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DEVELOPING THE AGRICULTURAL MACHINERY INDUSTRIAL SYSTEM
(AMIS) TO SUPPORT POVERTY REDUCTION IN RURAL AREAS

NC/GHA/02/016/11-01

Technical Report *

Prepared for the Government of Ghana

By the United Nations Industrial Development Organization

Acting as executing agency for the United Nations Development Programme

Based on the work of Mr S.Vasantha Kumar

International Consultant on rural agro-machinery design and engineering support

Project Manager: Mr Evert Kok, PTC/AGR, UNIDO

United Nations Industrial Development Organization

Vienna

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Abstract

The Project: DEVELOPING THE AGRICULTURAL MACHINERY INDUSTRIAL SYSTEM (AMIS) TO SUPPORT POVERTY REDUCTION IN RURAL AREAS NC/GHA/02/016.

Athor: S.Vasantha Kumar , International Consultant, UNIDO

Duration of the Activity: 2 months 3 weeks(Sep-Nov 2003)

objective: To assess the situation in relation to the target group of engineering industries and their relation with urban and village communities in Ghana, specifically identify obstacles for effective equipment manufacturing and utilization, enterprise creation and devise appropriate corrective strategies involving most likely technical and managerial training, supply of basic equipments, and if required raw materials. Assess the alternative options open for approaching the identified bottlenecks, and will develop criteria for selection of appropriate solutions, which will be reflected in the draft of a document for Phase II of the project the AMIS . To equally evaluate methods and ways to assure the continuous relevance of the project execution to the Presidential Special Initiatives. Identify appropriate tools and implements in the area of cassava harvesting, and processing. Based on the outcome of the above, to design a system for the local mass production of the necessary equipment.

Keywords: cassava harvesting,

The report contains the existing situation in Ghana regarding the cassava harvesting, cassava starch production. The bottlenecks in cassava harvesting identified and solution arrived in development of manual cassava harvesters and its production and reach out to farmers at the village level. Almost 100% of the manual cassava harvesting problems are solved by using the solution arrived at in the short term. In fact Ghana could be leading in this technology diffusion of manual cassava harvesters to other cassava growing countries. The current situation of the engineering industries is presented from the point of view of their capacities and capabilities for undertaking the serial production of the agricultural

equipments /implements. They are found to be totally lacking in the modern production technologies, quality of the products produced out of these machineries like cassava Starch to International standards.They also lack in the facilities for training and more importantly the trained manpower,training institutions. Recommendations made for upgrading existing support institutions for acquisitions of the latest technologies along with trained trainers for dissemination of the technologies, and introduction of standardization of agricultural machineries, and technical information network to the engineering industries and to the users of agric machines and implements in Ghana.

Consolidating on the identified demand and bottlenecks for agricultural produce, looking at the value chain, identifying manual harvestors locally or internationally and adapting them to suit the local conditions, the project has developed an approach for development of agromachinery and implements. Based on the value chain, the project identifies support requirements for the engineering sector, and consequently maps out the functional requirements for industry support institutions.

INTRODUCTION

Ghana is predominantly an agricultural country. It is estimated that one third of the Ghana's GDP is from Agriculture. Agro-business constitutes a major approach of the Government of Ghana towards national economic development and reduction of poverty, especially in rural Ghana. Cassava is a major agricultural product grown, serving as a staple food for the community at large. It is believed that agricultural industrialisation through mechanisation of harvesting the agroproduce , postharvest operations in processing the agroproduce for finished food products etc in the long-run promote economic growth and creation of jobs. Government of Ghana requested UNIDO intervention for exploring to establish a system. This system is named as AMIS(Agricultural Machinery Industrial System).

The "President's Special Initiative (PSI) (Annexure -3) on cassava starch production as a strategy is to achieve national socio-economic development in the shortest possible time through value addition. The value addition is in converting cassava to starch for export. This is the immediate objective of the PSI on cassava. The main ingredient for the starch is the cassava. Faster and quality harvesting of the cassava is the main requirement of the starch factory ASCO under the PSI initiative. At present the ASCO capacity to produce starch is much more than what the farmers' cooperative can harvest and supply.

The assignment focus is to immediately identify the bottlenecks of the farmers in the cassava harvesting and help them with appropriate design and development of affordable and physically tested cassava harvesting implements (manual or mechanized). This is demonstrated in the realisation of 3 alternative manual cassava Harvester implements.

The report is written by Mr S.Vasantha kumar International Consultant under the mission post NC/GHA/02/016/11-01.

The mission activity started from 10th Sep 2003 and completed on 30th Nov 2003 including travel for briefing. The job description is in Annex-1

The AMIS(Annex -1.1)is a system framework which when implemented would give the advantage of bringing out the Agricultural industrialisation faster.

The inputs for the assessment of the existing value chain as per AMIS framework are from number of field visits to farming villages, small and medium industries manufacturing agro machines, support institutions for these industries, finance institutions (mainly micro finance), other current related UNIDO projects e.g Rural Micro enterprise,PSI, Ministry of agriculture as main nodal points in the value chain. These visits provided the interaction with the primary stake holders in the value chain eg; the farmers and the village level micro and small enterprises in the design process for the immediate requirement of agricultural implements. Also the existing industry support institutions who are the important partners in the value chain and the micro and small Industries have been studied from the point of view of their capability and capacity to develop and manufacture agro machineries and implements.

The objectives of the mission as set out in the job description have been achieved. The basic objectives were not revised. However, the government requested this project to address immediately the priority bottleneck of cassava harvesting. Consequently a more focused allocation of project activities has been made on manual cassava harvestors.

I. SITUATION EXISTING AT THE TIME OF THE ASSIGNMENT

A. Introductory remarks about Mechanization of agriculture in developing countries:

In Ghana as in many developing agricultural countries more than 80% of farm power is provided by human beings. It was reported that some animalpower is used in the Northern regions of Ghana.

In the past, misunderstood concepts and inappropriate selection and use of certain mechanization inputs (mainly tractors and heavy machinery) have, in many parts of the world, led to heavy financial losses and lowered agricultural production as well as contributed to environmental degradation. In many developing countries, ambitious tractor schemes have often become a burden to the national budget and the farming community rather than being a productive input. This has also been the case in some centrally planned economies, where mechanization was heavily subsidized through the provision of government planned and operated machinery services. In Ghana this situation does not fortunately exist and hence is saved from great expense and time. The development of "appropriate" or "intermediate" machinery, tools and equipment is also a favourite subject for development assistance. The activities of these projects have generally taken place in the relative isolation of government and university departments and workshops. The resulting prototypes only occasionally find their way into commercial production and onto the market. Displays of improved machines and hand tools which have never been developed and marketed beyond the prototype stage can be found in virtually every workshop in university and government departments of agricultural engineering in developing countries. To an extent this is true of Ghana as well.

Further examples of misapplied mechanization inputs can be found in many technical co-operation projects, which were mostly planned and implemented with the best intentions but in an uncoordinated way and without due consideration of sustainability and economic aspects. It is an unfortunate fact that only a very few

mechanization projects aimed at "transferring" technology to developing countries can claim to have been completely successful.

Keeping the above scenario in mind the UNIDO AMIS concept has attempted to not to fall in line with the above scenario and really establish the introduction of appropriate technology and take it through all the stake holders in value chain in the system in Ghana.

The following findings which is a very specific example of the Implementation of the AMIS philosophy which basically defines the following as the guiding framework for future development of standardised set of machineries through nodal technology development centres proposed to be set up under the AMIS Project.

B.Objectives of AMIS

To assist in the design and setting up of a comprehensive, self -sustainable national system that would assure

- Supply of appropriate agricultural machinery and implements for pre- and post-harvest operations to local farmers and help
- Improve the efficiency of agricultural production in the country and minimize post-harvest losses.

The underlying principle of the above is depicted in the diagram at Annex-1.1.

C. Existing situation (Value Chain) of AMIS

1.Primary Manufacturing: The Primary manufacturing institutions are essentially the village level blacksmiths and artisans. They cater to a limited extent for the fabrication of basic hand tools like earth chisels, cutlass etc in addition to these tools supplied from organised industries. They invariably use scrap metals from various sources (mainly from automobile scrap) and melt them and forge them for making these tools. These tools are crude, heavy and donot last long. However the farmers use these as it is immediately available at the village level directly from the blacksmith or district level hardware stores.They serve the purpose and slightly cheaper and are reformed by the blacksmiths if worn out with reduced size from the original size.

2. Workshops for Hand Tools, Small Machines:

These shops exist in the industrial clusters and estates. The shop sizes range from 2 to 10 people and manufacture small agro machineries. They are slightly better equipped with manufacturing machineries although the technologies and machines adopted are old.

The Products are again crude and every machine made is non standard and hence it is like virtually custom made machine. The distribution is also direct point to point from the shop to the user of the tools or machineries or through the retail hardware shops. The raw materials are from scrap materials. The quality is again poor and spares are not easily available as a standardized part and hence to be again almost custom made.

3. Factories, implements, larger machines:

There are few factories which are very well organized like “Crocodile Matchet” for hand tools like cutlass and other hand tools for agriculture. They import the raw materials from UK with very good materials standardization and control. Also the manufacturing practices are based on well established technologies and quality control systems imported from abroad and adopted well locally. They have a network of distributors through whom the manufactured goods are marketed to the retail outlets.

4. Agricultural technology institute:

Other than the agricultural institutes dealing with agronomy aspects the institutions having the capabilities in varying degrees for developing agro industrial machineries and implements are:

- GRATIS
- TCC/ITTU Kumasi
- Institutes like Kumasi Technical Institute.
- Polytechnics like Kumasi Polytechnic.
- Workshops under the MOFA
- Agricultural Engineering Department of KNUST
- Mechanical Engineering Department of KNUST
- Institute of Industrial Research

- Food Research Institute

The comments made in general in the section heading "A" above apply by and large for these institutions. A determined and timebound project approach with adequate finance and output accountability as adopted in the development of manual cassava harvester is expected to yield results in the development of good quality small agroindustrial machineries by these institutions. These institutions could be individual like in GRATIS or in combination like the Agricultural Engineering and Mechanical Engineering Department of KNUST, and Institute of Industrial Research and Food Research Institute for the development of agroindustrial machineries and implements.

5. Training Institutions: The above institutions undertake and organize short term and longterm training programs for training of trainers, entrepreneurs and extension workers etc in the area of agro processing machineries and implements. With upgradations of the infrastructures and skillsets of the trainers in these institutions the training needs of the agroindustrial sector could be handled. The upgradation of skills will be broadly in the areas of metrology and quality control, materials analysis and testing, machinery design, production technology. The very basic infrastructure in these institutions may not warrant establishing new institutions unless it is of a very broad apex type of institution with a network to the above institutions and with an objective to serve the region as well.

II. AMIS objective realisation

The specific aspect of AMIS objective which the present mission interalia addressed is the supply of an agricultural implement to improve the manual cassava harvesting thereby improving the efficiency of agricultural production in general in the country. PSI on starch indicated that this issue of efficient and faster harvesting is a very critical issue in the value chain and had to be addressed immediately and a solution found.

It is also found in the field studies done at Bawjiase village under the PSI Ayensu starch company in the central region that 100 % of the farms are manually harvested using conventional earth chisel and cutlass as shown in the pictures shown in Annexure- 7.

The existing traditional harvesting process is manually lifting the cassava by clearing the land and cutting the stem so that the stalk may be 1.5 ft to 2 ft to facilitate lifting by hand. The farmer lifts the cassava tuber . The damage to the tuber can be seen to illustrate the inefficiency of extracting the full cassava tuber with the traditional methods. The time taken for this method and the drudgery and strain to the farmers while doing so have been the main bottleneck. This is the situation existing since decades. Also it was told that this is the situation in all regions of the country where cassava is grown.

This is the baseline ground reality in the cassava farms.

A. Design philosophy for the cassava harvesting implement

The design philosophy for any implement for uprooting the cassava arising out of the above realities in the field and clearly expressed by PSI Ayensu starch company are:

- Any implement designed should facilitate easy lifting so that the drudgery and fatigue experienced by the farmers are reduced thereby harvesting more quantity of cassava harvesting for the same unit of time. This was found to be the most fundamental and essential requirement from the Ayensu starch company.

It is reported and physically witnessed by me in the cassava farms that the traditional process of manually lifting the cassava tuber leaves some portions

of the cassava tuber in the soil which becomes waste. Also sometimes the tubers gets cut(as shown in the pictures in Annex 7- Existing practices of traditional cassava harvesting.) which exposes the cassava to the atmosphere and starts decaying if not processed to starch conversion in the starch processing unit within 48 hours.

- The feed back from ASCO revealed that an implement to facilitate manual harvesting to reduce the drudgery and improve the efficiency is the most immediate requirement of the cassava harvesting.
- From the baseline study made by the National Expert and also discussions with him the above findings have been confirmed.
- It was informed to me that there are 4 manual harvestors and I was asked to examine these. Only one of them was found to be existing and the others are only conceptual sketches or a drawing . These are depicted in Annexure-8 (paras 1,2,3,4). The design features of these harvestors are detailed in the same Annexue-8 against each.

B. Existing situation of cassava harvesting in Ghana:

The findings from the baseline studies and also my specific visits made to cassava farms and machinery manufacturers in the Tema, Kumasi and Greater Accra areas and the existing condition in Ghana regarding the cassava harvesting which emerged out of discussions with the PSI Starch company Ayensu Starch Co, resulted in the following observations of existing situation of cassava harvesting in Ghana:

- That there are no mechanical harvestors of any type used in the cassava farms in Ghana.

2 models of mechanical harvestors are being contemplated for further developments in the GRATIS, agricultural engineering Department of the Kwame Nkrumah University. No tested data is available to confirm the performance of these harvestors. The pictures of these are shown in Annex -6. In fact no detailed analysis of these exist as regards to their suitability for cassava harvesting. Both the models need extensive redesign to make them lighter so that the tractors which can pull them are in the range of 35 to 40 HP which are available in Ghana. Before redesigning they need to be compared with the available harvestors else where in the world. The other collected

data on cassava harvestors around the world are shown in Annexure-11. This data could be valuable in evolving suitable design of mechanical harvestors in the longterm. The above two models of mechanical cassava harvestors in Ghana are prototypes of conceptual design and semi finalized as shown in Annexure-6. which need to be field tested and benchmarked with other mechanical harvestors in the world in many other countries. The introduction of these mechanical harvestors will need basically, organized farming in the cassava farms and plane fields. This is non existing at this point but needing attention in the longterm after studying thoroughly the other international trends in the mechanical cassava harvesting.

III ANALYSIS AND SELECTION OF MANUAL HARVESTER MODELS FOR REDESIGN/ADAPTATION AND TESTING

Preliminary observations made in the Bawjiase village in the ASCO cassava farm revealed the following:

- Cassava is widely cultivated by smallholders in scattered patches of land. The small size of the fields (0.8 to 1.2 acres/farmer) and also not in a level field makes tractor-based mechanisation virtually impossible at this point. Therefore farmers rely mostly on manual work for harvesting using traditional tools which are available. The traditional cutlass from Crocodile Matchet factory (an English factory established more than 3 decades ago in Tema) at a cost of 20000 Cedi ex factory and available to the farmer at the retail 25 to 28000 Cedi) and the earth chisel at cedi 30000 retail at the farmer is the main source for the tools. The earth chisel and the cutlass are also supplied by the village blacksmiths as depicted in Annex-7. The village blacksmiths in the unorganized sector, prepare the tool from melted metal from scrap materials in their hearths using the oil palm fruit shells for heating. These tools are generally heavier, of poor quality and made available at 4 to 6000 cedi cheaper as told by some farmers.
- The farmers are accustomed for many years to use the traditional tools “cutlass and earth chisel” which is basically pole mounted implements. Any improvised devise or implement for immediate term should be around the philosophy of pole mounted design to match with the psychology of the farmer. The Thailand model is also a Pole mounted implement.
- Since the cassava farm is not organized and is presently in a thick dense growth as shown in Annex-7 pictures, the implement designed
 - ..Should be easily transportable by a single farmer.
 - ..It should be easily locatable around the cassava plant in the densly grown cassava farm.

..It should be able to grip the cassava stalk and simply lift the cassava by a leveraging action thereby reducing the effort and energy required for the uprooting of the tuber.

Based on the above basic functional requirement the existing 4 models were examined:

- Chain model Annex-8 para 1
- GRATIS design Annex-8 Para 3
- GREL Model Annex-8 Para 2
- DAPIT Annex-8 Para 4

The names of these were rationalized (the selected ones) and is mentioned later in the report.

Out of the above 4 alternatives the GRATIS design Annex-8 Para 2 and GREL Model Annex-8 Para 3 have been removed for further considerations for development and adaptation. The GRATIS design was only a conceptual sketch. Even from the sketch it is found to occupy a floor space which is not amenable for placing in the cassava farm densely grown as shown Annex-7. Even from design standpoint from the sketch it could be seen that it could be heavy and not easily transportable by single farmer So it was decided with discussions with GRATIS and also ASCO to delete this at this point for further consideration.

The GREL model was found to be much more heavier and in fact two people were needed to move it. Also for the same reasons applied to GRATIS design on the aspect of floor space and locating the unit around cassava plant in the dense cassava farm it was ruled out. It will be perhaps very good in rubber plantations where the plants are grown in rows and sufficient distance exists between rubber stems for conveniently locating the unit for lifting. Since the life cycle time between the rubber plant and cassava plant is very large it may be worth the while for even 2 farmers to use the GREL model for removing the rubber stems conveniently. Whereas in cassava the main bottle neck is large quantities of cassava tubers have to be lifted with all the constraints aforementioned.

Hence the chain model Annex-8 (para 1 and DAPIT Annex-8 Para 4 (for which there was no physical model) were selected for further modifications and field trial.

Because of the lack of proper data on this manual harvester a preliminary feed back in the form of taking this manual harvester chain model Annex-8 para 1 as it is and shown to Ayensu Starch company . Alongwith their staff the manual harvester was taken to their captive cassava farm in the Bawjiase village and gave the manual harvester to the farmers to try. It was tried in the field for 4 hours. What emerged out of this test was 6 parameters of the existing design have to be modified if it is to be acceptable for further trial by the farmers. Otherwise in its existing design it stands rejected. These are detailed in Annexure-8. This feedback was extremely valuable for further proceeding with the design of the manual harvestors.

With this direct feed back extensive discussions were held with GRATIS to make the model in 2 types . First type is with rope and the second type is with chain. The DAPIT model was asked to be fabricated as per the drawing as per DAPIT Annex-8 Para 4 with modifications to reduce the weight of the implement and is renamed as Vertical Pole Type. These three models were fabricated and field tested preliminarily in one village Bawjiase and are depicted in Annex-9. The technical specifications for each of the above 3 models of the manual harvestors and the mode of operation are detailed in the Annex-9.

A pilot quantity of 12 each of the 3 models were made and distributed to 12 farms under the PSI Ayensu for extensive testing by the farmers with monitoring by 2 field consultants specifically contracted for the purpose. The field testing philosophy and the guidelines for the consultants evolved is as per Annex – 10. The analysis of the field testing clearly evolved the performance of the models. This is detailed in the Annex-10 . The stakeholders feed back on the harvestors which were presented to them physically and all issues for implementing AMIS was discussed on 29th Oct 2003 is depicted in Annex-12.

However the issue of large scale holding of the land on which the cassava is cultivated has to be logistically solved through cooperative farming which has got

social implications. But the farms which are under the captive holding of Starch companies like ASCO already existing and the planned Eastern Starch company covering parts of the Eastern Region and Volta Region and the Sika Starch Company Ltd (SISCO), covering parts of Ashanti and Central Regions could definitely think of introducing mechanical harvesters in the coming 5 to 8 years. Some details of mechanical harvestors available around world is listed in the Annex-11.

The 3 manual harvestors were presented to the Hon'ble Minister for Ministry of Trade and Industry and PSI Alan Kyerematen by UNIDO rep Mr Akmel Akpa on 20 nov 2003 on the inauguration day of the Africa Industrialization Day. This is shown in Annex -17.

IV MANUFACTURING OF THE CASSAVA HARVESTORS:

A. Status of Further Production:

The manual harvestors developed are simple implements not requiring complicated and very precision manufacturing technologies. Hence the implements are manufacturable in the following places:

- At the SMEs level to a large extent in the industry clusters at the SUAME Kumasi and Greater Accra region. Here the serial manufacturing and the assembly kit manufacturing concepts are depicted in the Annex-13.1
- At the village microenterprise level, only the simple rope type could be manufactured in small quantities only.

Discussions were held in the stake holders workshop, SUAME, Kumasi SMEs and village level blacksmiths also for their feed back and confidence level in manufacturing the manual harvestors in series production. Except the village level blacksmith who can do only the assembly of the harvestors from subassemblies and components bought from other SMEs all the other manufacturers can undertake serial production of the manual harvestors. However discussions with more number of regional workshops would be required for distributed serial manufacture of the manual harvestors in various regions.

The raw materials supply: The raw materials are easily available from the hardware shops in the above regions and are not special materials.

The initial marketing is implicit with the PSI's decision

- To organise the buying of the required number of manual harvestors from identified SMEs directly and give them to the ACFA.
- To ask the ACFA to buy and own the manual harvestors for lending them to the farmers engaged by them for harvesting in various captive farms of PSI during the season and also outgrower farms. Since the harvesting using the manual harvestors is decisively advantageous in terms of more harvesting for the same unit of time and less tiring as proved in the field testing wherein the farmers liked to use the manual harvestors.
- The above initiation would also induce even individual farmers to own the manual harvestor as a necessary tool just as they are using the cutlass and earth chisel since many years.

The sales of the manual harvestors will be initially point to point purchase from the manufacturer directly to the ASCO or ACFA or to the individual farmer. When the demand builds up substantially throughout the cassava growing regions the business opportunity itself will automatically push the existing sales outlets even at village/district levels to stock and sell the manual harvestors in the same way as they are selling other tools like showels ,pickaxe, cutlass and earth chisels etc. A typical outlet is shown in the last picture in Annexure-13.

Maintainability by the village artisans: The manual harvestor implements are simple not needing any complicated techniques for assembly and disassembly techniques. Hence they are easily maintainable by the village level artisans.

B. Economics of Production

From the observations of the Small Manufacturing Enterprises more detailed in Chapter V, there are few SMEs in some regions which are fully equipped to undertake all the operations required for manufacturing the chain type and the vertical pole type of manual cassava harvestors developed. Hence two alternative models, one centralized production centre (Alternative 1) and the other a decentralized production centre (Assembly kit manufacturing, Alternative 2) are

considered as per Annex 13.1. Both the models could be operatable depending on the types of SMEs existing in different geographic regions. The economics of production will depend on the quantities of harvestors produced in the respective regions like Greater Accra, Tema and SUAME Kumasi. The harvestor manufacturing carries with it the added additional cost for transportation and servicing of the harvestors for various regions. The economics of production and distribution however will be from the central production centres(Alternative 1) in the Tema and SUAME Kumasi for the harvestors.

V OBSERVATIONS OF THE SMALL MANUFACTURING ENTERPRISES, VISITS TO SOME SMES

To get a first hand feel and an assessment of the SMEs, visits were made to the industries in Kumasi, Tema and greater Accra areas. Also a questionnaire (Annex -15) was designed and sent to them through the industries associations to fill up. The SMEs response is detailed in the Annex -15. The feedback forms filled up are left with the National Project Manager for future reference. The observations made from this feedback is described in a summary in Annex -22.1 and the actual conditions existing is depicted in pictures in Annex 13.

Annex -22 describes the Kumasi industrial area which is in a deteriorated state needing urgent attention. AMIS project document covers this area through institutional upgrading of the TCC/ITTU in Kumasi. Annex 13 also contains some pictures of the industries visited which can be physically seen as witness to the technology levels existing at this point of time.

The equipments for cassava processing are listed in Annex-16. The manufacturers have been making these implements and machineries with no standardisations of the designs, raw materials quality control, with the result no two machines even manufactured by the same manufacturer are identical. As a consequence there is no standardised spare parts supply and every spare has to be custom made by the supplier of the agric machinery. This is a direct result of the manufacturing infrastructure in these industries being very old with outdated machineries, technology, and no quality control techniques and equipments. I had visited a few of these manufacturers to see the existing conditions as a sample. These are depicted in Annexure 13.

