 x 3[illegible]	1	15	SHAFT for TRANSPORT WHEEL	[illegible]
7	GRATER PULLEY, 2[illegible] Sect. 'B'	1	16	COTTER PIN, 3 Ø x 32 LG.	[illegible]
8	PILLOW BLOCK BEARING	2	17	TRANSPORT WHEEL, 200 Ø STANDARD	2
9	GRATING ROLLER ASS[illegible]	1	18	FLAT WASHER, 32 I.D. x 50 O.D.	4

EXPLODED VIEW

THE INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE
POSTHARVEST ENGINEERING UNIT OYO ROAD PMB 5320, IBADAN NIGERIA

STANDARD TOLERANCE IF NOT SPECIFIED: MILLIMETER ± 1.0
THIRD ANGLE PROJECTION
ALL DIMENSIONS ARE IN MILLIMETER

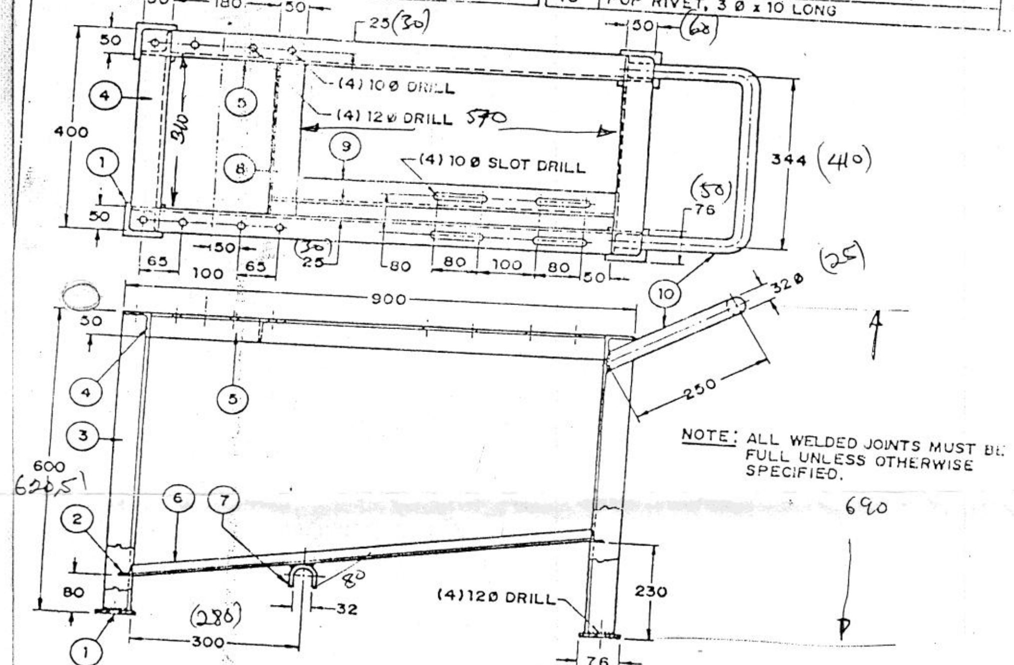
TITLE: GRATING MACHINE
SCALE: NOT TO SCALE
SHEET NO.: 1 of 3

VICTOR BOSOMPEM DARKO, AGRICULTURAL ENGINEERING DEPARTMENT

MATERIAL PARTS LIST

ITEM	DESCRIPTION	QTY.
1	BASE PLATE, 76 x 76 x 6 THK. M.S. PLATE	4
2	CONNECTING BAR, 25 x 5 thk. x 300 LG. ∠-BAR	2
3	VERT. FRAME, 50 x 5 thk. x 600 LG. ∠-BAR	4
4	HOR'Z. FRAME, 50 x 5 thk. x 400 LG. ∠-BAR	2
5	HOR'Z. FRAME, 50 x 5 thk. x 800 LG. ∠-BAR	2
6	CONNECTING BAR, 25 x 5 thk. x 800 LG. ∠-BAR	2
7	GUIDE BRKT., 25 x 3 thk. F-BAR	2

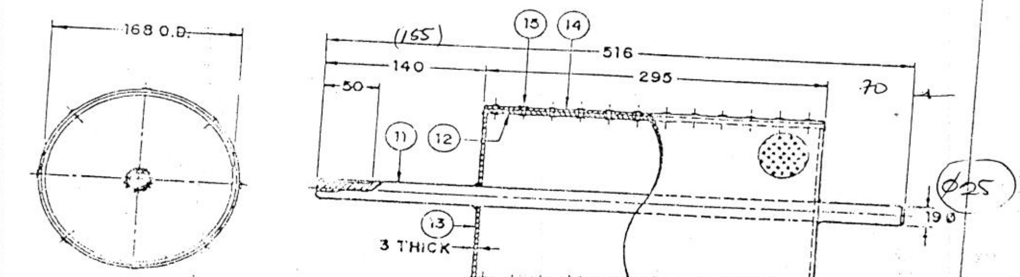
ITEM	DESCRIPTION
8	HOR'Z. FRAME, 50 x 5 thk. x 300 LG. ∠-BAR
9	HOR'Z. FRAME, 50 x 5 thk. x 600 LG. ∠-BAR
10	HANDLE, 32 Ø B.I. PIPE
11	SHAFT, 19 Ø CRS
12	ROLLER, 168 O.D. PIPE
13	FLANGE, 3 THK. M.S. PLATE
14	GRATING PLATE, GA. 18 G.I. SHEET
15	POP RIVET, 3 Ø x 10 LONG