B. Consolidated results of the Questionnaire

The consolidated results of the Questionnaire sent to the SMEs followed by discussions with the SMEs at the SUAME, Kumasi are:

- They are confident that the 3 harvestors developed could be manufactured by them.
- Few of the SMEs have all the machining and fabrication equipments for fabricating the manual harvestors.
- The raw materials are available for the harvestor manufacture.

- There was no definite feedback on the manufacturing time for the fabrication of the harvestors. They would like to fabricate a few samples before they estimate time for fabricating large number of harvestors.
- The capacities available for the usual shopfloor operations like milling, turning, drilling, grinding, shaping etc are mostly small size machines and few medium range machines.
- The number of skilled workers available on average is 5 to 8 in these SMEs.
- They all feel power tariff is high.
- Financing is a bottleneck for them, as the interest rates are high
- Most of the machines are more than 15 years of age.
- They need material testing facilities made available to them near their enterprise.
- There is absence of tool and cutter grinding machines for resharpening of tools used in machine tools.
- Raw materials supply is not uniformly spreadover.
- Most of them need committed orders so that they can plan and book orders for raw materials for manufacturing the harvestors.
- They need good heat treatment facilities to maintain the mechanical characteristics of the manufactured parts by them.
- Very few have expansion plans as they are mostly in survival mode.
- They all express the need for the establishment of engineering design centres and plate shops in the existing institutions like GRATIS, RTTCs will help the SMEs to get skill upgradation training and also common facilities aforementioned for use by them for their products manufacturing. This will also help them in maintaining standards in their products.

VI Financing for the manufacturing of cassava harvesters

The manufacturing of the harvestors is presented in chapter IV above describing the alternatives suiting to the existing situation in the industry. These models essentially project the manufacturing at central places comprising of the SMEs existing in the industry clusters in the regions. The following describes the financing model for the manufacture and distribution and retail buying of the harvestors.

A. Farmer's Role in ASCo

Adding value to the cassava crop by processing it to starch constitutes the basis for the PSI on cassava starch production and export. The mechanism for realizing the PSI on cassava starch production is through an innovative farmer-ownership scheme called the COVE(Corporate Village Enterprise) scheme. It is projected that a total of 50,000 core farmers (both existing and new), each with farm-holding averaging 1 acre of cassava crop, will be registered under the COVE project. Under the COVE project, each farmer will be given a production target based on the size of their farm holding. Extension services will be provided, improved agronomic practices, the supply of new high yielding crop varieties and finally the use of improved harvesting techniques on their farms using harvesting implements. Under the COVE the registered farmers own ASCo under PSI as a limited liability company with the other strategic investors viz Agricultural Development Bank and National Investment Bank Ltd. All participant farmers have been organized into a farmers' association- Ayensu cassava Farmers' Association (ACFA) for the supply of cassava to the factory. The association was registered as a company limited by guarantee in March 2003 with a 13 member elected National Executive council. When the processed starch from ASCO is sold on the export market, the profit will be shared according to the quantity of cassava produce delivered by each farmer. Hence the farmer's role is extremely important not only for the success of the PSI and also for the benefit of the farmer himself. Since the bonafide owners of the COVE are the participating farmers there will be an implicit demand pull from the farmers for better agronomy and harvesting methodology for cassava crop. This will ensure a steady market for the harvestors developed under this UNIDO AMIS project.

B.Important functions relevent to finance

The important functions interalia other functions relevent to finance are:

Source micro-finance for its members

- Ensure regular supply of cassava to feed the ASCo factory

As existing now and as discussed with the MD ASCo, the ACFA organizes harvesting gangs for harvesting and pays them the costs for harvesting. ASCo pays them the cost of the cassava supplied to the factory. The ACFA arranges for the microfinance for the farmers who are currently doing the traditional harvesting with cutlass and earth chisel. In the present case of employing manual harvesters there are 3 finances involved_as under_

- the cost of the manual harvestors to be borne by the user,
- the running capital for the SMEs to manufacture the harvestors as depicted in chapter IV and supply them to the customer
- the transporting of the cassava through trucks to the factory.

It was suggested by ASCo that the ACFA will buy the required number of manual harvestors from the SMEs_and stock them. Whenever cassava is required to be harvested they will issue them to the harvesting gangs and after finishing the harvesting the farmer returns to their pool. The ACFA also arranges the transporting of the harvested cassava to the ASCo factory.

Financing has to address ACFA and could be based on 2 models.

The 2 models for the financing are depicted in Annex 14. Either of the models could be adopted or both the models. Feasibility exists and since the demand for faster harvesting is satisfied by the manual harvesting equipment the above financing schemes could be adopted depending on the requirement for starch factory or for other agro products processing of cassava.

VII OBSERVATIONS ON INSTITUTION BUILDING IN GHANA

A. Observations of the ITTU & Kumasi Polytechnic, Kumasi and GRATIS, Tema

These institutions were established more than a decade back. These institutions at the time of establishment with finance from a few foreign donors did extremely well and had the state of art technologies which were used for development, training, and consultancy. Industry very well accepted these institutions. Because the industries needed such technology propping up as their own technological levels were very poor. These institutions did very well in training, development of some agric machineries, incubating small industries with technology and finance also. It could be witnessed even now at the TCC/ITTU Kumasi and GRATIS in their own premises. Also GRATIS established the RTTCs in 9 regions of Ghana as shown in Annexure - 23. These RTTCs are still under the management of GRATIS and thus providing a countrywide network of technology support institutions structure throughout the country except Ashanti region. This was possible because of some external funding and Government support for revenue expenses. The large industrial base at Ashanti region is covered by the TCC ,ITTU in Kumasi. The institutions maintained the same level of technology what it was when it was established with the result the industries do not find any technological potential difference between these institutions and the industries. The institutions lacked a sustaining business model for their services so that a build up of reserves could take place. The result is that these institutions have reached a level of technological obsolescence due to almost zero investment in acquisition/development of latest modern technologies with only a revenue expenditure being met by the government.

The GRATIS of late has been moving in the direction of sustainability and has the requisite organization structure, the workshop and design office for undertaking development of agric machineries. The ITTU enjoys the proximity to the KNUST University with relevant multidisciplines eg Agric engineering, Mechanical engineering. The faculty and laboratories and workshops which are very conducive for development of agricomachineries are available if the required organisational input is provided. Also the ITTU is located right in the midst of the huge industrial cluster and hence easily accessible to industries in the Ashanti region.

Comparitively the ITTU needs a total upgradation of their facilities and the GRATIS need appropriate upgradation with the latest technology machines and instruments.

The SMEs around the ITTU and GRATIS have good rapport with these institutions. With adequately defined business model backed by good services to the SMEs and upgradation of the facilities and training in the latest manufacturing technologies these organizations could be serving the needs of the agroindustry as per AMIS concept in particular and engineering industries in general.

The PSI on cassava starch project seeks to transform the cassava industry into a major growth vehicle by 2006 through establishing ten cassava starch processing plants and achieve 50% women farmer participation. The first starch plant in the country ASCO was totally imported. Except for few critical components and subassemblies many of the other items could be manufactured locally by some of the SMEs in the Tema area. The main raw materials for the starch plant like stainless steel are imported. This necessitates the strengthening through technology upgradation of the SMEs in particular so that they will be able to satisfy the design engineering and manufacturing needs of the 10 starch plants and also the machinery needs of the oil palm industry (expected to be 60 small scale factories at the village level) which are the current PSI projects. This automatically require local technology institution based approach like the GRATIS and ITTU for the development and transfer of design and manufacturing technologies to the SMEs in a similar way as done for manual harvesters development. Incidentally the manufacturing infrastructure upgradation done in these institutions for the two PSI projects on cassava starch and oil palm can also serve the general industries for other sectors. The services to other sectors including private sector utilizing the upgraded infrastructure could also add to the revenues of these institutions.

B.Observations of the other institutions

The following are a number of industry associations observed to be playing the role of maintaining the forum and voicing their members' concerns. Except for the Association of Ghana Industries the other associations need effective management and marketing skills to represent their industry in various forums. The reach to the industries could be realized through these associations.

- Association of Micro and Small Metal Industries (AMSMI),
- Association of Ghana Industries which could provide linkage of the SMEs to Largescale industries which are almost insulated from the SMEs.
- Blacksmiths Association
- Manufacturers Association, Kumasi
- Foundry Association, Kumasi

C.Observations of the Information Network for Agriculture

Information to farmers , SMEs and others in the value chain from the point of view of agromachineries becomes very important when the industrialization of agriculture takes place.

The following are the institutions which provide information on the agricultural aspects.

- Agricultural Extension Centres
- Ghana Agricultural Information Network System (GAINS)
- Question and Answer Service for Agriculture and Rural Development in Ghana (CTA)

They have established their own mechanisms for the storage and dissemination of the informations.

Focussed information on agro machinery and implements manufacture need attention as to how it will reach the farmers and others in the value chain.

As the support institutions on agromachineries concentrate and focus on the design and development of agromachineries linking this specific informations with the networks already existing would provide the synergy in the agronomy and agro machineries manufacturing. At the stake holders meeting this need for information down to the grass roots level was pointed out as an important requirement.

VIII FACILITATING THE NATIONAL PROJ MGR

In the beginning of the assignment the focus was on to workout a draft of the implementation time table, an activity table and a budget revision of the SPPD document. Considerable time was spent on the formulation of the sub contract for GRATIS through a number of discussions with GRATIS for the design, supervision of fabrication and testing of the 3 manual cassava harvestors and rationalising the designs for lesser weight and ease of operation etc. What has emerged is the final ones shown in Annexure -10.

Sufficient time spent on evolving the testing methodologies and drafting the Terms of Reference and format for the testing of the harvestors under a local subcontract. Later on when expert (11-02) joined, the base document was discussed along with the GRATIS to consolidate the field testing methodologies.

Continuous discussion with the Proj manager on the formulation of the Draft Project Document for the followon phase as per Annex -18

IX PROBLEMS TO BE ADDRESSED FOR AMIS PROJECT DOCUMENT

- Supply of poor quality, inefficient and unreliable agro-machinery, equipment, implements and tools for all aspects of agricultural production.
- The characteristic poor maintainability and repair of capital goods supplied by the local enterprises, as well as the unreliable support services provided by these enterprises, as well as the unreliable support services provided by these enterprises.
- Reliable supply of spare parts and replacement parts for the agro-machinery and equipment to facilitate and stimulate good maintenance practices.
- Generally the subsector demonstrates evidence of limited technological capability and capacity in product design, product innovation, production and marketing.
- There is evident lack of technological information, as well knowledge and understanding to facilitate effective and optimal use of technological information.
- Technological infrastructure, especially within the rural communities, is considerably unreliable. Particularly electric supply, telecommunication, access road network and financial services continue to hinder reasonable maintenance and repair practices.

The environment demonstrates characteristics of low level of education and formal training, the absence of technological support and relatively weak policy framework. Hence the choice of technology should reflect relevant characteristics that ensure efficient and optimum operation as well as maintainability under the identified conditions.(In this context the development of the manual harvestor in the present phase of the AMIS project was taken up).

X AMIS PROJECT SUSTAINABILITY

1. With the above situation in mind it is suggested in the project design for the technological upgradation of the two support institutions that at the end of the project implementation the institution should be able to sustain gradually with increasing revenues accruing out of their services. This may be slated for 5 years after the project is completed. Until then the Government could support the institutions for the revenue expenditure.

2. The main ingredients for the revenue generation from the technological upgradation of these institutions (GRATIS and ITTU Kumasi) proposed in the next phase of the AMIS project will be

Manufacturing of Critical complex components eg; large scroll screws required by the industries for the manufacture of specialized machineries like palm oil presses for which they are not having the necessary infrastructure and know how. Also they may not be able to afford those machineries.

To act as information source for the latest in technology available globally.

To help the centres to sustain, the Government may waive the VAT on the services rendered by the centres to the industries during the project execution phase and 5 years after that, the time that is given to the centres to be selfsufficient.

After the project period the centres to be run as autonomous institutions either registered as societies or incorporated as companies limited by guarantee. They could be resource centres for the region if the services are of good quality and infrastructure is state of the art.

The aspect of management for sustainability of the centres is that the staffing of the centres will be on need based contract services in the range of 3 to 5 years with all the benefits of a regular employment with salaries higher than regular civil service, so that it is long enough for any meaningful outputs and also the permanent liability of the staff for life long tenure need not be there. This would be motivating the younger technical staff to work for the system. Except core staff

rest of the staff could be on contract basis. This model is working in European and of late in several developing countries' technological institutions

While calculating for the services it is suggested that the capital goods provided by the project donors are not costed in the services provided. Only the running expenses for the centres as a whole with a 10 % small margin to be taken into reserves. In addition however the depreciation on the capital items put into the project may be taken in the accounting for the services to the customers for the centres. This will enable the replacement of these machineries at the end of 10 years with the state of art machineries at that time. With this arrangement there will be a continuity of infrastructure upgrading on their own. After the 10 years period from the start of the project the Government may review the situation for supporting even the revenue expenditure. The idea behind this is that the centres are set up to stimulate the industrial growth and consequently add to the GDP of the country rather than as a source of profit by themselves.

It is a difficult and painful experience of many institutions in developing countries when they switch over from a totally government funded (both revenue and capital) financing scheme to market driven service oriented self sustaining finance scheme. This is mainly because of the mindset of the people in the institutions built up over years that they are like civil servants and to be paid by the government and they are not accountable for generation of revenues to pay for themselves. It requires a gradual change management techniques to imbibe in the minds of the institutions' people and it takes quite a bit of time in terms of years (even upto 5 to 10 years) for the transformation to take place. It is in this context that the government support is required during the transition period through grants, subsidy etc. Perhaps the case may not be that much difficult if a totally new institution is planned with the full business model adequately defined.

It is also necessary to involve the Universities, Technical Institutes like Kumasi Technical Institute, Polytechnics through exposure to their faculty to the latest technology trends through the support institutions like TCC/ITTU Kumasi and GRATIS through the centres being established in them. They will be involved directly in the design processes for the standardized machineries by the support

institutions. One method could be that student projects which are a part/s of the redesigned agro machineries contemplated for cassava and Palm and other general engineering industrial machineries taken up by the support institutions, could be designed between the educational institutions and the support institutions and the students could be assigned the projects as a part of their curriculam. They will be guided by their faculty and the guide from the support institutions to design , assist in fabrication and testing etc and the students do the jobs/project work assigned to them.This will also help in securing the enormous student labour potential which if properly guided will be a substantial resource in the development process of machineries available very economically which otherwise would have costed much more. Even if 60% usefulness of the work is realized it would greatly help in bringing out the products faster and also the student learns practically the latest technologies which will be installed in the support institutions. He will be better equipped to get infusion into the industry instead doing some class room projects which in most of the cases will be theoretical. Even the faculty will be exposed to the latest technologies which may not be available in their educational institution.

XI CONCLUSIONS

1. Demand potential: There is considerable demand potential for the deployment of improved technologies within the agricultural sector in Ghana to boost both agricultural production and primary agro processing sub-sectors. The demand is strongly characterized by low purchase power of potential consumers or end users. However, activities of development agencies indicate the potential of significant assistance, which targets support to the micro and smallscale productive groups in the agricultural sector within the rural and remote communities.
2. Agro-metal sub sector characteristics: The main characteristics of the agro-metal subsector may be summarized as follows:
 - Typically informal with workforce between 2 and 10.
 - The operators are male entrepreneurs. The younger and more literate ones engage in other metal fabrication activities other than blacksmithy.
 - Apprenticeship and On-the job training are the major means of skills acquisition, which is estimated to be around 91%.
 - Raw materials are mainly scraps imported and supplied by local dealers in the regional capital.
 - The technologies employed are simple and modest.
 - Farm implements account for approximately 52% of products, while the remaining cover agro-processing and food processing machines and equipment.
 - Predominantly the operatives utilize between 25 to 50% of the capacity due to inadequate working capital.
 - Direct sales to customers is the principal means of marketing.
 - Absence of market outlets results in heavy reliance on orders from customers.

There is evidence of weak linkages between operatives within the subsector.
3. What has been realized: The design and development of an appropriate agricultural implement , the manual cassava harvester to improve the efficiency of the cassava harvesting in the PSI cassava starch initiative has been realized.

On 20th Nov 2003 the harvestors were presented to the Hon'ble Minsiter Alan Kyerematen, Minister of Trade, Industry & PSI at the Africa Industrialization day in the trade fair centre, Accra. Some pictures of these are shown in Annex -17.

XII RECOMMENDATIONS

1. Addressed towards cassava Harvesting: In the longrun when the planting and cultivation of cassava becomes organized in planned row by row planting of cassava plant and necessary field preparation so that regular mechanical harvester attached to a suitably powered Tractor could be a solution purely from the Technical point of view. The techno economic analysis for the total mechanized harvesting has to be studied as applicable to Ghana. The experience of Thailand and Brazil could serve as comparative study model examples. This necessitates the serious steps and measures to be taken by MOFA through their extension services to educate and train the farmers in the organized farming practices. Until then the manual harvesters developed could be used. With this the main hurdle and bottleneck of cassava harvesting will be solved for the short term. With this more and more women also could be deployed for harvesting rather than purely for helping to carry the cassava harvested.
2. Addressed towards support institutions: GRATIS and TCC should take up an in-depth_ study of a suitable mechanical harvester from the point of view of tecnoeconomics feasibility, social acceptability by the farmers who are accustomed to do manual harvesting. The market for the manual harvestor as developed now exists as evidenced from the feed back from the direct users, the PSI ASCO. As another intermediate step a manual harvestor which could be moved in the field and good interfaceability to the cassava stalk holding could be also thought of so that even the carrying of the harvester could be eased out. This could be thought of for very few farms where there is orgqanised farming of cassava and level ground. Alongwith this the issue of collection of the cassava uprooted needs attention as the quantities of cassava uprooted will be larger with the faster harvesting using the manual harvestors

The institutions should develop show room and demonstration centre and pilot processing of developed machines.

Development of machineries by the support institutions will be initially to the PSI on starch and oil palm.

These institutions will build up the capability for imparting training to the trainers for artisans, technicians and engineers through the upgraded facility planned under the AMIS. Some of the training programs are listed in the Annex-21.

3. Addressed towards small and village level micro entrepreneurs: The village level micro and small entrepreneurs can maintain and repair the manual harvesters manufactured centrally by the SMEs in the SUAME Kumasi and other regional headquarters. The training to the microenterpreneurs for the maintenance of these harvestors could be be done through the extension staff of MOFA who are in turn trained by the support institutions.

4. Addressed towards Distribution channels:

Apart from the procurement, production and utilization strategies, the government through the PSI need to organize and put in place through the existing extension centers to facilitate the spread and adoption of the manual harvesters. This will boost the demand for the harvestors and the marketing channels will automatically take shape. They should provide good access roads to the rural areas. This will ease the transportation issues presently faced by the farmers.

5. Addressed towards Quality production of agricultural machineries and technology upgradation:

The support Institutions like GRATIS and TCC to be upgraded with the appropriate latest technology machines and equipments, tools and other manufacturing technologies required by the sector to serve as a developmental agency to the Agric machinery industries sector in the country. This will ease the manufacture of standardized machineries with interchangeable parts which is not existing presently. With this a reliable spare parts manufacture and supply could be established and the overall efficiency of the total system could be enhanced. These institutions in which the centres are going to be set up will have a budget to redesign identified machines just as was done for cassava harvester under the project and make

the prototypes and test them and transfer the technologies to the manufacturers for serial production and put it to the distribution system.

They will also address the issue of lack of training by training the manufacturers in the maintenance of these machines through Agric extension personnel of MOFA and also through selected NGOs to reach the farmer level. Sufficient initial incubation budget to be included in the project budget. After the project phase is over and the system is established the institutions will continue to market and get the funding necessary from the manufacturers and finance institutions in a well defined business model based on the services rendered to the industries, so that the AMIS becomes self sustaining.

6. Addressed towards Support Institutions and Ghana Standards Bureau:

Formalized standards for agro machineries could not be noticed at this point. Standardisation of equipments and thereby the component parts through rationalised design to be done by GRATIS. The standardization of the machineries will have to be facilitated by the standards bureau in association with the GRATIS, TCC and industries in the agro machinery sector, being the national body with a mandate to evolve the national standards. As in any other country this is a consultative consensus process with industries and development institutions. The actual design will be done by GRATIS, TCC and/or even an industry depending on its capability. The standardisation effort should be time bound and franchising identified departments and agencies to assist the standards bureau could be used as execution mechanism for faster realization of the standards formulation and its acceptance. This was the suggestion from the stake holders meeting. The formulation of national standards is under the mandate of the government and there is a definitive budget from the government for the same. This franchising is suggested because the standards bureau may have only limited resources to undertake all the works involved for all the standards.

Identify the machineries for agro processing in consultation with all the stake holders and make standards of the machine, and design and fabricate and test and finalise the design with the same philosophy as done for manual cassava harvester. The development budget for agromachinery will not be under the

standards bureau. The raw materials cost only could be accounted by the project. The production cost has to be borne by the support centres as they get the capital funding for the latest technology machines.

The material cost for the spares for the machines to be included in the project budget. The institutions should stock the spares and may at a cost make it available to the manufacturers of their machines for may be 2 years and then on the manufacturers themselves supply.

7. Addressed towards materials supply channel:

A cluster of engineering agric machinery industries be formed. They will determine because of their own business interest the materials requirement for bulk purchase of materials and storage. This cluster formation for which members pay some contribution and derive the benefit of bulk purchase by the cluster and distribution of the raw materials to the cluster members. Initial seeding cost to be borne by the project for the formation of the cluster and 5 meetings and then on the cluster members bear themselves the cost of storage and distribution to their cluster members and eventually handle themselves. The project will facilitate and monitor in the beginning until the clusters become self sustaining. The clusters could be one in Greater Accra region, one in Kumasi Ashanti area. These cluster members and others outside the cluster will get registration with details of their manufactured item/s and their capacities in the subcontract exchange program of the UNIDO. GRATIS and TCC will be the nodal cluster transformation agents. This database will be put on the AMIS website to be created and maintained by AMIS during the tenure of the project and later will be maintained by the MOTI.

8. Addressed towards electric motors: One important component in all the electric powered agro machineries is the basic electric motor. The electric motor is not manufactured indigenously in the country. The requirement is met by imports totally of new electric motors or second hand electric motors. This requirement also came out from the stakeholders feed back although exact quantification of the demand could not be speltout. However a specific study of the demand for electric

motors could be taken up not only for agromachinery and interalia other type of machineries.

9. Addressed towards Information Dissemination to farmers, distributors etc in the value chain:

Networking with Ghana – QAS (Question and Answer Service) for Agriculture and rural development, GAINS (Ghana Agricultural Information Network System, Agricultural Extension Information Centres to channelise all the informations needed by the all the stake holders e.g the farmer, SMEs in the manufacturing sector, raw materials supplier, in the value chain in the agricultural machinery engineering/manufacturing sector. These informations pertaining mainly to the manufacturing of agro machineries and implements to be created by the support institutions and their affiliates and link to the already existing information network as mentioned above. This supplements the information network already existing with the specific aspects of agro machineries and implements. This will ensure that information is made available continuously from the aspect of agro machinery and implements. Also a website should be created for the AMIS project implementation which will contain all the informations stated above and also what is happening in the various aspects of the project definition. This should come out of the project budget. Dissemination work shops and cost of the staff also to be budgeted in the project. The parties for this will be the support institutions in the MOTI, GSB, MOFA. The informations of all the above will be maintained by the existing networks GAINS, QAS etc.

10. Addressed towards Government policies:

- The land tenure system has to be addressed through necessary government policy so that the existing bottleneck for increasing agricultural production is reduced.
- The need to cut down and rationalise taxes as a policy for at least the project period may be done by the government so that at the end of the project the AMIS system with all its ingredients are in place and self sustainable.

- Encourage more microfinancing.
- Strengthen Rural Banks to assist farmers.
- The PSI should ensure that the harvesters supplied to ASCo to be used by the farmers through the dry season during 2004. This will consolidate the designs of the harvestors with any modifications to be done for usage in the dry soil. The harvesting yield using the harvestors could be more realistic as it would have averaged out over longer usage and by different farmers.
- Also the harvestors are to be tested in the areas (eg Volta) where the bigger size cassava crop variety is grown (Annex -24) which is almost double the sizes of cassava grown in the central region in which the present manual harvestors were tested. Then on, the harvestors could be launched for mass production.
- Infrastructure development such as water, electricity, approach roads to villages, Industrial estate, Access to affordable credit / Low interest rate loans need attention.

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Job Description

NC/GHA/02/016/11-01

Post title: Consultant on rural agro-machinery design and engineering support.

Expected Start: asap

Duration: 2w/m (Initial Mission)

Duty Station: Accra, Ghana (with in country travel)

Purpose of the project: The current project is the first explorative and definition phase of an effort focused on supporting the national equipment manufacturing industry and the local blacksmiths through upgrading support institutions, based on introduction of a specific series of semi-standardized economically feasible sets of equipment that should contribute to the national objectives and President's special initiatives for agro produce.

Duties:

The consultant will be responsible to assess the situation in relation to the target group of engineering industries and their relation with urban and village communities, specifically identify obstacles for effective equipment manufacturing and utilization, enterprise creation and devise appropriate corrective strategies involving most likely technical and managerial training, supply of basic equipments, and if required raw materials. He/she will assess the alternative options open for approaching the identified bottlenecks, and will develop criteria for selection of appropriate solutions, which will be reflected in the draft of a document for Phase II of the project. He/she will equally evaluate methods and ways to assure the continuous relevance of the project execution to the Presidential Special Initiatives

The consultant will also be responsible to identify appropriate tools and implements in the area of cassava and palm oil plantation, transportation and processing. Based on the outcome of the above, to design a system for the local mass production of the necessary equipment, which includes, the assessment of economic competitiveness of the tools, the production system through private sector entities and sub-contracting mechanisms and capacity building related to the farmers and manufacturers.

The consultant is expected to carry out the duties in close collaboration with the international and national consultants and counterpart staff, as well as national and local authorities, and in close coordination with the staff of the UNIDO office in Accra and other relevant UN organizations, under the general guidance of UN HQ staff. The consultant's work will include but not be limited to:

1. Preparation of the detailed work plan of the project and coordination of efforts by other individuals involved

2. Preparation of a comprehensive desk study following UNIDO's method of AMIS, and selection of suitable crop/equipment combinations to study further
3. Proposing and facilitating the establishment of a steering committee
4. Contribute to the preparation of functional specifications for selected equipment / crop combinations.
5. Propose sets of equipment fulfilling the specifications, either by purchase, adaptation, or redesign for local manufacturing.
6. Preparation of alternatives, including alternative manufacturing practices, like larger series / assembly kit manufacturing. Detail cost price calculations. Estimate exploitation cost and breakdown / repair / maintenance behavior.
7. Detail an approach for introduction of equipments in communities, specifically the marketing aspects; identify additional support that producers, maintenance services, and operators will require, as well as detail an approach that organizes that support
8. Contribute to Value chain descriptions, and implementation approaches for support of local manufacturers and blacksmiths.
9. Supervise subcontracts for prototyping and field test of suitable equipment configurations.
10. Outline training programmes for design and innovation methodologies in industry support institutions, as well as training programmes for engineering industries and local blacksmiths and welders.
11. Introduce quality systems in the manufacturing practices for the training institution and local artisan for the manufacturing of the selected equipment.
12. Outline training programmes for the preparation of operational manual to accompany the manufactured products.
13. To prepare the draft project document to be discussed by the steering committee
14. To prepare a final report

Main duties for first mission	Dur. (dys)	Loc.	Expected results	Related activity
Preparation and one day briefing in Vienna	2	Home/ Vienna	Outline mission plan	Progr. preparation by nat. exp.
Discussions with national stakeholders, National Experts PSI (Cassava and Palm oil) and	3	Accra	Focusing of mission plan and dove-tailing feasibility study by Nat.	Nat Exp (FS) and IC (Cassava

Main duties for first mission	Dur. (dys)	Loc.	Expected results	Related activity
other (inter) national experts and UNIDO.			Exp and IC (Cassava Harvester)	Harvester)
Facilitate the establishment of National Steering Committee	3	Accra	Detailing functions of the committee	PM
Travel to Kasoa, Bodwiase, Agona and relevant farming communities to discuss equipment and tool needs of the farmers and field testing of selected prototypes	10	Kasoa, Bodwias e Agona	Confirm list equipment needs of the farmers and identify bottlenecks for improvement and efficiency.	Nat. expert.
Travel to Tema and Kumasi, to assess the manufacturing facilities of GRATIS and Suame to be used as training bases.	6	Tema and Kumasi	Capacity and capabilities of the institutions identified and recommendations made for upgrading (if necessary).	Nat expert and IC
Review list of local artisans prepared by IC (Cassava harvester) and AGI for mass production	3	Accra	Comprehensive list of manufacturers prepared	Project Manager
Based on assessment of equipments, series, and markets, identify defunct capabilities in industry as well as in industry supporting infrastructures.	3	Tema and Kumasi	Analysis of industry sector and support infrastructure	Nat. Exp and Project Manager
Prepare training outline and run a workshop for selected artisans and key staff of GRATIS and Suame	4	Tema and Kumasi	Workshop taken place in two locations (Tema and Kumasi) and understanding of AMIS	Nat. Exp and Project Manager
Prepare conceptual approach to industry support, within the framework of PSI, in terms of market and economy.	4	Accra	Intervention logic for overall project on AMIS	Nat Ex and PM
Assist in organizing workshops and trainings for priority areas based on assessment	4	Tema	workshop taken place	Nat Ex and PM
Prepare feasibility study for selected tools and equipment	5	Accra	Feasibility study ready for discussion	Nat Exp
Develop and present an optimum AMIS to be	3	Accra	AMIS report ready for discussion	Nat Exp and PM

Main duties for first mission	Dur. (dys)	Loc.	Expected results	Related activity
implemented and operated in Ghana				
Recommend and outline training programmes for GRATIS and private sector	2	Tema and Accra	Training programme approach ready for discussion	PM and Nat Exp
Drafting of project document for introduction of PSI related AMIS and industry support	5	Tema and Accra	Draft Prodoc for discussion	PM and Nat Exp
Drafting of mission report reflecting results and assessments, Debriefing of stakeholders, UNIDO field office, authorities etc.	3	Accra	Mission report Shared understanding of project approach and future steps.	Nat. expert.
Total	60			

Qualifications of the consultant:

Engineer with substantive experience in support institutions for rural agricultural equipment production and marketing, as well as enterprise creation and basic income generation, specifically in Africa. Conversant with design and innovation methodologies. Experience in development of training modules for trainers and for rural populations.

Background:

By improving the local agro-metal enterprises' ability to ensure reliable supply of quality machinery and equipment as well as provide effective and reliable maintenance services, the project contributes to the Ghana Poverty Reduction Strategy (GPRS). The project will provide opportunities to rural productive groups to improve efficiency in adding value to agricultural production and therefore generating more income. Ghana's Accelerated Agricultural Growth and Development Strategy (AAGDS) depends on effective and efficient mechanization and industrialization of smallholder farming units from subsistence farming level to cash cropping as well as enhanced utilization and consumption of agricultural outputs.

Under the Presidential Special Initiatives, increased production from cassava and the palm tree (oil) is foreseen. To have its intended effect on job and income generation at the rural level, a significant increase in process mechanization and transport will be required. On both issues, the active inclusion of the engineering sector for production of appropriate equipment, and of the local blacksmiths for repair and maintenance is essential.

This project intends to combine the enhancement of support institutions following UNIDO's Agricultural Machinery Industrial System's approach with the development of financially feasible sets of rural agro-processing and rural transport equipment based on detailed value chain analysis.



UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

VIENNA INTERNATIONAL CENTRE

P.O. BOX 300, A-1400 VIENNA, AUSTRIA

TELEPHONE: (0043 1) 260260 TELEX: 135812 uno a FAX (Common Centre): (0043 1) 2692 669 FAX (PRO direct): (0043 1) 26026 6817

HEALTH STATEMENT

_____ Date of Birth
Last Name of Candidate First DD MM YY

I certify that I am in good health and I am able to perform the proposed functions to the best of my knowledge and belief.

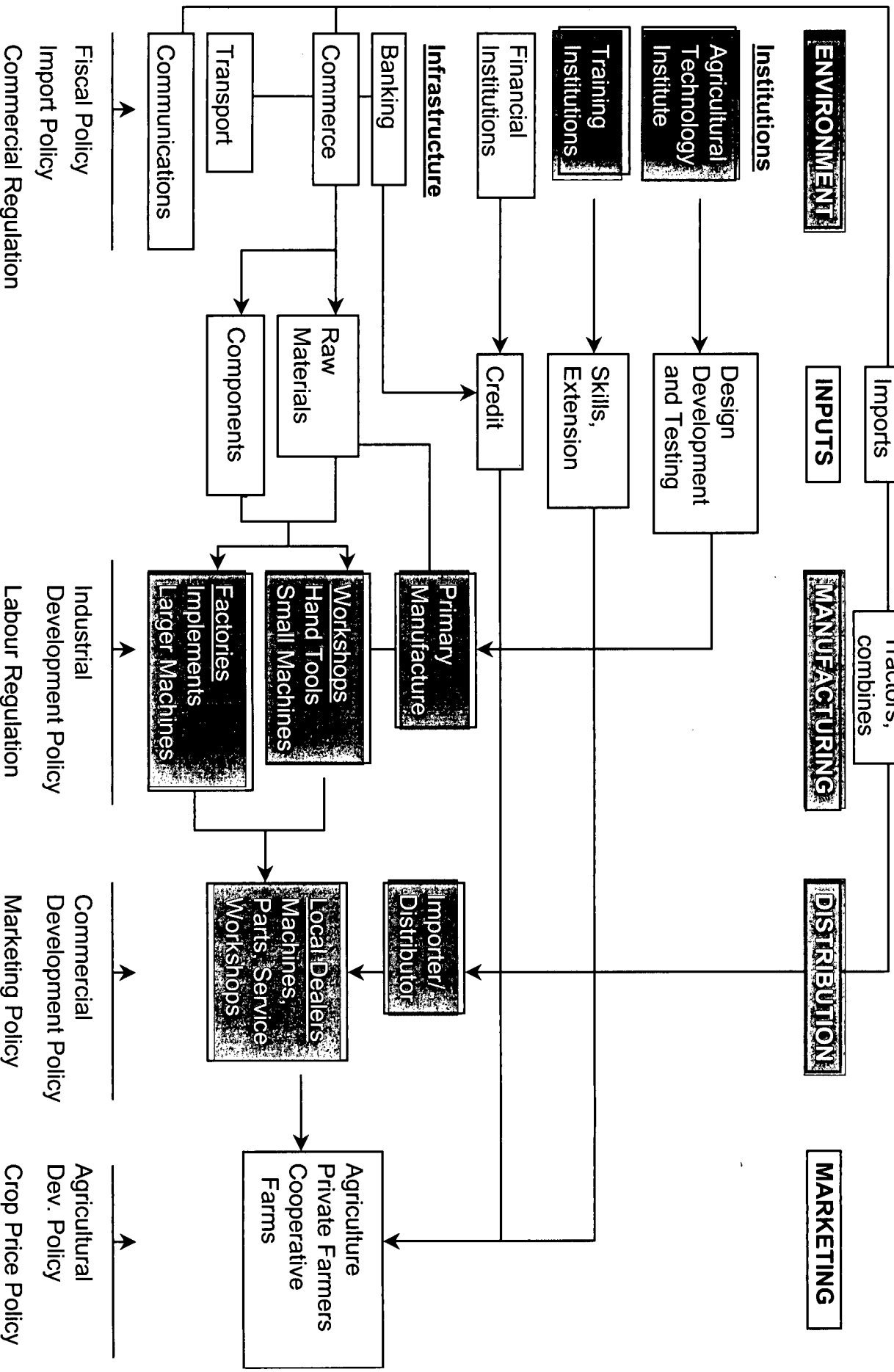
Signature of Candidate

The above candidate has been offered an appointment commencing

_____ DD MM YY

Signature of UNIDO Representative

AGRICULTURAL MACHINERY INDUSTRIAL SYSTEM (AMIS)



ANNEX - 2
List of Persons met

A. Ministry of Trade & Industry

1. Hon Alan Kyerematen, Minister of Trade, Industry & PSI
2. Mr Seth Evans Addo, Acting Chief Director.

PSI

1. Mr Nana Otuo Siriboe, Member, Council of State.
Chairman, PSI, Oil Palm Industry.
2. Ing Kwasi Poku, Co-ordinator Oil Palm Project.
3. Mr Osu Owusu Agyeman, Co-ordinator Cassava Starch Project
4. Mr Andrew E. Quayson, MD, Ayensu Starch Company Limited,
Kasoa Bawjiase Rd, Awutu-Bawjiae C/R

B. UNIDO/UNDP Officials

1. Mr Alfred Sallia Fawundu, UNDP Res Rep, Ghana
2. Mr Akmel Akpa, UNIDO rep , Accra, Ghana
3. Mr Solomon Boateng, National Project Coordinator.
4. Mr Dan Baffour-Awuah, Project Manager,
5. Mr Jacob Ainoo-Ansah, National Project Manager, Rural Micro
Enterprise.
6. Dr David D. Tommy, UNIDO rep Nigeria, Director of Regional
Industrial Development.
7. Prof Chidi, UNIDO Regional Programme Advisor for Africa,
POPs and International Waters.
8. Mr Dezene Tezera, Food Technologist Consultant, UNIDO,
ACCRA.

C. Engineering Industry

1. Mr Peter Donkar , Director, Technology
Consultancy Centre, Kwame Nkrumah University of
Science & Technology, Kumasi.
2. Mr Edward Victor Ogyiri Opare, Managing Proprietor
ENTERPRISE OF APPROPRIATE TECHNOLOGY
ITTU, KUMASI
3. Mr Robert Woode, MD, FATECO LIMITED, (mfrers of
multipurpose machineries), Accra.

4. Mr John K.Y. Dampthey, MD , President of Manufacturers association (automobiles), Kumasi,
5. Mr Rod Byers , General Manager – Operations Crocodile Matches (GHANA), Heavy Industrial Area , Tema
6. Mr Kofivi Nathaniel, MD, Hormeku Engineering works, Tema
7. Mr Isaac G. Anfom, Anfom Machine Shop, Tema
8. Mr M.M.Lawson, Production Engineer, Ceassuah Enterprise.
9. Mr Sam A.Quaye, MD, Engineering and Technical Services, Tema.
10. Mr Yann Mee, MD, Calli Ghana company Ltd, Agricultural and spraying equipment, Tema.
11. Mr Marcus Casel, Director, Business Development Centre, Association of Ghana Industries
12. Mr Daniel Kwame Numo, Denco Foundry, CEO, Tema.

D.Palm Oil Industry

Ghana Oil Palm Development Company(GOPDC), Kwae near Kade.

1. Mr J.C.E Inkumsah, MD
2. Mr Christian Amoh-Otu, Director of Agricultural Services
3. Mr L.S.K. Atsrim, Technical Director.
4. Mr Kemeh-Mensah Michael, Outgrower extension manager

E. GRATIS, Tema

1. Mr Kwabena Dankyi Darfoor EXECUTIVE DIRECTOR

2. Mr Sheini M.Abu-Bakar, Deputy Director(Technical)
3. Mr Seth K. Dotse, Technology transfer Manager.
4. Mr Isaac K.Krampah, CADD Designer.

Kwame Nkrumah University, Kumasi

1. Agriculture Engineering Department

- Dr K.Dzisi (020-818 0346)
- Mr J.Aveyire , Technical Education Design Specialist (024-652593)
- Mr Stephen Aikins (051- 60242)
- Mr Boem Turkson, AG General Manager (051-26865)
- Mr A. Twum , Senior Lecturer, National consultant (17-02)

1. Technology Consultancy Centre

- Mrs Peggy Oti-Boateng, Director
- Mr Sosthenes Bhatsi.
- Mr Peter Donkor, former Director.
- Mr Edward Victor Ogyiri Opare, Managing Partner, Enterprise of Appropriate Technology, Suame, ITTU

Ministry of Food and Agriculture

1. Mr Joseph Kwasi Boamah, Ag Director, AGRIC ENGINEERING SERVICE DIRECTORATE , Ministry of Food & agriculture.

p.o. box Mb82, Accra,

Tel: 233-21-777789/87

233-21-70100261

2. Mr Samuel Adu Somuah

Institutions

1. Dr Abeeku Brew-Hammond, Director, Kumasi Institute of Technology and Environment, Kumasi.

2. Mr E.E.K.Agbeko, Lecturer, Dept of Mech engineering, Kwame Nkrumah University of Science & Technology, Kumasi.

Ghana Standards Bureau

1. Dr E.J.L. Ablorh, Director Physical Science Division

2. Mr Peter Fleku, Special Projects

3. Mr M.A.Pappoe, Metrology Division

Others

4. Mr Paulao A.V. Wolowski, Brazil Ambassador in Ghana.

5. Mr Thomas Lenzian, Branch Manager, Sikaman Savings and Loans company Ltd, New town ,Accra

Annex-3

General Economy Indicators of Ghana

Ghana's economy is mainly rural and based on agriculture, with industry and service as the other major sectors. Whilst Government has since the 1980's embarked on a number of Economic Recovery and Structural Adjustment Programmes aimed at moving the country into a period of economic transformation and sustained growth and development, Ghana's economic performance has been generally characterised with slow growth ratio, averaging 4.6 percent over the last decade.

The process of industrial development which has for some time been based on import substitution policies targeted at replacing imported consumer goods with locally produced ones has not achieved national objectives generally. Export earnings needed to fuel national development continue to rely mainly on cocoa and gold whose prices on the world market tend to suffer periodic sharp variations and shocks, much to the disadvantage of the country.

To correct the low pace of economic development, fresh attempts are being made to move the economic base to grow faster so as to get Ghana become a middle income country within the shortest possible time; the target is a per capital income of US\$1000 per annum.

Prominent aspect of national development plans has been the Government's desire to reduce poverty. Consequently, since the 1990's, a series of plans which place emphasis on poverty reduction and human development have been drawn and implemented in the country by the state.

Among current national efforts at economic development and poverty reduction has been the implementation of the Ghana Poverty Reduction Strategy (GPRS) [2002 – 2004] launched in January 2002, and the Presidential Special Initiative (PSI) on a number of areas announced in October, 2002.

The purpose of the GPRS has been to develop new and comprehensive policies in support of poverty reduction and economic growth, and to strengthen national policies and activities relating to issues of poverty among Ghanaians.

Under the GPRS, modest changes in key macro indicators are expected in the short to medium term (2001-2004), with real GDP expected to rise to 5% by 2004. Agriculture is expected to play a progressive role in achieving set national goals, with a growth rate from 2.1 percent in 2000 to 5 percent by 2004, whilst the Industrial Section is expected to experience accelerated growth rate from 3.3 percent in 2000 to 6 percent in 2004 through the implementation of agro-processing initiatives. Table 1 gives the overall targets for selected key macro-economic indicators for the short to medium term period.

Table 1: Targets for Selected Key Macro-Economic Indicators, 2001 – 2004

Economic Indicator	Annual Change (%)				
	2000	2001	2002	2003	2004
Real GDP Growth	3.7	4.0	5.0	5.0	5.0
Real Per Capita Growth	1.2	1.4	2.4	2.4	2.4
Agriculture	2.1	2.8	4.0	4.8	5.0
Industry	3.8	4.1	5.5	6.0	6.0
Services	5.4	5.4	6.0	4.7	4.5

Source: GOG (2001) Ghana Poverty Reduction Strategy. Poverty Policy Framework – Accra, July, 2001.

The broad objectives are to promote private sector-led growth, including small-scale business development in a manner consistent with poverty reduction.

The Presidential Special Initiatives announced in October, 2002 stems from these national desires to move Ghana from the over-reliance on her traditional export of unprocessed commodities of cocoa and gold , and to reduce poverty. The major challenge facing the country therefore has been that of funding new pillars of growth , while protecting and expanding existing citadels.

The two Presidential Special Initiatives are conceived as major vehicles for job creation and general poverty reduction, especially among rural Ghanaian communities.

Annex -4

President's Special Initiative (PSI) on Cassava

Cassava accounts for about 22% of Ghana's agricultural GDP and has the lowest entry barriers to production compared to other major crops. Over 90% of Ghanaian farmers cultivate the crop either as a main crop or mixed with other crops.

Annual production of the crop has been increasing since 1980 (Table 2.1) and current production stands at 13.8 million tonnes (1.4 million hectares) with a growth rate of 4.8% per annum.

However, notwithstanding the dominance of cassava in Ghanaian crop farming, the full benefits of the crop in terms of its varied uses is yet to be realised. The potentials of crop, especially the competitiveness of cassava starch against other starches on the international market is now recognised and current thinking of the Ghanaian Government is to improve the economic utilisation of the crop. Increased production of the crop is to be used as not only to diversify the country's export base, but also as a job-creation strategy under the Poverty Reduction Strategy. Hence the launch of the President's Special Initiative (PSI) on Cassava Starch Production and Export in Ghana.

The PSI Cassava Project seeks to:-

- transform the cassava industry into a major growth vehicle by year 2006.
- establish ten (10) cassava starch processing plants in a phased implementation plan by year 2006
- obtain fifty per cent (50%) women farmer participation.

It is projected that 1.9 million cassava tubers will be produced over the next four years (2002 – 2006), yielding 380,000 tonnes of starch for export under the project. Ghana will earn about US\$95 million.

Table 2.1 gives outputs and projections over the first four years of the project

Current statistics at ASCO indicates that cassava yield is 20mt/ha, and starch yield stands between 20-37%. Inherent average crop yield is quoted by RTIP to be 27-30 mt/ha. after 12 months maturity

Table 2.1: Targets for Cassava Starch Production by ASCO

Indicator/Year	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005
Target Districts (Number)	2	5	8	10	10
Farmers Involved in Project (Number)	1,147	3,508	5,000	N/A	N/A
Employment to be Generated (Number)	5,000	12,500	20,000	25,000	N/A
Area Under Cassava	418	2,800	4,800	N/A	N/A
Starch Export (mt.)	-	-	-	18,000	22,000

Source: ASCO data

The dynamics of the global starch market requires that for Ghana to be considered as a serious player in the global starch market, Ghana should be exporting at least 100,000 tonne of starch per annum. The strategy to achieve the above objectives revolves around the establishment of Ten (10) medium-scale farmer-owner companies, using the Corporate village Enterprise (COVE) concept, with each COVE as a limited liability company whose shareholders shall be the farmers and other strategic investors.

Each COVE will own its own cassava starch processing plant which will process the fresh cassava tubers produced by the Company. Ten (10) of COVE will eventually be established throughout Ghana by year 2006 in the main cassava producing areas of the Country. It is projected that a total of 50,000 core farmers, each with a farm-holding of 0.8 – 1.2 ha (2-3 acres) will be participating in the project by 2006.

The first of COVE and its cassava starch processing plant under PSI has been established at Bawjiase in the Central Region, about 40km west of Accra, under a company of AYENSU STARCH COMPANY (ASCO). It is currently operational. ASCO has an operational zone of 40 km radius from Bawjiase and covers the contiguous districts of Awusu-Efutu-Seyna, Agona, Gomoa, Asikuma-Odoben-Brakwa and Ajumako-Enyan-Esiam, all in the Central Region, West Akim, Suhum-Kraboah-Coaltar and Akwapim South, all in the Eastern Region, as well as Ga in the Greater Accra Region.

Annex -5

President's Special Initiative (PSI) on Palm Oil

In October, 2002 the Government of Ghana announced the President's Special Initiative for the development of the oil palm industry in Ghana. The vision is to make the oil palm industry one of the new key drivers of economic growth, wealth and job creation in rural Ghana.

Key facets of the PSI on oil palm include the development of the production base, processing, marketing and allied multiplier effects. The project is projected to deliver palm oil based value added products for the domestic and the West African sub-regional markets in the short-run. This will be extended in the long term onto the world market.

Ghana currently produce about 10,000mt of crude oil from a cropped area of one million hectares (Table2.2) which production is unable to satisfy a domestic demand of about 240,000 mt.

Table 2.2: Annual Production of Oil Palm in Ghana, 1995-2000

Aspect of Production	YEAR							
	1995	1996	1997	1998	1999	2000	2001	2002
Area Planted ('000 ha)	262	267	273	279	285	286	295	304
Yield ('000mt ffb)	901	984	956	1,022	1,032	1,034	1,066	1,102

Source: i) MOFA, Statistics, Research and Information Directorate, Accra, September, 2003

The PSI is projected to put additional 100,000 ha. of land under cultivation in the next five years to satisfy largely domestic demand. The long term planning is to put 300,000 ha. of land under cultivation in an aggressive strategy to attract the West African market between year 2003 and 2006.