Base plate = 60x50x6

MAIN FRAME ASSEMBLY

REQ'D: 1 ASSEMBLY
SCALE: 1 : 10



GRATING ROLLER ASSEMBLY

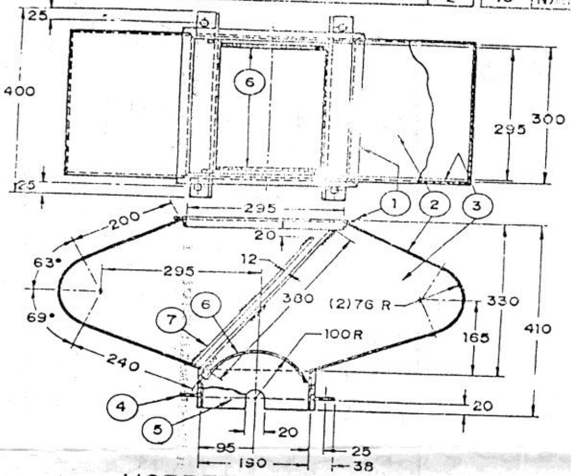
REQ'D: 1 ASSEMBLY
SCALE: 1 : 5

NOTE:
- GRATING PLATE SHOULD BE MOUNTED WITH POP RIVETS ON THE ROLLER WITH THE ROUGH SURFACE OUT.
- POP RIVETS SPACING SHOULD BE DETERMINE DURING ASSEMBLY.

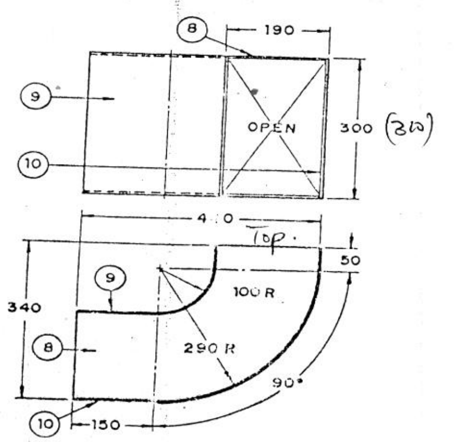
SHEET NO.: 2 of 2

MATERIAL PARTS LIST

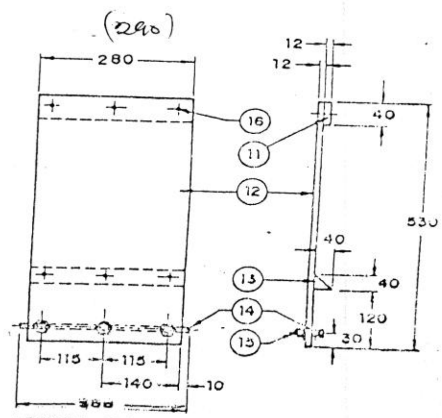
ITEM	DESCRIPTION	QTY.
1	TOP FRAME, 12 x 12 x 3 thk. m.s. ∠-BAR	4
2	HOPPER WALL, GA. 18 G.I. SHEET	2
3	HOPPER WALL, GA. 18 G.I. SHEET	2
4	MOUNTING FRAME, 38 x 38 x 5 thk. m.s. ∠-BAR	2
5	MOUNTING FRAME, 5 thk. m.s. PLATE	2
6	ROLLER GUARD, 12 x 3 thk. m.s. FLAT BAR	2
7	GUIDE BAR, 6 Ø m.s. ROUND BAR	4
8	CHUTE SIDE WALL, GA. 18 G.I. SHEET	2
9	CHUTE UPPER WALL, GA. 18 G.I. SHEET	
10	CHUTE LOWER WALL, GA. 18 G.I. SHEET	
11	HANDLE, 12 thk. x 40 x 280 long wood	
12	COVER, 12 thk. plywood	
13	STOPPER, 40 x 40 x 280 long wood	
14	SLIDE BAR, 6 Ø m.s. ROUND BAR	
15	HEX. HD. BOLT w/NUT & F.W., M6 Ø x 19 LONG	
16	NAIL, 25 (1") LONG C.W.N	



HOPPER ASSEMBLY
REQ'D: 1 ASSEMBLY
SCALE: 1 : 10



DISCHARGE CHUTE ASSY.
REQ'D: 1 ASSEMBLY
SCALE: 1 : 10



FEED CONTROL COVER A
REQ'D: 1 ASSY. SCALE:

SHEET NO.: 3 of 3