Alongside the plans to increase the area under cultivation are also plans to provide processing facilities to mill, refine the crude oil and produce

palm-oil-based products through value addition for further industrial uses of the palm oil.

To achieve set targets, PSI production strategy will among others:-

- expand existing large/medium estates with out-growers schemes**
- establish new large/medium nucleus estates with out-grower scheme and**
- establish block co-operatives for small-scale farmers.**

On primary processing of the palm fruits from the plantations into crude palm oil and palm kernel oil, the PSI plans to put in place in the next few years sixty 60 mills each of 20 tonne/hr ffb capacity and capable of handling the fruit yield from 5,000 hectares of the proposed 300,000 hectares. The project plans to achieve this processing capacity by up-grading existing small commercial mills, and the establishment of new ones. The PSI-Palm Oil will concentrate in the Western, Central, parts of Eastern and the Ashanti Region.

60-80% of the crude palm oil so produced will be further processed for industrial and food uses. On social benefits, the PSI-Oil Palm is projected to provide 1.2 million farmers and 2,000 engineering workers with job opportunities during its implementation.

ANNEX -6

MECHANICAL HARVESTORS AS FOUND EXISTING



MECHANICAL Harvester PROTOTYPE called as Leipzig Model as found at GRATIS, Tema, Ghana on 15th Sep 2003



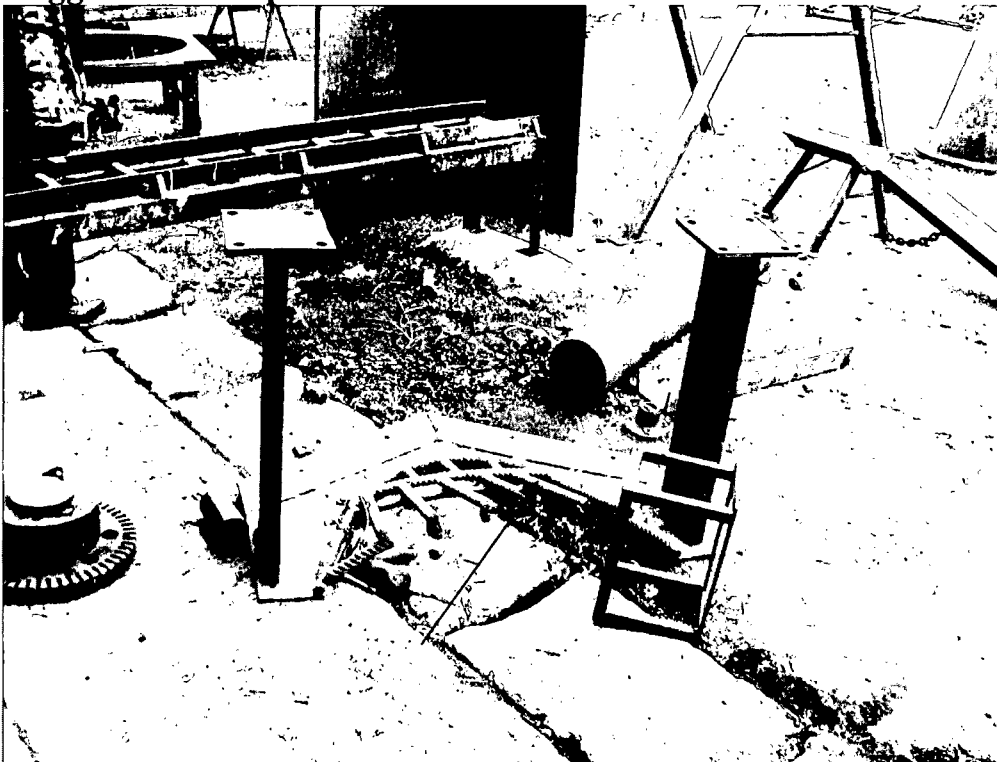
Close up view of the above

Harvester

The Mechanical Harvester as found and told under development at Agric Engg Dept of the kwame Nkrumah University on 10 Oct 2003



A portion of the Mechanical Harvester told to be developed by Agric Engg services Dept of MOFA



The second portion of the Mechanical Harvester Mechanical Harvester

ANNEX -7
EXISTING PRACTICES OF MANUAL CASSAVA HARVESTING



Picture shows the Traditional Earth chisel used by the farmers for Cassava Harvesting in one of the Captive Cassava Farms under the Ayensu Starch Company, under PSI



Pictures above Showing the Existing Unorganised way in which the Cassava tuber is grown since decades. The Earth Chisel could be seen again. It could be seen that some farmers (mostly male and a few females) harvest The Cassava , and the rest help in stacking the Cassava and transporting etc by hand and carrying on baskets as headload.



TRADITIONAL CUTLASS USED FOR CLEARING GROWTH AROUND CASSAVA STEM AND CUTTING THE STEM 1.5 TO 2 FEET TO ENABLE LIFTING BY HAND THE CASSAVA TUBER WITH LOT OF EFFORT

TRADITIONAL CUTLASS USED FOR CLEARING GROWTH AROUND CASSAVA STEM AND CUTTING THE STEM 1.5 TO 2 FEET TO ENABLE LIFTING BY HAND THE CASSAVA TUBER WITH LOT OF EFFORT.



with damage
seen.

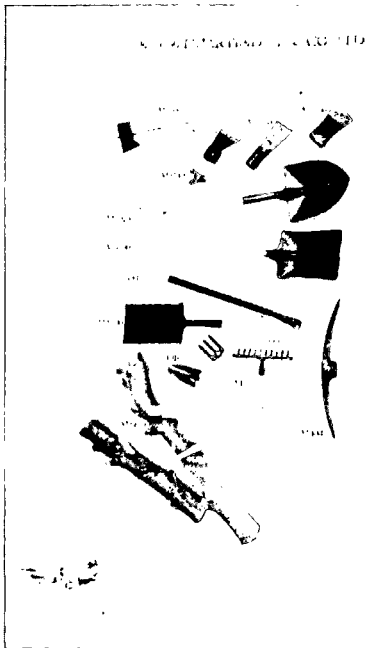
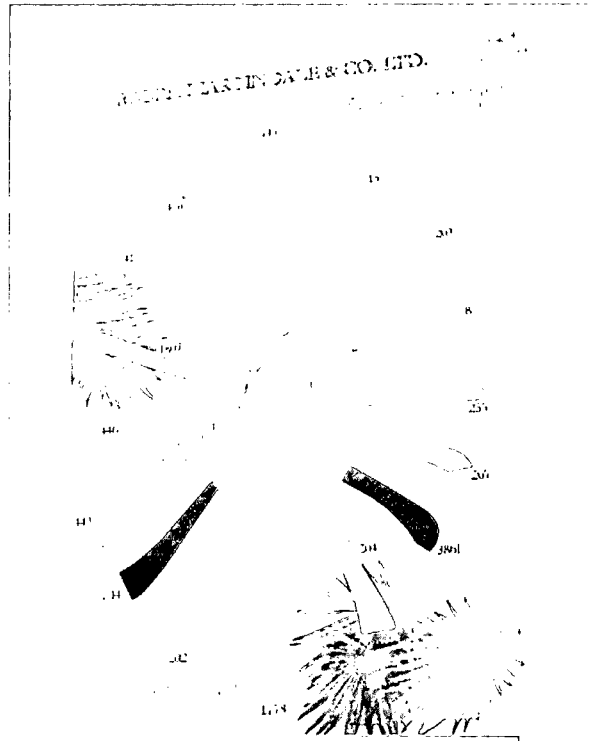
The damage to the Cassava tuber can be also seen with existing method

The above traditional tools Cutlass and Earth Chisel made by village blacksmiths in their small village shops depicted as under:



Scrap materials used by blacksmiths for making the cutlass, earth chisel etc

The cutlass and earth chisels made by Cocodile Matchet company:



ANNEX -8
DETAILS OF THE 4 MANUAL HARVESTORS FOUND

1. One Manual Harvester was found at GRATIS, Tema which was with them. This is shown below



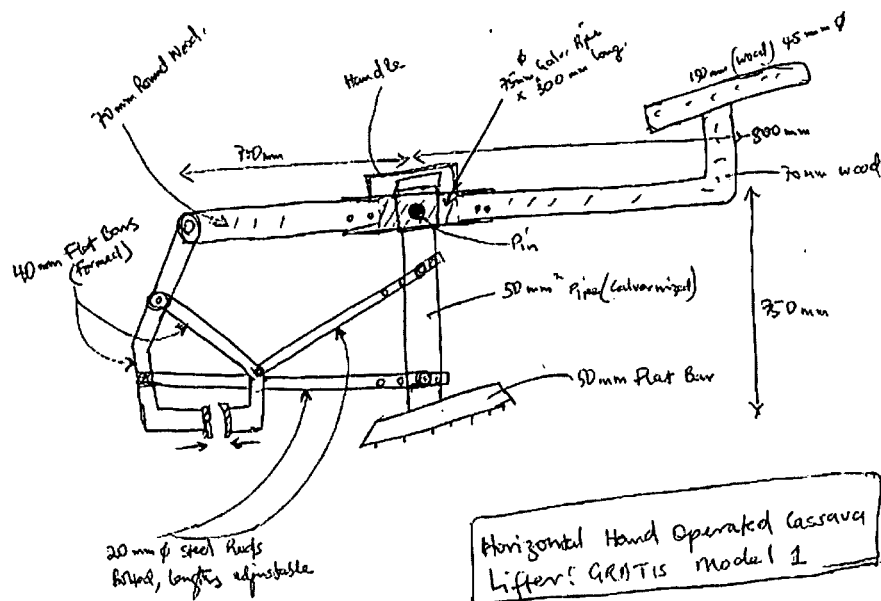
Manual Harvester chain type found in GRATIS, Tema
Specifications of this Manual Harvester:

- **Wooden Pole based leverage type.**
- **Base is wooden.**
- **Gripper : Notched V Groove to grip the Cassava plant stem.
A chain attached to the Notch for wrapping the Cassava stem to a hook welded to the V Notch.**
- **There was no formalized testing data or the feed back from the users. However it is gathered that some pieces were done by Agric Engineering service Directorate of Ministry of Food and Agriculture. But there was no feed back data in a report from the Farming communities.**

2. Another entirely different design was found in the ASCO factory and is shown which is used in Rubber Plantations. They asked it to be examined.

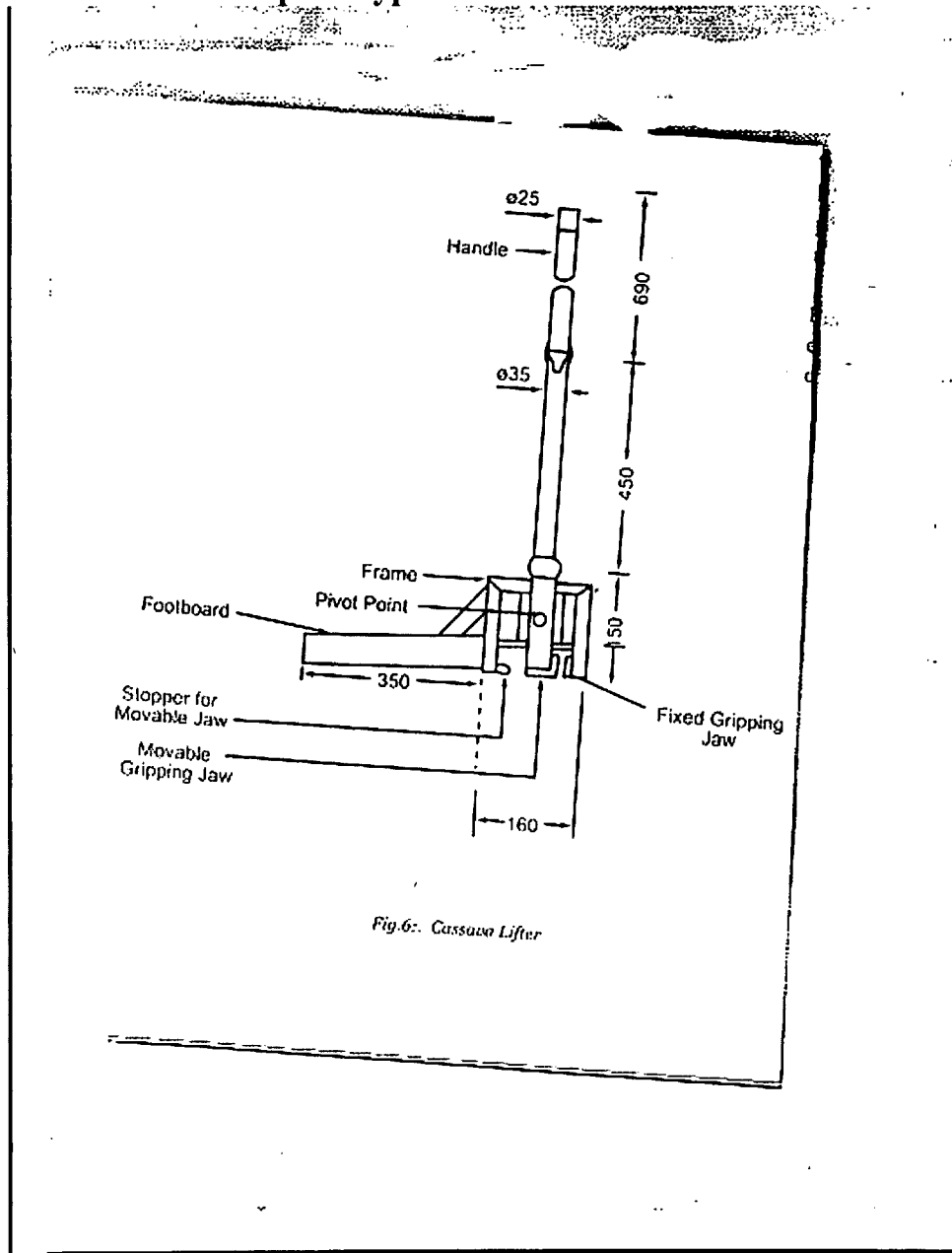


GREL Model for Rubber Stump Lifting .



3. Horizontal Design of a Manual Harvester found at GRATIS: Only a sketch existed . Not prototyped.

4. DAPIT model for which only a Design Drawing existed at GRATIS and not prototyped



Strong Points of the Design:

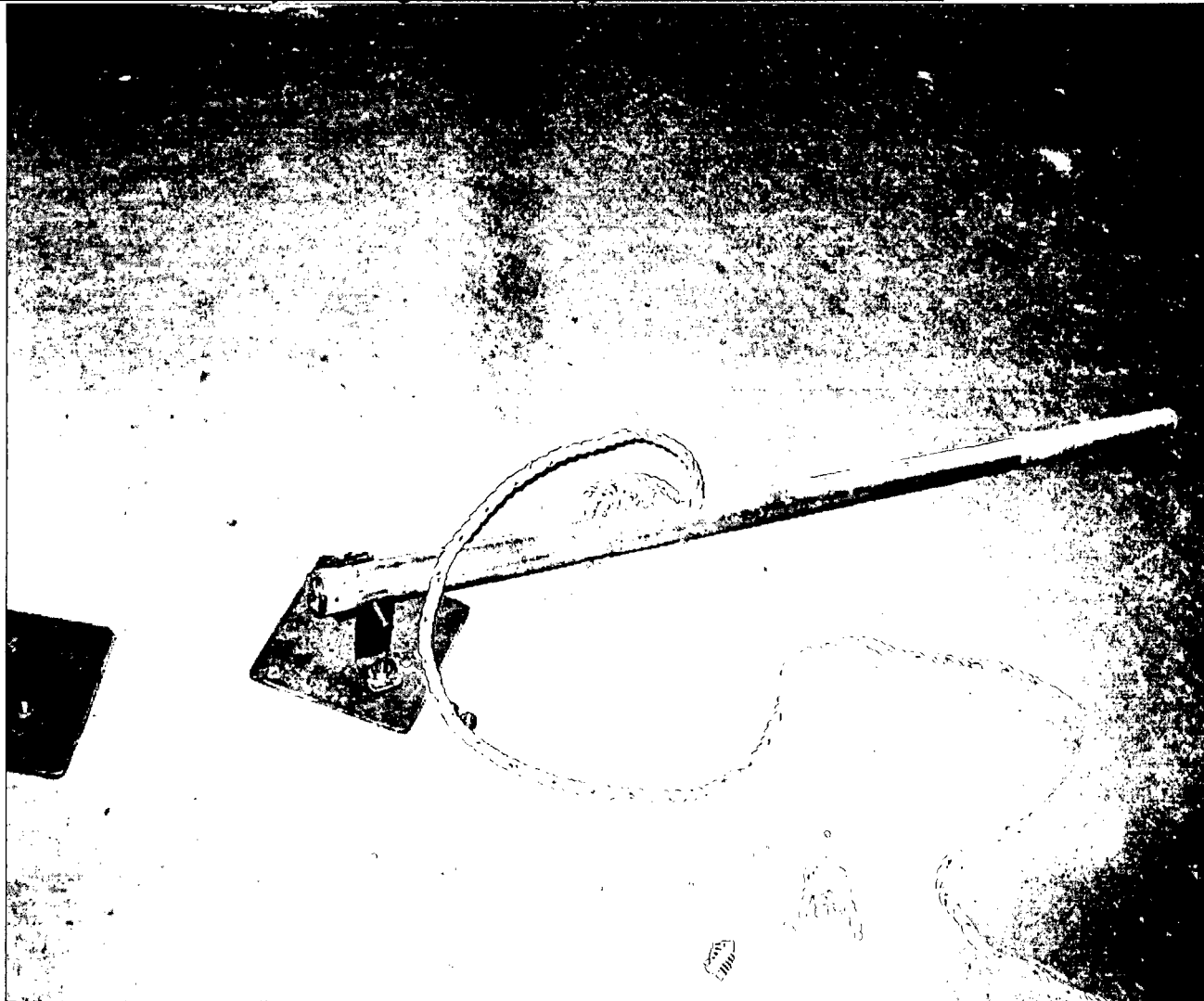
- The rod is simple GI pipe used in water supply system. Hence it is always available. It lasts long as it does not rust.
- The base unit is to be simply inserted on to the Cassava stem and the gripper action takes place alongwith the lifting action thereby the speed of operation is expected to be higher.

The feed back from farmers when the chain model was sample tested as in para 1 above in the Bawjiase village:

- **The wooden base has to be changed to metal.**
- **There should be 3 more hooks to be provided at the identified places and marked for flexibility of tying cassava tuber which grows in non standard sizes.**
- **Size of chain to be thinner by 50 %.**
- **The height of the pole to be shorter by 350 mm.**
- **The gripper angle to be made more acute. 2 different angles to be tried.**
- **The angle of the teeth to be reversed so that the cassava stem cannot slip while pulling.**

These served as vital inputs for the designs of the alternatives to be prototyped and tested again in 12 villages under the PSI.

Annex -9 Preliminary Redesigns of the 3 types of Cassava Harvestors



**PICTURE No 2.2 : : THAI
MODEL OF Manual
Harvester Rope Version(as
modified by GRATIS)**



PICTURE No 3.1 DAPIT Model built by GRATIS

**TECHNICAL SPECIFICATION FOR MODIFIED DAPIT MODEL (PICTURE 3.1)
Renamed Vertical Pole type**

1. Normal Operating Height: 1.2m -1.4m
2. Width of metal base 460mm
3. Weight 6 kg
4. Capacity 500kg/hr

5. Special Consideration
6. Operator does not bend to do the harvesting like most of the other harvesting operations.
7. No time wasted to hook chain or rope, approximately 60 seconds per operation. (With practice it could reduce considerably to about 40 seconds per operation)

8. Mode of Operation
9. Harvester is lifted over truncated cassava stem
10. Ensure stem is between the two jaws of harvester.
11. Vertical pole is pulled towards oneself ensuring that stem is gripped properly
12. Harvester is pulled with base acting as a fulcrum until all tubers are uprooted.

13. Strong points of the above design:
14. It is simple
15. Farmers are accustomed to carry hand held implement which they call Earth Chisel mounted on a wooden pole and as such the issue of carriage will not be a problem..
16. The rod is simple GI pipe used in water supply system. Hence it is always available. It lasts long as it does not rust.
17. The metal base is also made of thick sheet and sufficiently rigid and will also last long needing not much of a maintenance.
18. The design is simple and provides the leverage to farmer while lifting the Cassava tuber thereby reducing his effort than the conventional way
19. The length of the rod could be easily made for the convenience of the farmer, to an optimum height after getting feed back from different farmers in different regions.
20. The village artisan can easily maintain as it does not involve any major tools for repair, except standardized spanners and screws and nuts which are readily available in hardware shops.
21. The design does not involve precision parts and hence Manufacturing could be easily done in normal workshops which are existing in Ghana.

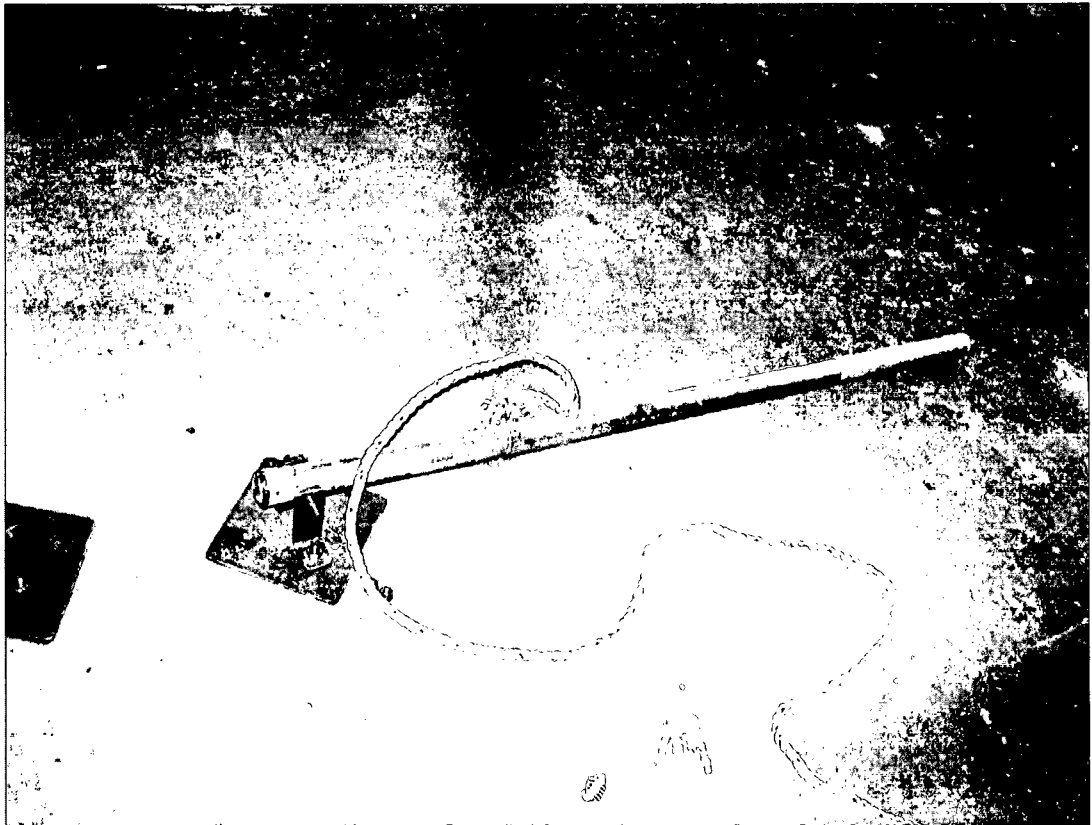
TECHNICAL SPECIFICATION FOR MODIFIED MODEL ROPE TYPE (PICTURE 2.2)

1. Normal Operating Height: 1.2m -1.4m
2. Width of metal base 300mm
3. Weight 5 kg
4. Capacity Yet to be substantiated

5. Special Consideration
6. Operator does not bend to do the harvesting like most of the other harvesting operations.
7. Approximately 60 seconds per operation. (With practice it could reduce considerably to about 40 seconds per operation)

8. Mode of Operation
9. Rope wraps around the stem
10. Ensure stem is gripped properly.
11. Vertical pole is pulled towards oneself ensuring
12. Harvester is pulled with base acting as a fulcrum until all tubers are uprooted.

13. Strong points of the above design:
14. It is simple
15. Farmers are accustomed to carry hand held implement which they call Earth Chisel mounted on a wooden pole and as such the issue of carriage will not be a problem..
16. The rod is simple GI pipe used in water supply system. Hence it is always available. It lasts long as it does not rust.
17. The metal base is also made of thick sheet and sufficiently rigid and will also last long needing not much of a maintenance.
18. The design is simple and provides the leverage to farmer while lifting the Cassava tuber thereby reducing his effort than the conventional way
19. The length of the rod could be easily made for the convenience of the farmer, to an optimum height after getting feed back from different farmers in different regions.
20. The village artisan can easily maintain as it does not involve any major tools for repair, except standardized spanners and screws and nuts which are readily available in hardware shops.
21. The design does not involve precision parts and hence Manufacturing could be easily done in normal workshops which are existing in Ghana.



**PICTURE No 2.2 : : THAI
MODEL OF Manual
Harvestor Rope Version(as
modified by GRATIS)**

**TECHNICAL SPECIFICATION FOR MODIFIED THAILAND MODEL CHAIN TYPE
(PICTURE 2.1)**

1. Normal Operating Height: 1.2m -1.4m
2. Width of metal base 300mm
3. Weight 7kg
4. Capacity Yet to be substantiated

5. Special Consideration
6. Operator does not bend to do the harvesting like most of the other harvesting operations.
7. Gripper : Notched V Groove to grip the Cassava plant stem. A chain attached to the Notch for wrapping the Cassava stem to a hook welded to the V Notch.
8. Approximately 90 seconds per operation. (With practice it could reduce considerably to about 60 seconds per operation)

9. Mode of Operation
10. 8. Chain wraps around the stem along with the V-notch
11. Ensure stem is gripped properly.
12. Vertical pole is pulled towards oneself ensuring
13. Harvester is pulled with base acting as a fulcrum until all tubers are uprooted.

14. Strong points of the above design:
15. It is simple
16. Farmers are accustomed to carry hand held implement which they call Earth Chisel mounted on a wooden pole and as such the issue of carriage will not be a problem..
17. The rod is simple GI pipe used in water supply system. Hence it is always available. It lasts long as it does not rust.
18. The metal base is also made of thick sheet and sufficiently rigid and will also last long needing not much of a maintenance.
19. The design is simple and provides the leverage to farmer while lifting the Cassava tuber thereby reducing his effort than the conventional way
20. The length of the rod could be easily made for the convenience of the farmer, to an optimum height after getting feed back from different farmers in different regions.
21. The village artisan can easily maintain as it does not involve any major tools for repair, except standardized spanners and screws and nuts which are readily available in hardware shops.
22. The design does not involve precision parts and hence Manufacturing could be easily done in normal workshops which are existing in Ghana.

PICTURE No 2.1 : Manual
Harvestor Chain version(as modified by GRATIS)



ANNEX 10

Field Testing Guidelines evolved out of discussions with GRATIS, ASCO, Mr Twum(17-02) and Consultant (11-02) and PM:

MANUAL CASSAVA HARVESTER

This manual gives a description, operation and care of three types of manual cassava harvester for use by farmers. The types are chain type, vertical pole type and the rope type.

Chain Type

Description

The chain type manual cassava harvester consists of a metal handle carrying a gripping jaw with a chain lock and a base plate. The base plate is located at one end of the handle and the gripping jaw about 400mm from this plate.

Features

- Simple, robust and easy to operate and maintain
- Low weight
- Fabricated from locally available materials.

Operation

The operation of this machine is very simple. The following procedure is used in uprooting the Cassava tubers.

- Cut the cassava plant stem at a height of 200 – 250mm above the ground.
- Grip the stem with the jaw and secure firmly with the chain.
- Gently lift the handle until the cassava Tubers are pulled from the soil.

Maintenance

The harvester is simple, robust and as such requires practically no maintenance. However, ensure the following from time to time.

- Loose nuts are tightened
- The machine is cleaned after use
- The machine is re-painted occasionally especially the base plate, gripper and chain.

Rope Type

Description

The Rope type manual cassava harvester comprises a metal handle carrying a base plate at one end and a rope at a point about 400mm from the plate.

Features

- Fabricated from locally available materials.
- Simple, robust and easy to operate and maintain
- Low weight

Operation

It's operation, just like the chain type is very simple.

- Cut the cassava plant stem at a height of 250 – 300mm above ground.
- Noose the rope around the cut stem to grip it
- Lift the handle gently to uproot the cassava.

Maintenance

Ensure the following simple

- Loose nuts are tightened
- The machine is cleaned after use
- The rope is replaced when worn-out
- The machine is re-painted occasionally (base plate).

Vertical Pole type

Description

This version of the manual cassava harvester consists of a frame of welded angle irons carrying a fixed and a hinged/movable jaw:

The movable jaw is welded to the adjustable handle at lower end.

Features

- Positive gripping of stem
- Simple and robust,
- Adjustable handle to suit all height and soil condition
- Easy to operate and maintain
- Fabricated from locally available materials.

Operation

- Cut the cassava plant stem at 250 – 300mm above ground
- Grip the cassava stem between the two jaws by placing the machine over it
- Move the handle towards self to uproot the cassava, turning the whole tool over the tail end of the base.

Maintenance

This harvester, as all the other two types, requires practically no maintenance.

However, ensure the following are carried out.

- Moving part is oiled
- Machine is cleaned after each use
- Occasionally re-painted, especially the angle iron base.

CAUTION !!! (All types of harvesters)

- For very hard and dry ground, apply the force to the handle gently, giving a gradual jerk as the uprooting operation proceeds.

Some cassava plant will not just be uprooted by the manual harvester, so use alternative methods such as digging with Earth Chisel.

Specification

Chain Type	Rope Type	Vertical Pole Type
Overall dimensions: 200 x 200 x 1700 (mm)	Overall dimensions: 200 x 200 x 1700 (mm)	Overall dimensions: 110 x 384 x 1700 (mm)
Weight 8 kg	Weight 5 kg	Weight 4.5 kg

Vertical Pole type**Rope type****Chain type****Cutlass & Earth Chisel**

Costs	110.000 c - - -	110.000 c -	120.000 c - -	80.000 c 0
Efficiency	2 ton/4h +++	1,9 ton/4h ++	1,6 ton/4h +	1,5 ton/4h 0
Damages	13% ++	10% +++	14% +	15% 0
Handling	no bending +++	partly bending ++	partly bending +	bending 0
Weight	4 kg - -	5 kg -	8 kg - -	3 kg 0
Total	+ 8 - 5	+ 7 - 2	+ 3 - 5	0

Comments **Continue testing in dry season (March)**

And it is also necessary that the farmers continually use the harvestors and improve further on the efficiency of usage of the implements. This has been discussed with the MD of ASCo and ensured.

Manufacturing cutlass and earth chisel

Current chain



- + Tools: simple techniques by every blacksmith.
- Lack of standards: poor quality & few spare parts

"The earth chisel is easy to manufacture and the scrap is easy to get."

Manufacturing newly developed harvest tools

New value chain



- + Increase of product quality
- + Economics of scale by standardization
- + Increase profit margin
- Increase of material costs

"I could make the harvester, but I will also need training and capital to buy the material"

Cassava harvesting with cutlass and earth chisel

Current chain



- + Cheap hand tools (30,000 cedis)
- + Easy maintenance
- High drudgery
- Low efficiency; due to damages (15%) and low harvest quantity

"The harvesting job is difficult. The bending has an effect on my waist"

Harvesting with the new tool

New value chain



- + Less drudgery
- + Increase productivity & income: 20%
- + Damage reduction on tubers: 33%
- + Decreased operating cost
- Increase investment costs to 120,000 cedis
- + Harvester can be rent or leased

"Now it is so easy to uproot the cassava out of the ground. I can do more and better work"

Selling Cassava on the domestic market

Current chain



- Low profit
- Dependency on traders
- Low and Irregular market prices and income
- No re-investment in income generating activities

"I don't know how much cassava I will sell for today"

Processing & Export Cassava starch (ASCo)

New value chain



- + Guarantee stable market for farmers
- + Increase supply and quality of raw Cassava from the farms
- + Increase processing capacity utilization from 160 to 200 tons/day
- + Increase export value by 20%

"The harvester helps to bring in more cassava, so the plant can run and export more. This reduces poverty in that area"

The above are based on the field testing data provided by the local consultants contracted for Testing the Manual harvestors .

Annex -11
Experiences abroad in Brazil and Thailand and Italy

1. Experience from Brazil a large Cassava producing country:

Quote

“ Manually operated Cassava Harvester equipment are not produced in Brazil.

There are two private companies that produce equipment for Cassava,

- a. for seed germination and**
- b. for harvesting, both tractor driven.**

The above-mentioned harvesting machine primarily softens the ground around the cassava tubers and makes uprooting quite easy. Uprooting is still done by hand.”

Unquote

6th Oct 2003.

criativa@newnet.com.br

According to our contact through telephone, we have to inform that there are no Cassava Harvester manufacturers in Brazil.

We know of a German company, installed in Brazil, in the State of Mato Grosso, which is working in the development of this equipment; nevertheless, we do not know the name of such company since everything is happening in a secret way.

In Brazil there is a manufacturer of an equipment (100% Brazilian product), called

“FOFADOR DE MANDIOCA” (Cassava Scarifier) which works plugged in the power socket of the tractor . This equipment has a soil penetration of up to 50 cm and has a coupled device which enables the extraction of cassava roots. The main technical characteristics and price of this equipment are given below :

PRICE OF THE EQUIPMENT - US\$ 1.900,00

PRODUCTION CAPACITY - 5 hectares/day

REQUIRED TRACTOR POWER - 65 to 90 CV (HP) SIMPLE

MATERIAL - STEEL 1020

WEIGHT OF THE EQUIPMENT - 350 Kg

MANUFACTURER : PLACAR / ARAPONGA IND. COM. IMPLEMENTOS AGRÍCOLAS

**Rua Estados Unidos, 2100 - Parque Industrial
17606-020 TUPÃ - SP - BRAZIL**

Phone : + 55 14 3491 3773 Fax : + 55 14 442 7070

Contact : Mr. Paulo Nitchepurengo (General Director)

We would like to inform you that we render services in the sale of equipment, machines and tools for various industrial segments, such as : Agricultural, Chemical and Petrochemical, Construction, Food, Metal Working and Metallurgy, Mining, Pharmaceutical, and others.

Respectfully,

Marcos Jefferson da S. Sobrinho,
General Business Director

CRI-ATIVA PRODUTOS E SERVIÇOS LTDA

AV ORLANDO OLIVEIRA PIRES, 1521 - CAEIRA - 2º ANDAR

44700-000 JACOBINA - BA - BRASIL

**TELEFAX : + 55 74 621 0893/ 9859 - CELULAR : + 55 74 9125
2504**

**CNPJ 00.183.676/0001-68 - INSC ESTADUAL 40119654 - INSC.
MUNICIPAL 340320**

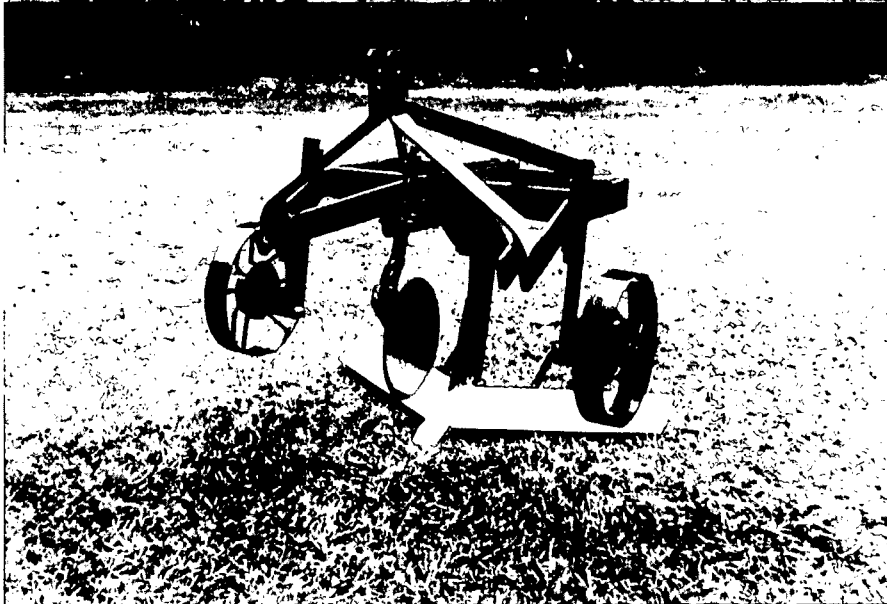
Respected Gentlemen,

As requested follows picture enclosed of Arrancador of Manioca / Fofador.

Respectfully

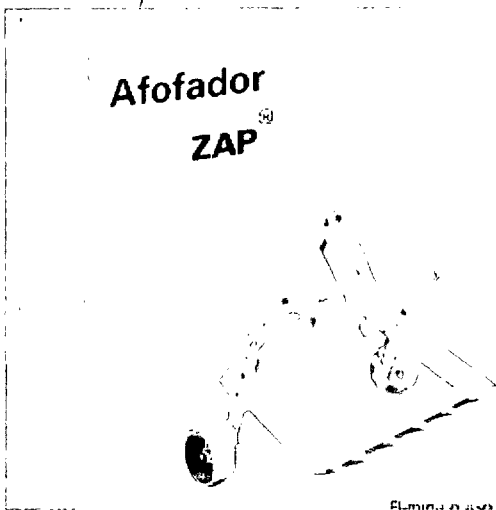
BELIEVE-ACTIVE PRODUCTS AND SERVIÇOS LTDA

Marcos Jefferson da S. Sobrinho
General director of Businesses



Mechanical Harvester

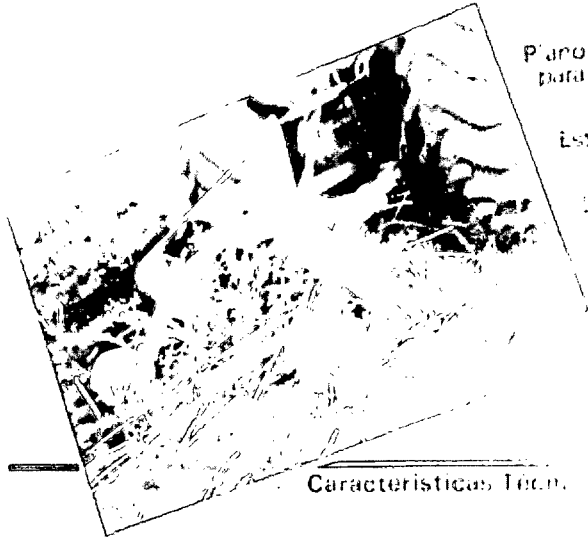




Afofador
ZAP[®]

Pa
C
N

Other mechanical harvestors in Brazil:



Plano incli
para alic

Estrat.

Lam
d'...

Elimina a semente da fazenda

Características Tec.

1. Experience of Thailand from Cassava and Starch Technology Research Unit :

Quote

“

Dear Vasantha,

The normal trading standard for cassava starch is as follows:

Starch content (dry basis) = 96 or more

Ash content max(%) = 0.15

Fibre (%) = 0.10

Viscosity (min) 600 BU

These requirements can not be prepared by small farmers. What they can produce is just cassava flour which contain more ash, fibre and impurities.

With the low cost of root and low labour cost, we still prefer having manual harvesting using small tools.

Regards,

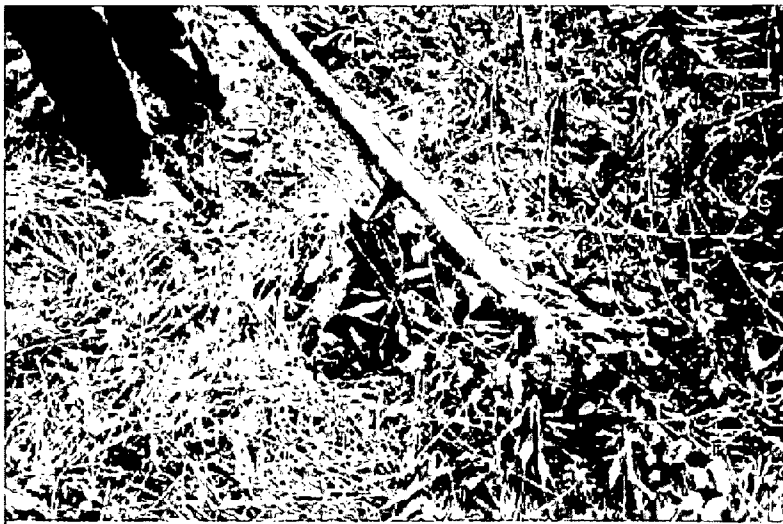
Dr Klanarong
Director
16 Oct 2003 "

Unquote

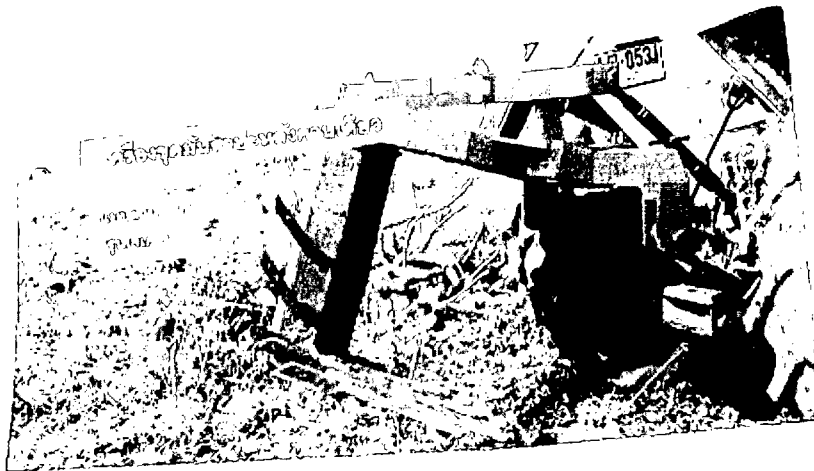
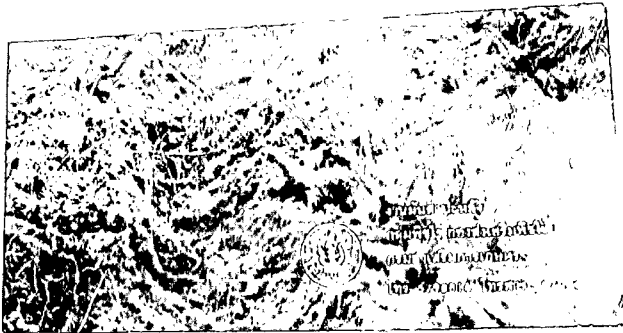
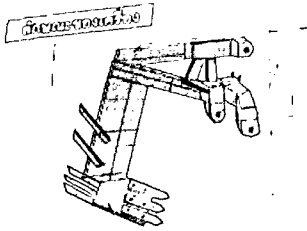


Manual Harvestors from Thailand





Mechanical Harvestors in Thailand



Work done in Italy

Improvement of Cassava collection and processing chain

1. INTRODUCTION

In southern Nigeria cassava is widely cultivated by smallholders in scattered parcels. The small size of the fields makes tractor-based mechanisation not convenient, therefore farmers rely mostly on manual work. Cassava is often processed in “gari”, a coarse flour obtained by grating, drying and then frying the tubers, that constitutes one of the most popular foods.

In this area, cassava is manually cultivated because of the small size of the plots, and among field operation the most tiring is harvest because it is performed by grabbing the stem and pulling the tubers out of the ground. Often this operation is facilitated by loosening superficially the ground around the stem with the cutlance (machete), but it usually still requires several jerks on different sides. This operation, besides being quite time consuming, results harmful for the farmers since it requires a considerable effort on the back structure. The force required for uprooting cassava tubers depends mainly on the kind of soil, on its content in moisture and on the development stage of the plant. Forces up to 1 kN have been recorded during field trials

2.2. MECHANICAL AIDS FOR UPROOTING

The Green River Project has been providing to associated farmers means of light agricultural mechanisation such as motor hoes and transporters. This equipment, based on 7 kW Diesel engines, has not enough power and traction to loosen the soil or to plough it in order to mechanise cassava harvesting [6], but is capable of providing a sufficient force to uproot the tubers by pulling them vertically just like the farmers do. This force is produced by a simple device



consisting of a ring which runs free along a 2 m metal pipe firmly connected to the transporter with an inclination of about 15° on the ground with the back end higher than the front one (figure 1).

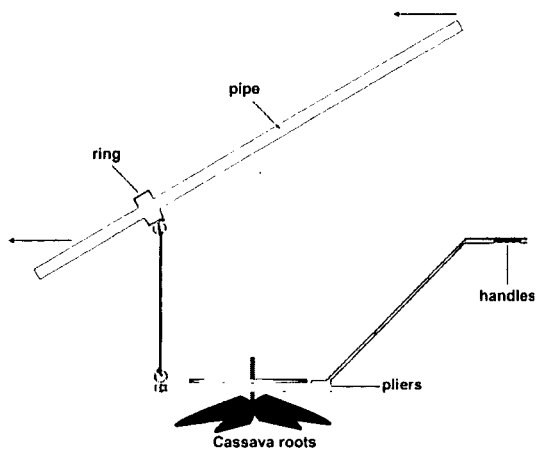


Fig. 1- Scheme of the uprooting tool for motor-trailer.

While the transporter proceeds along a row, the previously topped cassava stems are caught with manually operated pliers connected to the ring and hence extracted. The lifting force is provided by the inclination of the pipe that proceeds through the ring which is retained by the stem grabbed by the pliers. Two operators are needed: a driver and an assistant. The assistant catches each cassava with the pliers holding it while the advancement of the tractor makes the connected pipe move forward through the ring that is held by the plant. Since the back end of the pipe is higher, the ring moves upwards and the plant is hence uprooted as shown in figures 2 and

3. The assistant then drops the roots in the trailer and drives the pliers down to the front end for next plant.

Fig. 2 - The operator holds the pliers while the motor-trailer is proceeding.

Fig. 3 - The operator holds the harvested roots.

ANNEX 12

Consolidated Feed back from the stake holders workshop on 29 Oct 2003:

Appendix I - Programme

09.00 – 09.20	Opening	UNIDO Representative
09.25 – 09.40	Purpose of Meeting	IP Coordinator
09.40 – 10.00	Coffee/Tea Break	
10.05 – 10.45	AMIS Concept	Project Manager
10.50 – 11.10	Discussions	
11.15 – 11.35	Presentation of Field Findings Local Consultant	
11.35 – 12.15	Presentation of Field Findings International Consultant	
12.20 – 13.00	Discussions	
13.00 – 13.45	Lunch	
13.50 – 15.00	Group Discussion	
15.05 – 15.15	Coffee/Tea Break	
15.20 – 16.20	Presentations by Groups	
16.20 – 16.30	Closing UNIDO Representative	

Conclusions of the workshop

The workshop among other things, draw conclusions that in most cases manufactures copy machine designs without testing them. Although the reason for not re-designing machines to suit the country specific need was identified and acknowledged (client request) manufacturers were encouraged to develop set standards. Although there are no standards and specifications for agriculture machinery used nationwide, stakeholders make the efforts to develop some guidelines without compromising the ingenuity of individuals.

The workshop made the following suggestions for consideration:

- There is the need to think about new innovations, which help improve the sector
- Need to train individual artisan on manufacturing skills through capacity building.
- Need to cut down on taxes
- Need to strengthen and enforce standards for manufacturers to follow.
- Develop laws and legal framework on standardisation.
- Standards Board should re-think and if possible franchise identified departments and agencies assist them with their work, particularly at the district and community levels.
- There is the need for the establishment of Engineering Design Centres and Plate shops for GRATIS, RTTC's, and at strategic industrial locations in the country. This if done will also help in solving the problem of standardization.
- There is the urgent need to have a well-stocked supply source or service centre for the reliable supply of such items as
 - Motors, Hydraulic systems, pumps, (Raw Material, Parts and Components)
 - Steel plates and bars of various sections
 - Stainless steel plates
 - Aluminium tubes, bars and sheets
 - Brass sheets and bars, and others.

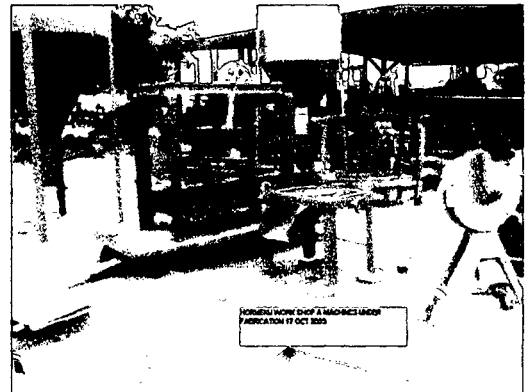
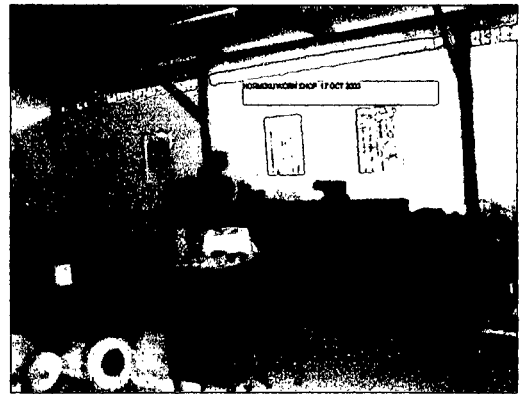
List of Participants

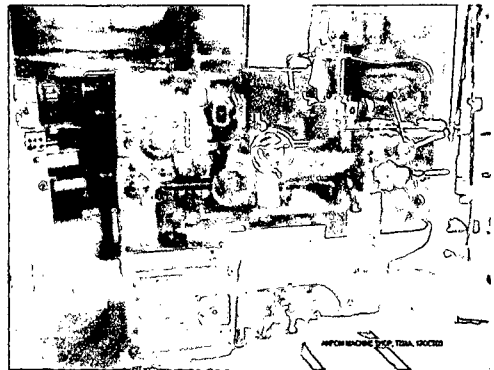
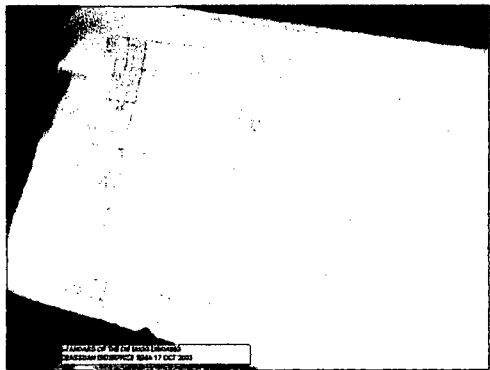
NO.	NAME	ORGANISATION	CONTACT ADDRESS
	Emmanuel Lamptey	NBSSI	P.O. Box M85 Accra 021-661396
	K. Dankyi Darfoor	GRATIS Foundation	P.O. Box CO151 Tema 022-207609
	E.V.O Opare	AMSMI	c/o Suame ITTU/TCC KNUST Kumasi
	Albert Boachie Amofa	NBSSI	P.O. Box M85 Accra
	Daniel Numo	IT Ghana Denco Foundry	P.O. Box BT 508 C2 Tema
	Sam Adu Somuah	MoFA-AESD	P.O. Box M82 Accra
	Sylvester Owusu	MoFA-AESD	P.O. Box M82 Accra 024-628305
	Felix Quansar	FP Quansar Resources	P.O. Box CT5810 Accra/Tel. 021-781874
	Dr. M. Y. Woode	KNUST Chemical Engineering Kumasi	KNUST Kumasi
	J.K. Boamah	MoFA-AESD	P.O. Box M82 Accra/Tel. 021- 7010262/777789 (87)
	Sheini Abu-Bakar	GRATIS Foundation	P.O. Box CO151 Tema/Tel.020- 8118233
	Silva Lumor	Ayensu Starch	P.O. Box 113 Bawjiase Tel.020- 8183725
	G.K. Workey	A.M.S.M.I	W.G.T/TCC/ITTU/UST Kumasi
	George Dake	UNIDO/REDS	UNIDO/REDS P.O. Box Hp958 Ho
	Dr. K. Dzisi	KNUST Kumasi 051-60233/60242 kdzisi@yahoo.com	Department of Agric Engineering, School of Engineering 020-8180346
	Robert B. Tandor	MoTI/PSI	P.O. Box M47 Accra
	S.K Dotse	GRATIS Foundation	P.O. Box CO 151 Tema/Tel.022- 207610
	G.Y Obeng	TCC - KNUST	KNUST Kumasi
	Robert Woode	FATECOWD,	P.O. Box 899 Accra

		CTED	Tel.502914/502547/024383858
Dr. Peggy Oti-Boateng		TCC, KNUST	TCC, KNUST/Tel.051-60296/7
Dr. Dominic Quainoo		AGI, EMADOM LTD	P.O. Box CT 385 Cantonment Accra
D.Y. Frimpong		ASSI Kumasi	P.O. Box AH 8756 Kumasi/Tel 024-763906
David Wiredu		AGI	P.O. Box 8624 Accra-North
P.T. Kwapong		NIB	P.O. Box 3726 Accra/Tel.661703
J.J Afuakwa (Dr.)		Ayensu Starch	P.O. Box 113 Bawjiase
A.E Quayson		Ayensu Starch	P.O.Box 113 Bawjiase
E.E.K Agbeko		KNUST, Mechanical Engineering	P.M.B Kumasi
E.S.D Afrifa		KNUST Mechanical Engineering	KNUST Kumasi
P.K Fleku		Ghana Standards Board	P.O. Box MB 245 Accra
M. A. Pappoe		Ghana standards Board	P.O. Box MB 245 Accra
Elaine Asafo-Adjaye		UNIDO	P.O. Box 1423 Accra
Theophilus P. Obeng		ARB Apex Bank	P.O. Box GP 20321 Accra
Alexander Twum		KNUST	KNUST Kumasi
Daniel Baffour-Awuah		UNIDO	UNIDO, Accra
Mr.S.Vasantha Kumar		UNIDO	UNIDO, Accra

ANNEX -13

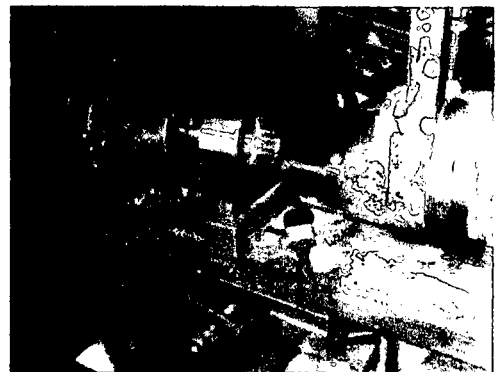
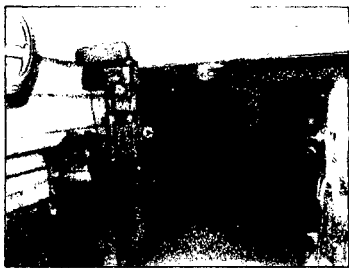
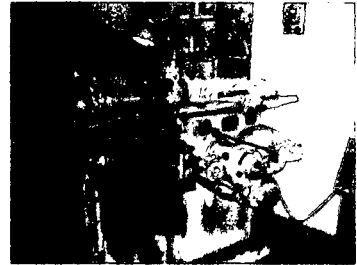
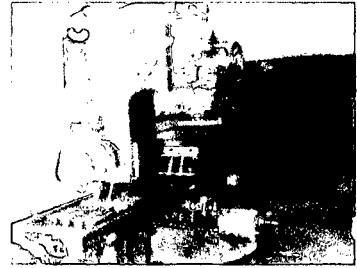
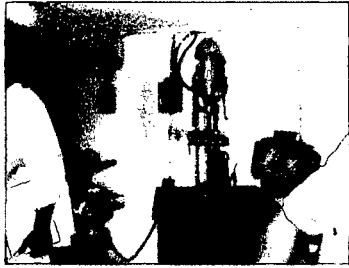
**SAMPLE PICTURES OF THE
INFRASTRUCTURES
IN THE SMEs IN GHANA
In TEMA, Kumasi & ACCRA areas.
Sep- Oct 2003**

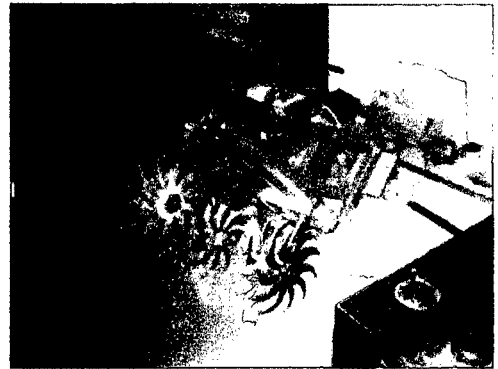
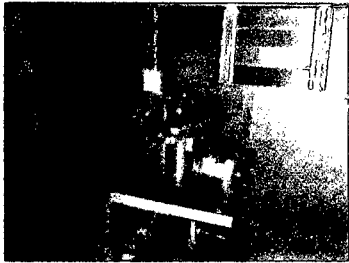
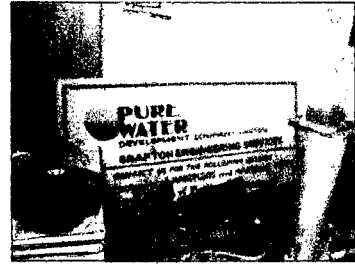
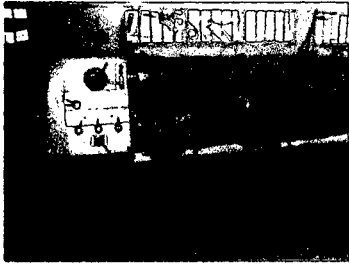




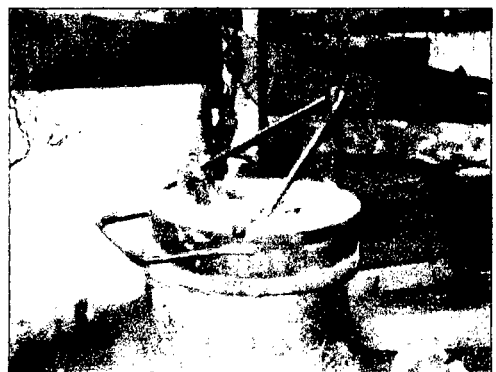
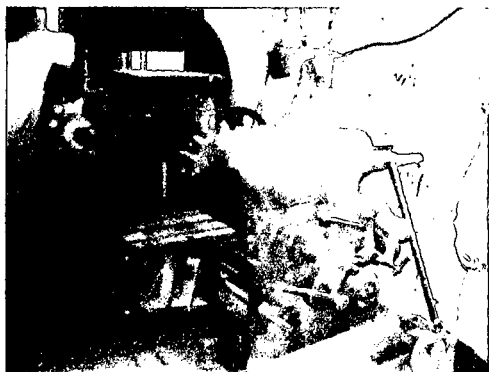
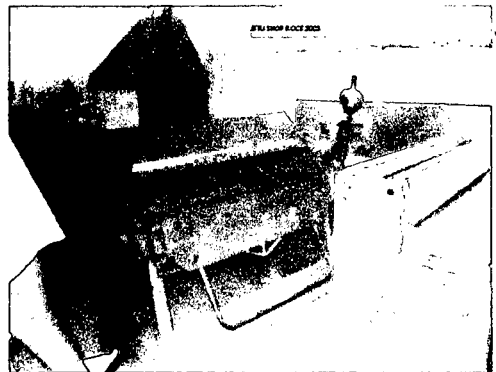


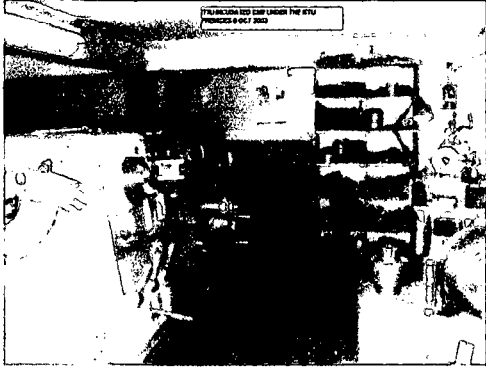
SMALL INDUSTRIES IN KUMASI



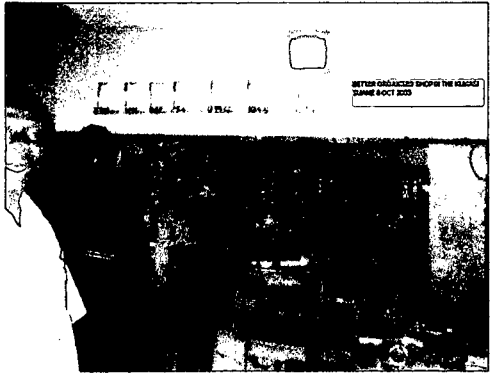


ITTU SHOPS IN KUMASI SUAME
8 OCT 2003









STAFF CONDUCTED SEARCH THE HOUSE
DURING 8 OCT 2001



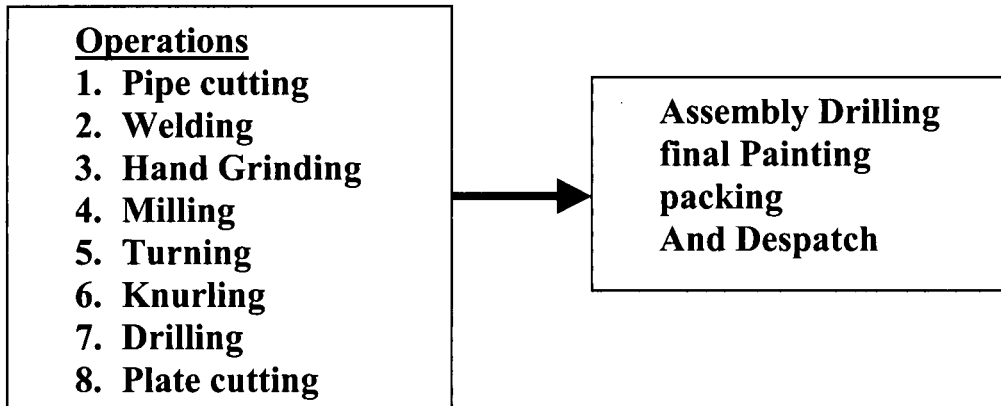
PHOTO TAKEN BY STAFF FROM
LOCAL BLACK BROTHERS HOUSE
DURING 8 OCT 2001

Annex- 13.1

Serial Manufacturing of Manual Cassava Harvestors

Alternative 1

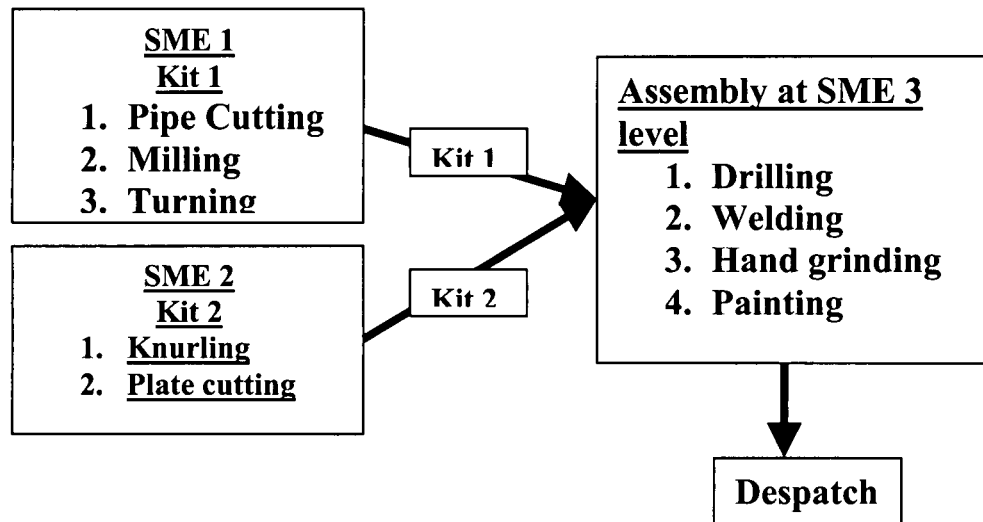
Functions to be performed in a fully equipped SME
From a Technical point of view.



Alternative 2

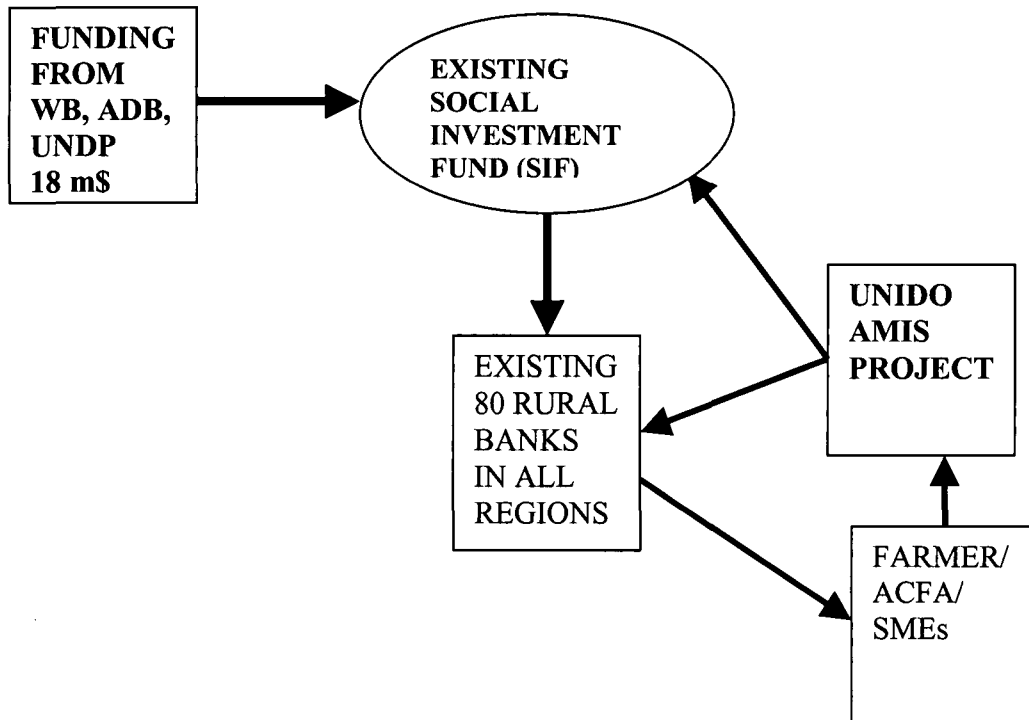
Assembly kit Manufacturing

Functions to be performed in not fully equipped SMEs



ANNEX 14

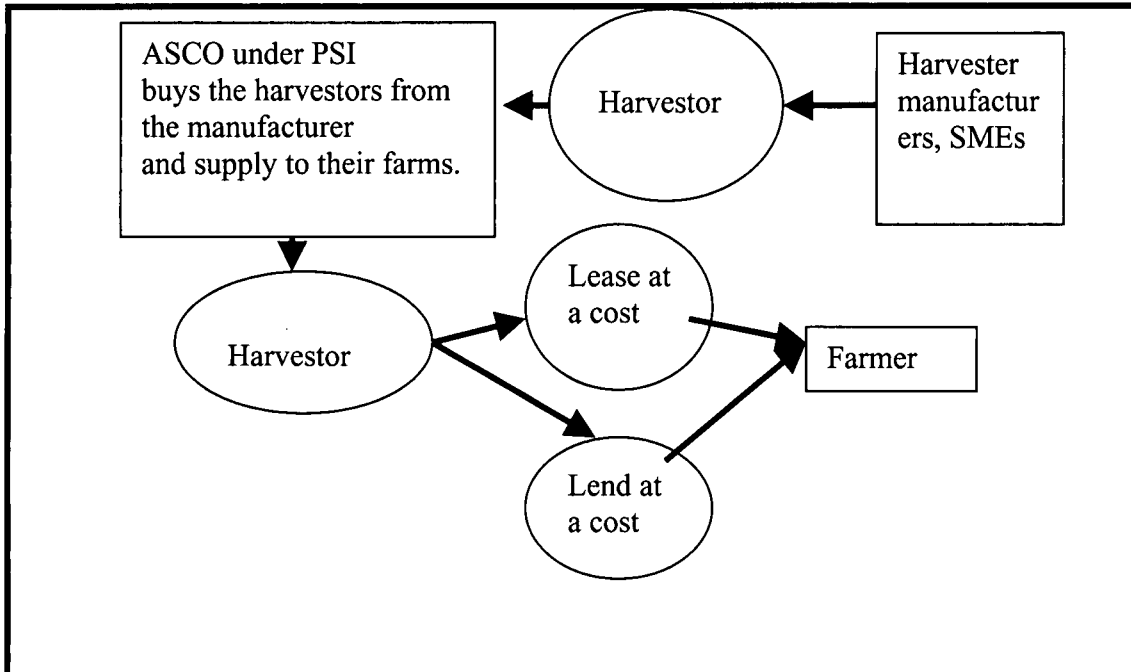
FINANCIAL INPUTS TO FARMERS AND SMEs
MODEL 1



The Model works as follows:

1. Farmer /ACFA approaches SIF with Linkage from UNIDO AMIS.
2. SIF can lend upto maximum of 4 mCidi per farmer or SME. A group like ACFA can also get. eg a group of 10 gets 40m cidis. Other groups not supplying to ASCo but to the open market could be facilitated/incubated by AMIS/ similar to the REDS (Rural enterprises Development Support) project's group networks. They have done 18 groups now, with 25 members per group. They are in the process of making 48 groups. It is working fine as per the Project Management of REDS project.
3. Interest rate at 36% per annum as against 50% per month.
4. Repayment period 1 year.
5. Loan could be for the SME for working capital for making the harvestors and it could be for the farmers to buy the harvestors from the SME directly or through regular agricultural implement sales outlets when the supply volumes get well established.

FINANCIAL INPUTS TO FARMERS AND SMEs
MODEL 2



1. This will also work for the outgrower farms since ASCO stake and interest exists for feeding the cassava into their starch plant with higher quantities of cassava.
2. This need further discussion with PSI and ASCo.

ANNEX -15

Questionnaire for Assessing the Manufacturing Companies' in Kumasi

The following questions if attempted to be answered will give us the Integrated firm analysis of your firm:

A. General:

1. What is the Name and Address and contact person's name, Telephone, Fax , Email address and website address if any.

Name & Address of the Company.		
Proprietor/Contact Person.	Name and Telephone nr	
e-mail address		
When Established?		
What is the Nature of Your business?		
Total no of Employees		
How many women employees		

-2-

B. Understanding Customer Needs

Who are your Customers?		
Are You manufacturing any agro processing machineries? What are they?		
What do you think are the needs of the Customers?		
Do you speak to your customers to understand their needs?		
What are those needs of the customers that you are now satisfying?		

C. Understanding the Environment

How are you upgrading and cope with Technology changes?	
Collaboration?	

Development (inhouse) Tech transfer from National Institutions	
Are you aware of latest Government Policies affecting your business?	
How do you get the Running Capital? If the present arrangement not suitable to undertake manufacture in large numbers the Cassava Harvester which is physically displayed to you, what financial arrangement do you suggest?	

D. Distribution

Do You have Selling Agents or Distributors?	
Your business does direct selling? If not do you prefer that?	
Your company has reserve funds to give implements under short term credit with some guaranter from government or Collataral from a larger Bank like Agriculture Development Bank or any other suitably agreed upon?	

E. Specific Questions regarding the 3 Manual Harvestors shown to you which are under evaluation to arrive at a BaseLine model acceptable to all stake holders:

1. After seeing physically the proposed 3 Manual Harvestors What is your feedback regarding the following aspects:
 - 1.1 Simplicity of the Design from usage point of view?
 - 1.2 Manufacturability in your shop?
 - 1.3 Do you have all the required machining and other fabrication equipments needed to fabricate the 3 Manual Harvestors for Cassava?
 - 1.4 Which model appears easy from the Manufacturing point of view?
 - 1.5 Do you get all the raw materials for the fabrication of the Manual Harvestors for Cassava?
 - 1.6 What do you think the fabrication time for fabricating the 3 Manual Harvestors for Cassava if it is ordered in bulk say in quantities of 5000, 10000, 20000 including the lead time for procurement of raw materials?
 - 1.7 Are the raw materials readily available?

F. Format for assessment of your Manufacturing Capacity

- a. Capacity available for
 - Milling (Table sizes, Maximum weight of the job that could be mounded)
 - turning, (Swing over bed and cross slide, maximum length of job)

- grinding (Cylindrical and or Surface Grinding, Hydraulically operated or Manually operated)
- welding (what are the different welding operations you can do?)
- shaping (maximum job size?)
- tool sharpening (any 3 or 4 axis tool grinders available? Can you sharpen HSS milling cutters , Drill bits, turning tools ?)
- heat treatment (what equipments you have)
- Ask the manufacturers association whether they have the data.
- Number of Skilled workers available?
- Gear cutting machines ,what is the min and max modules of gears you can cut, and what max size?
- What are the ages of the machines? 0-5 , 5-10, 10-15 years
- Any census the manufacturers association is doing?
- Is adequate and continuous Electric Power available to your industry from the Government Energy supply company? Do you have Captive Power Generation to run 70% of your production Machineries?
- Are you having an expansion/Upgradation program in the next 2 , 5 years and in what areas of machineries and oter Infrastructures?
- Any other data other than the above preliminary data for assessment of your company?

Responses received for the Questionnaire

Sl no	Name and Address of Company	Nr empl	Nature of Business
1	Zubary Gariba, Plot 29 th Blk, Kumasi 027 877156	<u>5</u>	Corn mill part & rep
2	Barik Engineering Ltd, Box K 293, Kumasi 020 81 33777	5	Corn mills, spinning Clamps, Truck axles
3	Abu & Sons, Lathe turners, Kumasi 024 465626	10	Axle shaft & Beams
4	Gofp Engineering Products, Box KS 9370, Kumasi 020 8133956	5	Sugar cane crushers, Corn mill
5	Addomejsent, Box M 1215, Kumasi 051-29525, 020 8113487	24	Machining for Hand wells
6	Enterprise of Appropriate Technology c/o Suame ITTU/TCC, Kumasi 051-21177/60296 024-222678	4	Foundry, welding/fab Cation ,subcontract m/cning
7	Yaw Owusu, Tanker & Articulator Welder, 90 Jordan river, Box 505, Kumasi 020 8192177/72209 024 786655	31	Truck builder
8	D.Y.Frimpong Engineering, Box 3756, Kumasi 051-20639 04 763406	20 2 women	Block making, wood Hydraulic press, food Processing machines
9	Karima Engineering Enterprise, Box 8215 Ahensan , Kumasi	32	Agro processing m/cs Corn mills, pepper m rice hauler,cassava

			grater etc
10	Adepa Engineering works, Box SE 317 suame, Kumasi, 051- 32580/	5	General repairs
11	Grafton, Eng services, Box 1947, suame, Kumasi	2+ 5 tra inees	Maintenance and Fabrication
12	J,N.Precision Engineering systems, ox SE 1714 Kumasi, 024 809123/523048 Joenkumah2003@yahoo.co.uk	7	Agro processing m/cs Maize, tomato, gari, cassava & dryers
13	Stone foundry works, Box SE 1105, Kumasi 027 7873839	5	Foundry, casting and Moulding
14	Brother Joe Engg, Box 8590, Ahensan, Kumasi 024 239636	6	Metal Manufacture
15	Miracle Metal Works, Box 1312, Kumasi 027 7400303	4	Cash safe, welding & Fabrication
16	Fosu & sons Engineering, Box 2014, Kumasi 024 463647/284106	12	Gear cutting,mainter Nceof equipments
17	S.K.Bonsu Engineering, Box 1972, Kumasi 051-21130/21131, Fax: 233-51-25306 goldlink@ghana.com	45 1 woman	Metal Fabrication
18	Baba Sika Mohammed engg works, Box 2062 Kumasi, 024 460904	10	Oil press, cassava grater, Oil extracting machines.
19	Muntals Engineering enterprise, Box SE 779, Kumasi, 024 230261	6 1 woman	Cassava grater, flour Mixer,seed cleaner, Beehive smoker

ANNEX -16

LOCAL PROCESSING EQUIPMENTS MANUFACTURED NEEDING
ATTENTION FOR INTERVENTION IN THE PHASE II OF THE PROJECT

CASSAVA PRODUCT	AVAILABLE PRODUCTION MACHINE	MAJOR MANUFACTURING FIRMS
1. Gari	a. Cassava Grater, complete with drive electric motor or diesel prime mover b. Mechanical screw press c. Hydraulic Press d. Gari Roaster/Toaster e. Sieve	1. GRATIS Foundation/RTTC's, Tema 2. Technology Transfer Centre, KNUST, Kumasi 3. Agricultural engineers ltd, Accra. 4. MEMOT Co. Ltd, North Industrial Area, Kaneshie, Accra 5. SIS Engineering, Ltd, Kumasi 6. Homeku engineering Works. 7. Farmers Technical Services and Technological Centre, boba, Accra
Chips and Flour.	a. Cassava Chipper b. Kokonte Chip c. Burr-Plate Mill d. Hammer Mills e. Ovens	RTTC at all Regional Centres, MEMOT Co. Ltd, Accra, Hormeku Engineering Works, Tema SIS Engineering Ltd Kumasi. <i>Burr mills mostly imported but also locally manufactured</i>

Main Farm Tasks and Equipment for Oil Palm Cultivation

Farm Task	Main Hand tools and equipment used		
	Large Commercial Farm	Medium Farms	Small-Scale Farm
1. Land clearing/Land Preparation	Crawler Tractors	Cutlasses Axes mattocks	Cutlasses, Axes, Mattocks
2. Planting	Earth chisels, Tractor-mounted post-hole diggers		Earth chisels
3. Weed Control		Earth chisels	
4. Fertilizer Application	Cutlasses, cover crops	Cutlasses	Cutlasses
5. Pruning	Manual Broadcasting	Manual broadcasting	Manual broadcasting
6. Harvesting	Pruning Knives and sickles		Cutlasses
	Harvesting sickles on aluminium poles	Pruning Knives and cutlasses	
7. Collection to Farm-gate		Harvesting sickles on aluminium poles	
8. Transport to mill	Head Loading with baskets		Headloading with baskets
	Tractors and Trucks	Head Loading with baskets.	
		Tractors and Trucks	Tractors and Trucks.

Locally - Manufactured Equipment Set Available for Processing Palm Oil and Palm Kernel Oil

Machine Unit	Major Manufacturers
<p>1. Palm Fruit Stripper</p> <p>2 Palm Fruit boiler/Sterilizer</p>	<p>i) Agricultural Engineering Co. Ltd., Accra</p> <p>ii) Hormeku Engineering Works Ashiaman, Tema</p> <p>iii) SIS Engineering Co., Kumasi</p> <p>iv) Memot Engineering Co., Kaneshie, Accra</p> <p>v) Agricultural Engineering Dept., KNUST, Kumasi</p> <p>vi) Farmers Technical Services and Technological centre, Accra</p> <p>vii) Agbemskod Engineering Ltd., Accra</p>
<p>2. Palm Fruit Digester</p> <p>3. Palm Oil Press (Screw Press and Hydraulic press)</p>	<p>viii) Sun Ray Engineering Co., Tema</p>
<p>4. Cake Ejector and Fibre/Nut Separator</p>	
<p>5. Oil Clarifying Tanks</p>	
<p>6. Palm Nut Cracker</p>	
<p>7. Palm Kernel/Shell Separator</p>	

ANNEX -17

Presentation of the Manual Cassava Harvestors to Hon'ble Minister MOTI



Presentation of the Manual Cassava Harvestors developed to Hon'ble Minister for Trade and Industry Alan Kyerematen, by UNIDO res rep Mr Akmel Akpa and UNDP Res rep Mr Alfred Sallia Fawundu 20 nov03



Inaugural Function 20th Nov 2003 at Ghana Trade Fair Centre, Accra

ANNEX -18

Facilitating other works to the Proj Mgr relevant to the assignment

- 1. Facilitating with proposal for the formation of Steering Committee for the present phase.**
- 2. Considerable time spent on the formation for the Sub Contract for GRATIS for the design ,supervision of fabrication and testing of the 3 manual Cassava Harvestors and rationalising the designs for lesser weight and ease of operation. What has emerged is the final ones shown in Annexure -10.**
- 3. Sufficient time spent on evolving the testing methodologies and drafting the Terms of reference and format for the testing of the Harvestors local subcontract. Later on when expert (11-02) joined the base document was discussed along with the GRATIS to consolidate the field testing methodologies.**

ANNEXURE 19

Bibliography/References

1. Integrated Programme, Ghana, A Progress Report (as of 31 July 2003) , Titled “Capacity-building for Growth-oriented and competitive micro, small and medium enterprises development.
2. Agricultural Equipment Feasibility – Draft Fianl Report dated 13th Oct 2003 by Alexander Twum- National Expert.
3. **References of leading Cassava Research Organisations**

Tropical Research and Education Center, University of Florida
18905 S.W. 280 Street, Homestead, FL 33031
Tel. 305-246-7025; Fax 305-246-7003; E-mail: sko@gnv.ifas.ufl.edu

CIAT Cassava Program, Apartado Aereo 6713, Cali, Colombia
Tel (57)-2-4450-000 Fax (57)-2-4450-273 USA Fax (305) 592-4869 E-mail
CIAT-CASSAVA@CGNET.COM

IITA Root Crops Program, Oyo Road, PMB 5320, Ibadan, Nigeria
Tel. (234-2) 2412626, 241269, 2411430, Fax (INMARSAT): 874-1772276,
Telex 31417 or 31159 TROPIB NG E-mail IITA@CGNET.COM

EMBRAPA, Centro Nacional De Pesquisa De Mandioca E. Fruticultura,
Rua Embrapa s/n, Caixa Postal 007, Crus Das Almas, Bahia, Brazil,
CEP: 44380-000
Tel. 55 (075) 721-2120 Fax 55 (075) 721-1118 E-mail
cnpmf@brfapesp.bitnet and
postmaster@cnpmft.embrapa.anba.br

4. Kumasi Suame Magazine A Background Paper. George Yaw Obeng (Sept. 2002).
- 5.

ANNEX -20
Abbreviations

1. **PSI:** **President's Special Initiative**
2. **AMIS :** **Agricultural Machinery Industrial System**
3. **COVE :** **Corporate village Enterprises Scheme**
4. **MOFA:** **Ministry of Food and Ariculture**
5. **ASCo:** **Ayensu Starch Company established under PSI for Starch**

6. **TCC :** **Technology Consultancy Centre, Kwame Nkrumah University , Kumasi, Ghana
Under which ITTU functions.**
- 6.1 **ITTU:** **Intermediate Technology Transfer Centre Kumasi.**

7. **GREL :** **Ghana Rubber Estate Ltd**
8. **GSB :** **Ghana Standards Bureau**
9. **GRATIS:** **Ghana Regional Appropriate Technology Industrial Service project**
10. **RTTC :** **Regional Technology Transfer Centre in 9 regions of Ghana established by GRATIS.**
11. **MOTI:** **Ministry of Trade & Industry**
12. **DAPIT:** **Development of Appropriate Intermediate Technology**

ANNEX -21**Training programs to be implanted in the Support Institutions*****1. COURSE: MACHINE TOOL INSPECTION & TESTING***

ABSTRACT: With increasing demand on the quality and performance of machine tools, it is essential to ensure that the basic requirements of accuracy, productivity and functional reliability are ensured in a machine tool. To evaluate the machine tools for their performance, tests have been existing based on the experience of machine tool manufacturers, users and R & D organisations. Full scale evaluation of a machine tool entails tests ranging from verification of specifications to machine dynamics and process capability.

This course covers the measurement of positional accuracy, noise & vibration, capability tests and basic metrology instrumentation required, through lectures and practical demonstrations.

OBJECTIVES:

The course aims to impart:

- The concept of evaluation of machine tools.
- Exposure to modern equipment needed for machine tool evaluation and analysis.
- Exposure to various metrology aspects.

CONTENTS:

- Introduction to evaluation of machine tools.
- Concept of geometrical accuracies in machine tools.
- Positional accuracies of machine tool slides oriented to CNC machines.
- Metrology Instrumentation.
- Static rigidity measurement and analysis.
- Instrumentation for machine tool testing
- Power utilization.
- Process capability evaluation.
- Machine tool vibration and its measurement.
- Noise measurement.

PARTICIPANTS REQUIREMENTS: A degree in Mechanical Engineering with two years experience or those with equivalent standing.

2. COURSE: MACHINERY CONDITION MONITORING FOR PREDICTIVE & PROACTIVE MAINTENANCE

ABSTRACT:

Concepts of maintenance of industrial machinery has undergone changes in view of the necessity for maximisation of utility, minimisation of unforeseen interruptions and avoidance of duplication of machinery. There is increased stress laid on concepts like condition based intervention strategy for maintenance work. Computers are being effectively used as diagnostic aid for machinery maintenance. This course aims at imparting latest information on techniques of condition monitoring for effective maintenance. Topics such as vibration monitoring, non-destructive testing and use of computer aided measurement/analysis are covered in this course.

OBJECTIVES:

The course is designed to meet the following objectives through lectures and extensive practical demonstration:

- Highlight concepts and relevance of condition monitoring for predictive maintenance.
- Extensively cover all aspects of vibration monitoring, including instrumentation, measurement techniques, data evaluation and decision making aids for predictive maintenance.
- Impart information on non-destructive testing methods, particle counting in contaminated fluids, etc.
- Introduce advance maintenance concepts, machinery problem diagnostic techniques, etc.

CONTENTS:

- Maintenance strategies of industrial machinery.
- Parameters and techniques to evaluate machinery health.
- Predictive maintenance of rotating machinery through vibration monitoring.
- Non destructive testing methods as applicable to maintenance.
- Use of computer aided instrumentation in maintenance concepts.

PARTICIPANTS' REQUIREMENTS:

Mechanical Engineering Graduates with 2 years experience in machinery maintenance or Diploma holders with 5 years practical experience in plant and machinery maintenance.

3. COURSE: MANUAL PART PROGRAMMING

ABSTRACT:

The course is intended to provide the basic knowledge to programme CNC machines manually. Part Programming for 2 axis lathe & trainer lathe and machining centre are dealt with. Participants are required to write programs and prove the programs of simple components on the machines available at CMTI. Systems like FANUC, SINUMERIK, HEIDENHAIN are dealt with. The course will be useful to organisations who have NC or CNC machines and intend to programme their parts manually.

OBJECTIVES:

The participants will be able to

- Follow and understand the CNC Machine configurations, machining sequences, tool layout and part geometry oriented towards NC machining.
- Write programmes for production parts in 2 or 3 axis configurations for NC lathe, machining centre and on CNC trainer machines.

CONTENTS:

- NC Programming Standards: Co-ordinate Systems, NC Tapes and its coding, Block Format
- Machine Configurations: Machine axis nomenclature, Tool & cutter consideration, Part geometry, Tool and machining data selection,
- Manual Part Programming for: CNC lathe (Production machine), CNC Trainer lathe, Machining centre,
- Tape punching, Editing and Tape Proving
- Latest manual programming techniques
- Demonstration on CAD/CAM system

PARTICIPANTS' REQUIREMENTS:

The participants either must have working experience on NC machines or have practical experience in production planning and/or methods.

**4.COURSE: MAINTENANCE OF CNC MACHINES
(MECHANICAL & HYDRAULIC)**

ABSTRACT:

The course is intended to take the participants through the constructional aspects of CNC Machine tools. It provides a good understanding about mechanical, hydraulic and pneumatic elements of the CNC Machines. The course gives ability for maintenance personnel to troubleshoot and maintain the CNC Machine Tools.

OBJECTIVES:

- To highlight the constructional aspects of CNC Machine Tools.
- To familiarise the participants with the mechanical and hydraulic elements of CNC Machine Tools.
- To make the participants aware of inspection methods and inspection equipment to troubleshoot accuracy problems of CNC Machine Tools.
- To highlight preventive maintenance procedures, periodic checks, record keeping, spare parts, lubrication, etc., relating to Mechanical, Hydraulic and Pneumatic elements.

CONTENTS:***Mechanical Elements :***

- Construction of NC Machines, Slides and Guideways, Ball lead screws, Automatic tool changer, Rotary and indexing tables, Spindle and drives,
- Preventive maintenance: Advantages, Aspects & Organisation of preventive maintenance, Survey, Inspection, Work schedule, Maintenance report
- Lubrication, slide way protection, wipers, covers
- Spares and documentation

Hydraulic Elements :

- Hydraulic fluids
- Classification of hydraulic elements: Power generating elements (pumps), Power controlling elements (valves), Power utilising elements (motors & cylinders)
- Accessories: seals, connecting elements, filters, accumulators, pressure switches, etc.
- Hydraulic power pack
- Installation, precautions in filling and running in
- Preventive maintenance, periodic checks, fluid sampling
- Troubleshooting and repair work
- Spares and documentation

Performance Testing & Inspection :

- Accuracy testing, Geometrical accuracy, Rigidity, Idle running performance
- NC Machine tool standards
- Measurements using laser interferometer and other test equipments
- Foundation and foundation hardwares
- Installation, leveling, installation equipment and test part proving
- Condition monitoring and instrumentation for noise and vibration testing.

PARTICIPANTS' REQUIREMENTS:

Graduate in Mechanical Engineering having working knowledge of machine tools either in design or maintenance or Diploma holder in mechanical engineering having working experience of 5 years in the field of machine tool maintenance.

5.COURSE: CNC SYSTEM MAINTENANCE

ABSTRACT:

This course is intended to train the in-house maintenance personnel in CNC System Maintenance. The course provides a good understanding of the internal architecture of a typical CNC system and deals in detail the operation of different areas of the system. Supported by laboratory and practical demonstrations to provide working experience in trouble shooting and maintenance.

OBJECTIVES:

This course enables the participants to familiarise and understand:

- advance logic elements and logic families.
- microprocessors and memories used in the microcomputers.
- the operation of a CNC system.
- programmable machine interface.
- the different peripheral devices used in the CNC system and their maintenance.
- practical training in trouble shooting the control system and interface between system & the machine tool.

CONTENTS:

- Numbering Systems: Binary, BCD and Hexa decimal
- Logic Fundamentals: Logic symbols, functioning of different logic circuits, different logic families.
- Microprocessors: Description of microprocessors, memory devices, their operation.
- Typical CNC System Description: Block diagram level introduction, system features, typical operator's panel, system software structure, peripheral interface, tape reader, tape punch, CRT interface, axis controller and machine interface.
- Programmable Machine Interface: Introduction, ladder network and typical example.
- Feedback Devices: Brief description of resolver, inductosyn, rotary encoder and linear optical scale and their maintenance.
- Servo Drives: SCR drives, PWM drives, adjustments and maintenance.
- CNC Maintenance: Preventive maintenance, diagnostics, trouble shooting procedures and test equipments.
- Case histories of CNC systems maintenance.

PARTICIPANTS' REQUIREMENTS:

Graduates in Electrical/Electronics Engineering or diploma holders with five years experience in the field of maintenance of electronic equipments, should have a fair idea of NC machine tools.

6. COURSE :PRECISION MEASUREMENTS AND METROLOGY

ABSTRACT: This course aims at providing a theoretical base along with practical training on shop and laboratory methods for measurement of dimensional and geometrical errors and surface finish. It covers various measurement methods and evaluation techniques adopted in precision measurement. Participants will also be appraised of the usage of sophisticated equipments such as Laser Interferometer, Co-ordinate Measuring Machine, Lead Screw Testing Machine etc. Use of computers for evaluation of data with case studies is also highlighted. The participants will be given hands on experience on different types of measuring equipment.

OBJECTIVES:

The objectives of this course are to be disseminate knowledge about:

- Instruments used and methods adopted for measurement of length, angle, form errors, surface finish, gears, lead screw etc.
- Various methodology adopted in inspection of precision components such as spindles, lead screws, bearings etc.
- Measuring techniques used for calibration of gauges such as gauge blocks, taper gauges, plain and thread gauges.
- Limitations of the shop methods of measuring geometrical errors, such as flatness, roundness, surface finish, etc.
- Latest developments in the field of metrology instrumentation such as microprocessor based instruments etc.

CONTENTS:

- Participants with troubleshooting and small repairs & adjustments as part of maintenance work.
- To familiarise participants with Concepts of Computer Aided Inspection: Need for computerisation; present day trends in the use of computers in the field of metrology and inspection. Stages in development of basic measuring instruments towards computerisation.
 - Introduction to Computers: Types and uses of computers, peripherals and languages, methods of inputting the data and getting the output, storing and leading of programs. On-line & off-line data collection and analysis using computers.
 - Quality Management: Importance of quality management systems; usage of computers for quality management as applied to gauge management systems and instruments management systems.

- **Computer Aided Inspection Planning:** Significance of inspection planning, adaptability of inspection planning as a part of manufacturing plan, description of inspection planning using computer.
- **Computer usage in CMTI: CMM and its applications,** various dimensional and geometrical features requiring software developments, different analysis and application programmes available with latest Carl Zeiss CNC Co-ordinate Measuring Machine.
- **Evaluation of contours using computers:** Commonly used contours used in machine tool industry, case studies of the evaluation of complicated contours like gears, special cams, turbine blades etc., using Carl Zeiss Co-ordinate Measuring Machine.
- **Computer usage in form error measurements:** Definition of various form errors, instruments used for the measurement of the commonly used form errors like circularity, cylindricity, straightness, flatness etc., computation and evaluation of these errors using computer.
- **Surface roughness analysis:** Definition of surface roughness parameters and its function effects, instruments used for measurement.
- **Computer usage with laser measuring system:** Laser measuring system & its application in machine tool metrology and analysis of calibration of NC/CNC machines & measuring machines using laser measuring system. Use of HP computer for the data obtained from laser measuring system both on-line and off-line.
- **Latest measurement systems and the use of computers:** Principle of the latest measurements systems like laser scanning system, vision systems, use of computers for data collection and evaluation.

PARTICIPANTS' REQUIREMENTS:

Graduates in Mechanical/Electrical/Electronic Engineering with working knowledge of Metrology and Inspection or Diploma holders with five years experience in the field of Metrology & Inspection and capability to analyse analytically the inspection problems

7. COURSE: CO-ORDINATE MEASURING MACHINES AND ITS APPLICATIONS

ABSTRACT: In industrial measurements, the advent of co-ordinate measuring machines has provided the capability for comprehensive measurements at one measurement station. Multi-axis CMMs' with associated computers and software not only reduce the inspection time, tooling (for measurement) costs, measurement costs, clerical work etc., but also improve the accuracy and reliability of measurements. Present day CMMs are capable of checking dimensions, positional relationships, geometrical errors, gear parameters, 2-D and 3-D surface measurements, batch measurements and a combination of all the measurement under teach and programmed CNC run.

OBJECTIVES:

This course is intended to give an introduction to the working of CMMs, probes, mathematical automatic alignment, measurement of dimensional and geometric errors, curve measurements, gear measurements, CNC programming for measurements etc. The course also includes hands-on practical training and demonstration of complicated measuring tasks.

CONTENTS:

- Introduction to CMMs highlighting the various types of CMMs available in the market.
- Introduction to probes, their calibration and computerised alignment.
- Insight into dimensional and geometrical measurements.
- Use of softwares for various measurement tasks.
- Introduction to gear measurements.
- Hands-on training and demonstrations.

PARTICIPANTS' REQUIREMENTS: Graduates in Mechanical/Electrical/Electronic Engineering with working knowledge of Metrology and Inspection or Diploma holders with five years experience in the field of Metrology and Inspection and capability to analyse analytically the inspection problems.

8. COURSE : CALIBRATION OF DIMENSIONAL MEASURING EQUIPMENTS AND MACHINE TOOLS

ABSTRACT:

The course aims at providing a theoretical base along with practical training on calibration of Dimensional Measuring Equipments, machine tools and measuring machines. It basically covers the aspect of "WHY & HOW of Calibration" which include requirements, methods and evaluation procedures for calibration of Dimensional Measuring Equipments and Machine Tools. Participants are also appraised of the usage of sophisticated equipment such as Laser Measuring System, Co-ordinate Measuring Machine, Form Tester, etc. and use of computers for the evaluation of data. The participants will be given hands-on experience on different types of measuring equipment.

OBJECTIVES:

The objectives of this course are to disseminate knowledge about::

- Awareness about calibration - " WHY " Calibration is required.
- " HOW " to Calibrate.

- **Relevance of Calibration to ISO-9000**
- **NABL Certification for Laboratories involved in Calibration**
- **Instruments used and methods adopted for calibration of dimensional measuring equipments and machine tools.**
- **Measuring techniques used for calibration of masters and gauges.**
- **Traceability and Periodicity aspects referring to the Calibration of dimensional measuring equipment and machine tools.**

CONTENTS:

1. **Introduction to Calibration.**
2. **Relevance of Calibration to ISO-9000 and NABL Certification.**
3. **Traceability in Calibration .**
4. **Importance of Environmental conditions during Calibration.**
5. **Requirements and methods of Calibration.**
6. **Masters and artefacts used for Calibration.**
7. **Concept of Uncertainty of Measurements**
8. **Measurement System analysis**
9. **Examples of Calibration of Dimensional Measuring equipment.**
10. **Use of Laser Measuring Systems for Calibration of Machine tools and Measuring Machines.**

PARTICIPANTS REQUIREMENTS: Graduate in Engineering with working knowledge of Calibration of Dimensional Measuring Equipments or Diploma Holders with FIVE years experience in the filed of calibration of Dimensional Measuring equipments.

**9. COURSE: FINITE ELEMENT METHODS FOR
MECHANICAL DESIGN**

ABSTRACT:

Finite Element Method (FEM) is being successfully applied in engineering analysis. This course identifies the base of FEM and its application to solving problems relating to structural analysis. The course is aimed at those involved in engineering design, analysis and testing.

OBJECTIVES:

This course is intended to provide theoretical back ground followed by practical hands on experience in applying Finite Element Method for engineering/structural analysis. The course will provide exposure to those involved in design analysis and testing to be followed for solving their own problems of structural analysis in the fields of static deformations, stresses, vibrations and heat transfer.

The participants will be exposed to:

- **Fundamentals of theoretical background to FEM.**

- Considerations in modelling practical structures and guidelines for the selection of element types and mesh generation.
- Interpretation of FEM results through case studies.
- Use of CAD systems for mesh generation, analysis and post processing of results.

CONTENTS:

- Introduction to FEM and its scope in engineering analysis.
- Analysis of static deformations using FEM.
- Finite element analysis for stress behaviour in structures.
- Thermal analysis for temperature and the associated distortions, using FEM.
- Dynamic analysis covering natural frequencies, mode of shapes and responses.
- Mesh generation using interaction CAD workstation.

PARTICIPANTS' REQUIREMENTS:

Engineers engaged in machine design analysis and testing.

10. COURSE: FAILURE MODE AND EFFECT ANALYSIS

ABSTRACT:

Failure Mode and Effect Analysis, FMEA for short, is a very powerful and effective methodology available for evolving good designs and processes taking inputs from various functions like design, assembly, materials engineering, servicing etc.

FMEA aims at broad basing the thought inputs/ideas that go into the decision making process before the finalisation of the design or the details of a process during its development stages. Thus it is an 'error preventive oriented' and proactive methodology that tries to preempt occurrence of errors, reduce their significance (even if they were bound to occur) and in unavoidable circumstances, increase the chances of error discovery so that errors could then be suitably disposed.

FMEA is normally necessary in case of new developments, new technologies and components/assemblies or products which have inherent problems showing up in practice.

In case of components/assemblies supplied by vendors, for which the vendor/supplier has full or partial design and process planning responsibility, FMEA has to be conducted by the vendor and approved by the purchaser. Thus the vendors would be assuring the quality of their supplies if FMEA is effectively adopted at their end.

FMEA is an aid for continuous improvement which fits into a PDCA (Plan-Do-Check-Act) pattern of activity. Whenever changes in product or processes or vendor/supplier are envisaged or effected, FMEA is redone to evaluate their effects.

OBJECTIVES:

- To introduce the FMEA methodology and give background information on how to organise FMEA groups.
- To highlight the important aspects of FMEA through group interaction exercises on DESIGN and PROCESS FMEA with specific examples.

THE ADVANTAGES OF FMEA ARE:

- it brings in a compulsive and systematic methodology to comprehend potential problems in order to prevent errors in designing and manufacturing.
- it brings in and fosters a team-work culture of cross-functional nature in the developmental activities which is very essential for enhancing the reliability of complex design/systems and processes.
- it reduces the risk of product recall through follow up of critical errors.
- it aims at blocking errors in the design and planning stages so that costly and time consuming post-error actions are avoided.
- it documents specific know-how on problem areas and thus helps in preventing error recurrence and subsequent rework.

METHODOLOGY:

The methodology adopted in the course is a combination of lecture sessions and group exercises with specific simulation examples.

PARTICIPANTS' REQUIREMENTS:

Graduates in Engineering or a Post Graduates in Science. Candidates with knowledge in quality assurance system are preferred.

11. COURSE: PATENTING & IPR AS APPLIED TO ENGINEERING INDUSTRIES

Abstract:

The course is aimed at bringing awareness about the need for patenting and benefits of patent information to the Scientific and Engineering Community. The course will provide information on IPR and Patents in particular. It will focus on the Introduction to Patents, Sources of Patent Information, PCT/TRIPS/WIPO, Patenting Procedures, Case studies, Patent Fee, Legal aspects, Patent Searches, etc. Special emphasis is given on patent application procedure and filling of application form for patenting an invention.

14. COURSE: Metallurgy, Engineering Materials and Heat treatment of Ferrous materials
15. COURSE: Ferrous and Non Ferrous metals casting, Automated foundries, Furnaces, Modern Pattern making techniques,
16. COURSE: Machine Design course and usage of CAD for the same.
17. COURSE: Assembly and Maintenance of semi precision and precision machines
18. COURSE: Reliability Engineering and Industrial safety
19. COURSE: Metal forming Technology
20. COURSE: Quality control and Management and TQM and ISO 9000-2000
21. COURSE: Technology Management
22. COURSE: Entrepreneurship Development Program.
23. COURSE: Project Management trg program
24. COURSE: Gear cutting artisanal Programs
25. COURSE: Pattern Making Artisanal/Technician Programs
26. COURSE: Foundry working Artisanal/Technician Programs
27. COURSE: Metal Forging Artisanal/Technician Programs
28. COURSE: Heat Treatment Artisanal/Technician Programs
29. COURSE: Engineering Drawing & interpretation Artisanal/Technician Programs
- Management training programs
30. COURSE: Book keeping, Record keeping / Accounts
31. Personnel Management
32. Marketing Skills development
33. Costing/pricing of products
34. Entrepreneurship development
35. Business communications skill development
36. Negotiation skills development

37. COURSE: COMPREHENSIVE COURSE ON MACHINE TOOL TECHNOLOGY IN 3 MODULES

in 3 Modules		
Topics covered		
Module 1 (6 weeks)	Module 2 (6 weeks)	Module 3 (6 weeks)
Standards	C N C Machine tools	C N C Machine tools
Limits fits and tolerances	Cutting tools	Tooling
Drawing practice	Spindle design	Automation
2-D Drafting – AutoCAD	Machine Tool Slides	Cost analysis – Target cost
Engineering mechanics	Ball screws and L M Guide ways	Machine tool cladding
Materials and heat treatment	Feed motors and drives	Industrial design-Ergonomics, aesthetics
Design fundamentals	Spindle motors and drives	T Q M
Hand book study	Casting design and foundry practice	Manufacturing concepts
Machine tool elements	Hydraulic elements and circuits	Assembly concepts
Shafts and anti friction bearings	Electrical elements and circuits	F E M Analysis
Gearbox design	Pneumatics	Ansys
Spindle design	PLC, Feed back devices	Productivity
Primary machine tools	C N C Systems	Maintenance aspects
C N C Machine tools	Fixturing	Process capability
Cutting force considerations	3-D Modeling	H R Concepts
Basic Manufacturing & Assembly Practice	Vibration in Machine tools	Part Programming Concepts
Component inspection	Testing of Machine tools	Sales and Marketing
Project work - Sub assembly	Project work - Design of C N C	Managerial Skills
Drawings and component drawings	Unit heads / SPMs	Project Work

ANNEX -22

Kumasi Suame Industries

The Suame Magazine, who are a cluster of informal micro and small enterprise artisans who operate in the industrial slum of Kumasi, Ghana. The small, medium and micro-scale engineering enterprises (MSEs) of Suame play a major role in the servicing of vehicles and manufacture of small engineering, agricultural and industrial products which contribute directly to the economic livelihood of the people of Ghana and even elsewhere in West Africa. Infact, there is every indication that the Suame Magazine, Ghana's largest informal industrial area, is by all standards, one of the biggest clusters of MSEs in Africa.

Suame Magazine lies on the side and bottom of a hill to the east of the main road to the northern regions of Ghana, and to the west of a creek. The trapezoidal-shaped area is nearly 1.80 kilometres long with an average width of 320 metres. Within the last decade, the area has seen a steady development, expansion and springing up of concrete structures of workshops, stores, petrol stations and residential buildings which line the 1.8 kilometre stretch of road on the main Magazine area. Currently the perimeter of the *nucleus of the cluster* covers a distance of 7 km.

The Major Sectors and Products

Major Sectors	Product Group and Services
Manufacturing	Food processing machinery & equipment and farm implements, Improved cook stoves, commercial and domestic utensils, foundry products
Vehicle repair and maintenance	Engine overhauling, auto electrical works, vehicle interior upholstery, auto body straightening & spraying
Metal working	Metal fabrication and plant construction using sheet metals, angle irons, channel irons, bars etc.
Sale of engineering materials & accessories	Sheet metals, bars, iron rods, steel sections. Hand tools, fasteners, electric motors, pumps etc.
Sale of automobile spare-parts	Used engines and parts, car decorating materials etc
Communication and Business Centres	Telephone and facsimile services, photocopying, computer type setting, internet services, sale of mobile

	phone cards, video cassettes and barbering.
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On formal basis, there is rarely an enterprise in Suame Magazine that exports its products. This may be due to several reasons including the following: low financial base to support their export drive, low level of technological development; complicated licensing requirements for export; lack of export related information etc. While none of the enterprises exported its products, a surprisingly high proportion (26%) of the engineering enterprises had clients from outside Ghana (Dawson 1988). They usually purchase items such as bolts and nuts, bushes, shafts, corn-mill grinding plates, animal traps, locally manufactured guns and food processing equipment.

Day-to-day engineering services and manufactured products of the Suame Magazine are classified as below.

Table 2: Scope Of Engineering Activities Of The SMMES Of Suame

SERVICING Of Trucks, lorries, Cars, Tractors, Mummy- wagons etc.	MANUFACTURE Of Food processing Machinery, Equipment and implements	MANUFACTURE Of Improved cook stoves, Domestic and commercial utensils etc.	MANUFACTURE Of Commercial items, Foundry products, Electrical devices, etc.	SALE Of Tooling And Eng. materials
<ul style="list-style-type: none"> " Engine reborning and Relining " Crankshaft regrinding " Cylinder head repairs " Replacement of parts " Replacement of fasteners and screws " General overhauling " Auto electrical repairs " Auto body straightening 	<ul style="list-style-type: none"> " Palm Oil / Cassava Presses " Shea-butter Presses " Gari processing equipment " Hand Pumps " Corn-milling machines " Animal feed mixers/mills " Flour mixing machines " Dough Kneaders " Biomass dryers " Rice Hullers " Rice Threshers " Seed Planters " Palm Fruit 	<ul style="list-style-type: none"> " Sawdust Stoves " Ahebenso cook stoves " Charcoal-burning Stoves " Gas Stoves from scrap " Kerosene Stoves " Gas-fired Ovens " Meat /Fish Grills " Iodised Salt Dryers " Gari Roasters " Groundnut Roasters " Frying Pans " Cast Aluminium Pots (Dadesen) 	<ul style="list-style-type: none"> " Metal safes " Iron Gates " Gate Hinges " Watering Cans " Sieves " Head Pans " Bulk Petrol Tanks " Buckets " Shovels " Brass Bushes " Corn-mill Grinding Plates " Cast-iron Stone Grinders " Cast Blanks " Stabilisers " Welding Transformers " Compressors 	<ul style="list-style-type: none"> " Metal tool bits " Drill bits " Saw Blades " Milling Cutters " Punches " Grinding Stones " Studs " Belts " Hammers " Reduction Gear Boxes " Electric Motors

" Auto body spraying etc. " Auto body welding " Vehicle Interior Lining and upholstery " Vulcanising Etc.	Digesters " Palm Kernel Crackers " Hoes and Cutlasses " Shepherd Crooks Etc.	Etc.	Etc.	" Sheet Metals " Bars " Angle Irons " Gear Wheels etc.
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Technology Development and Transfer

A number of initiatives exist in Ghana to support technology development and transfer to the MSEs of Suame Magazine and the community at large. The Technology Consultancy Centre (TCC) of KNUST in Kumasi was established with the objective of acting as an interface between research undertaken at KNUST and the business community. The perceived need to accelerate technology transfer process and provide a more visible demonstration of basic engineering practices in the small, medium and micro-scale engineering environment led to the establishment of the Intermediate Technology Transfer Unit (ITTU) in Suame Magazine in 1980. The proliferation of small foundry businesses in Suame and elsewhere in Ghana has been largely due to the efforts of the Suame ITTU, which introduced the casting of corn mill plate and other ferrous and non-ferrous castings. Another important initiative is the GRATIS Foundation, which manages a network of ITTUs whose objective is to develop the capacity of urban and rural enterprises to design, manufacture and service machinery and equipment for agricultural and engineering development. The GRATIS Foundation has supported a few of the artisans of Suame Magazine to acquire certain machine tools and equipment, which will enable them to undertake certain specialised engineering operations.

Among various associations representing the area, the following are the ones of relevance to the AMIS Project:

- *Association of Micro and Small Metal Industries*

In the 1990s, the clients of Suame ITTU also came together to form the Association of Micro and Small Metal Industries (AMSMI) with the aim of addressing the problems of the metal manufacturing sub sector. *Currently, active membership of AMSMI is between 50 and 60 artisan entrepreneurs who are workshop owners engaged in welding and fabrication, metal machining, foundry business, sheet metal works, engine reboring etc. Members of AMSMI meet in the premises of Suame ITTU to deliberate on issues affecting their operations. In 1998, the Suame ITTU recommended 6 entrepreneurs of AMSMI to the GRATIS Foundation in Tema, for working capital loans and machine tool hire-purchase assistance to expand their*

businesses. The association is affiliated to the Association of Small-Scale Industries (ASSI) and the National Board for Small-Scale Industries (NBSSI). A chairman who is assisted by a vice-chairman and a secretary heads it. The association is working in collaboration with the TCC and the GRATIS Foundation to establish a nation-wide network of AMSMI so as to have a common voice on issues concerning small engineering manufacturing in Ghana.

- *Magazine Spare-Parts Dealers Association*

The Magazine Spare-Parts Dealers Association is composed of middle-class business people who deal in imported spare parts and accessories for automobile repair and service. By virtue of their business, the spare-parts dealers tend to use communication facilities like telephones, fax machines, pagers, more than the vehicle repairers and the other artisans, to communicate with their local and international business partners on imported goods to be received or money to be transferred and other transactions. In shops where there are no communication devices, people use the services of Communication Centres in and around the Magazine to enhance their businesses.

Problems facing the mses of suame

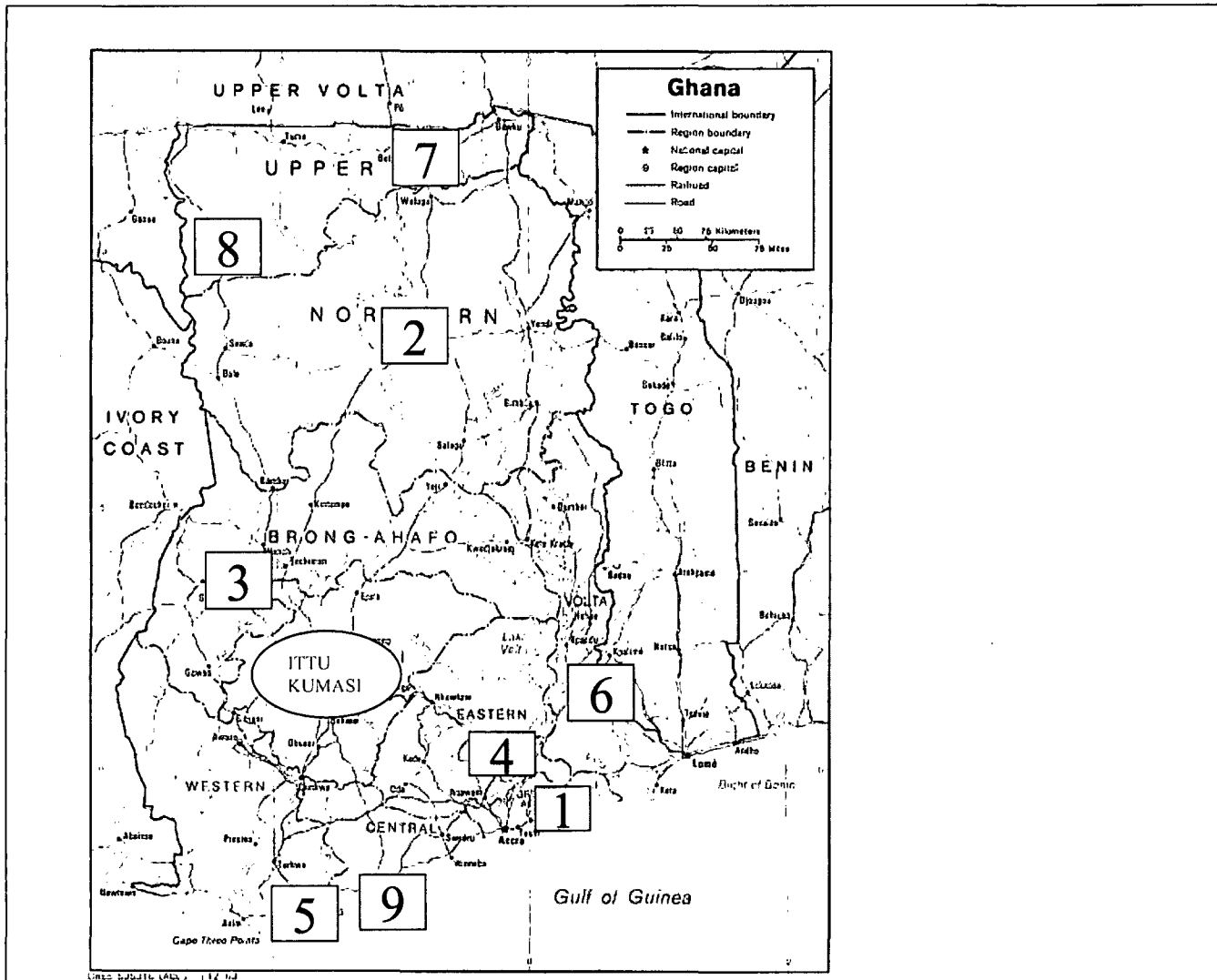
Being a cluster of grassroots engineering enterprises, the MSEs of Suame Magazine have their own problems. They have gone through a series of socio-economic metamorphoses which though, very interesting, have however, received little attention, despite the obvious economic importance. Studies on Suame Magazine carried out in 1971 and 1984 by the Department of Housing & Planning Research (DHPR) of the Kwame Nkrumah University of Science & Technology, indicated some constraints, a few being that: Only 29% of the workshops were connected to electricity supply; a greater number of the artisans lacked management, organisational and enterprise promotion techniques; in comparison with large industries, the artisan entrepreneurs were charging far too low for labour, and could not therefore break-even over a long period of operations. In the final report, Ernst & Young (1997), a 1993 study undertaken for the World Bank, revealed some generic constraints, which cover a range of business-related and other non-technical issues. Some constraints facing the manufacturing enterprises were identified as follows: Lack of capital, risk of non-payment of credits and loans, lack of entrepreneurial and managerial skills in running a business, lack of technical know-how and inefficient technologies, complex legal and regulatory environment that requires MSEs to comply with the same legal standards as large multinationals employing more people and having adequate and skilled human resources to deal with regulatory burdens, inadequate physical infrastructure e.g. electricity, telecommunication, roads, efficient transportation system etc., no business support services, government restrictions, lack of access to Information and Communication Technology etc.

The market for the goods and services being offered by the Suame MSEs fluctuates between excitement and fear. This is so because, the current liberalised economy has seen a lot of cheap imported goods flooding the Ghanaian market. Now, the perception of low-grade technologies from the cluster is contributing to gradually stifle their efforts. Repair of modern saloon cars and cross-country vehicles as well as the trading in automobile spare parts, engineering materials such as thick gauge steels, pipes and sections, tools and other accessories have seen more prospects, over the years, than the manufacture of small machines and plants for food and chemical processing. Over the years, the products manufactured in Suame have not met the acceptable quality levels (AQLs) required to influence both foreign and home markets. Lack of modern engineering technologies for the design and production of jigs and fixtures; and the high cost of production have contributed to a wide variability of machined and cast parts. Castings from the foundries of the Suame MSEs usually have blowholes and surface cracks, which affect their marketability. In the foundry business, high cost of imported inputs such as graphite crucibles for use in lift-out furnaces and coke used as energy source in cupola furnaces increases production cost for local castings which affect their market prospect. Of equally great concern is the problem of the unavailability of quality engineering materials required for the production of quality-finished goods. Most metal manufacturers in Suame depend on metal scraps that are already defective in quality. The use of heavy hand tools like sledgehammers, mallets, fly presses to correct the defects and deformities of component parts affects the final finish of the products. All the same, those who are able to upgrade their skills and machinery and additionally control the quality of their products, to some extent, get worthy return on their investment. If essential support structures, the needed engineering facilities and training programmes on quality management and control of production are put in place, the goods and services from Suame could have a steadily increasing share of the Economic Community of West Africa States (ECOWAS) market.

CONCLUSION

The small, medium and micro-scale engineering enterprises of Suame have been playing a major role in the servicing of vehicles and manufacture of small engineering, agricultural and industrial products which contribute directly to the economic livelihood of the people of Ghana and elsewhere in West Africa. In contrast to the formal sector technologies that are regarded as advanced, the technologies from the informal sector MSEs are perceived by many a Ghanaian as low and inferior. This observation appears to be contradictory to the positive role and contribution, which clusters like Suame Magazine are making to the socio-economic development of the country. It must be emphasised that, without this sector, Ghana will continually depend on importation of items, which require very low and simple technologies to produce. In spite of the significant contributions, the social and productive potential of the enterprises of Suame are being disregarded and not considered in national develop policies. As a result, the enterprises are being constrained by the lack of appropriate government policies and financial institutions support that will create the enabling environment to enhance

productivity and growth. In the past two decades when there was great shortage of spare parts and equipment on the Ghanaian market, consumers had to buy whatever was offered to them. But now, a wide range of choice is available on the market. This, however, poses a great challenge to the enterprises of Suame, in terms of the quality of the products, their utility and the selling prices. The cost of skills training, technologies and facilities that are required to produce quality goods and services that can be offered to foreign markets transcends the capabilities of most of the enterprises. This level can, however, be attained if the key players (government, research and financial institutions, NGOs etc.) contribute immensely in assisting the enterprises to continuously upgrade their technologies by having access to relevant information technologies (ITs), low interest credits as well as the availability of quality engineering materials for quality finished products. In other words, if the appropriate growth poles are put in place, the potential and the dynamism of the MSEs of Suame will be greatly felt in the economy of Ghana.



ANNEXURE -23 DISTRIBUTION OF RTTCs under GRATIS IN 9 REGIONS of GHANA

SINo	REGION	LOCATION
1	Greater Accra	Tema, Heavy Industrial Area
2	Northern Region	Tamale, Industrial area, Lamashegu
3	Brong Ahafo	Sunyani, Premises of Sunyani Polytechnic
4	Eastern	Koforidua, Near Jackson Park
5	Western	Takoradi, Secondi-Takoradi Beach Road
6	Volta	Ho, Near Regional Police Head Quarters
7	Upper East	Bolgatanga, Near Ghana National Fire serv
8	Upper West	Wa, Tumu Road, Opposite Cotton Ginnery
9	Central	Cape Coast, Near Ameen Sangari

ANNEX -24
COMPARISON OF CASSAVA CROP VARIETIES GROWN IN
VOLTA AND THE CENTRAL



**Picture showing the very big size
cassava tuber variety grown in Volta**



**Above shows the considerably
smaller size of Cassava variety
grown in Central Region,
Kwakrobi village farm in Awutu
Efutu, Agona Swedru
13 Nov 2003**