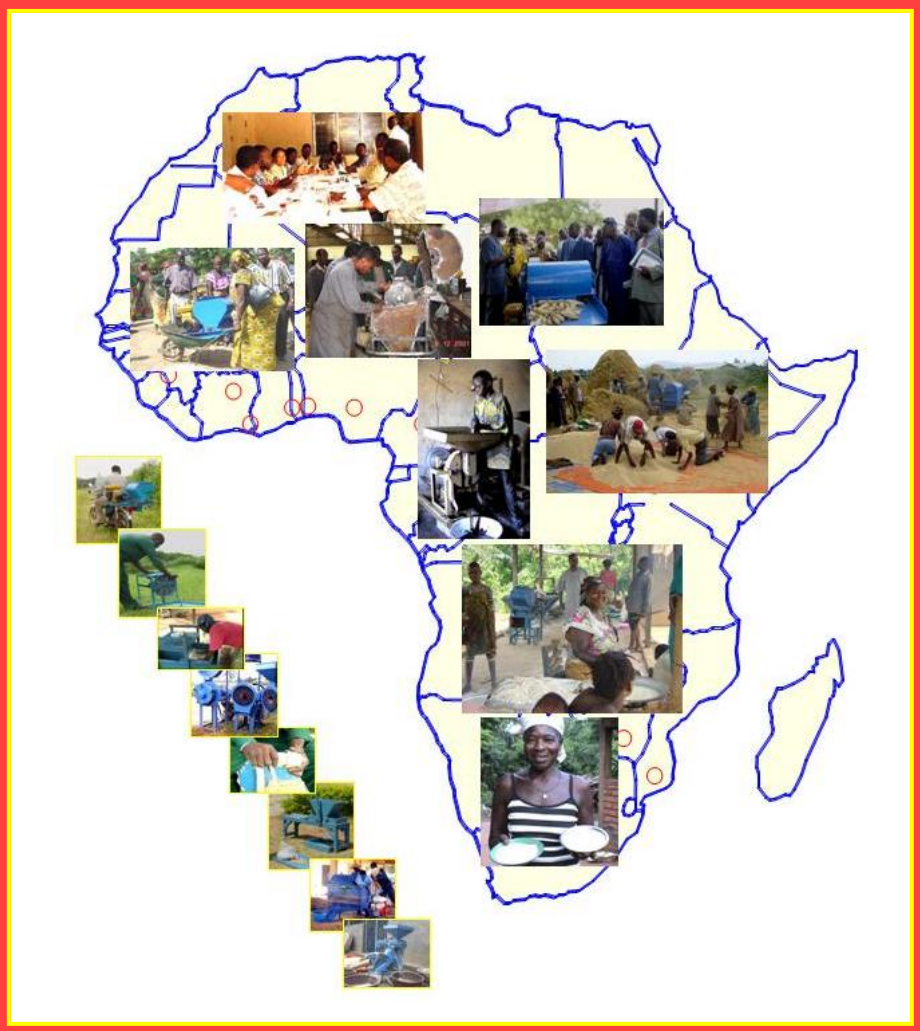
Improving Postharvest Systems -
Promoting Agro-Industrial Development in Africa

Leonides Halos-Kim & Toshiro Mado
Sasakawa Africa Association (SAA)



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An account of a decade of research, development and extension on improving crop postharvest systems in sub-Saharan Africa under the auspices of the Agro-processing Project of the Sasakawa Africa Association (SAA), Tokyo, Japan, in collaboration with the International Institute of Tropical Agriculture (IITA), Nigeria and the governments of Ghana, République du Benin and Ethiopia.

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The cover~

A collage of activities and impact of the SAA-AP program on introduction of improved postharvest technologies in sub-Saharan Africa

Improving Postharvest Systems -
Promoting Agro-industrial Development in Africa

An Account of the SAA Agro-processing Program (1994 – 2004)

by: Leonides Halos-Kim & Toshiro Mado[1]

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The Project Management and Technical Staff

(1994 – 2004)

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FOREWORD

This report documents an exciting story—of rural livelihoods improvement, inter-institutional collaboration, and effective public-private-farmer partnerships in agro-industrial development in Africa.

It begins in West Africa at the International Institute of Tropical Agriculture (IITA) and the pioneering Postharvest Engineering Unit originally headed by Dr. Yong Woon Jeon, an Agricultural Engineer and Rural Sociologist, who began to develop small-scale agricultural machinery in Southeast Asia during the 1970s and 1980s, largely related to rice harvesting and processing. While at the International Rice Research Institute (IRRI) in the Philippines, Dr. Jeon developed a range of equipment appropriate for the rural areas of developing countries. One of his research associates in IRRI, a Filipino Agricultural Engineer, was Miss Leoni Halos (later Mrs. Leoni Halos-Kim). When Dr. Jeon moved to IITA in the late 1980s he continued to develop postharvest machineries and in 1991 he invited Miss Halos to help him.

Together they set up IITA's Postharvest Engineering Unit, which combined equipment design, prototype manufacture, and training of local equipment fabricators and rural technology operators. Their first challenge was to develop improved technology for the production of fermented flour from cassava, called *gari*, a staple food in Nigeria and much of West Africa. Traditional *gari* processing was labor intensive, arduous, damaging to the health of the processors, and not very profitable. Jeon and Halos studied every step of gari production process, and then began to develop small-scale machinery—hand and motor powered—to improve on traditional processes. They were very successful.

The second part of the story began in Ghana in 1988, where a former Japanese overseas volunteer, Toshiro Mado, had been assigned to work with the December 31st women's movement to help improve the profitability of various agro-processing enterprises. *Gari* processing was one of the specific activities of various women's groups in this movement. Relatively large scale equipment was provided, but Mado felt that more locally adapted technology was needed. After returning from a postgraduate training in 1992, Mado resumed his interest in postharvest technology. His research led him to IITA in 1993, where he was introduced to Jeon and Halos-Kim, and the work of the Postharvest Engineering Unit. Their encounter proved to be an excellent match, and a partnership soon emerged.

IITA, primarily a research and development organization, was searching for an NGO partner, to help in the technology diffusion process. In 1994, SAA and IITA established a collaborative agro-processing project. The first phase would run for

five years. In it IITA would focus on technology generation, and technical backstopping for equipment fabricator training and SAA would focus on working with farmers groups—largely made up of women—who would use the IITA technology and equipment to develop agro-processing micro enterprises.

This report provides a comprehensive accounting of the evolution of the SAA-IITA agro-processing project. It describes partnerships with local organizations, primarily in Ghana and Benin that have made the project so successful. It surveys the range of equipment and technology that was introduced to farmers and it looks at the impact that this technology has had on the lives of farmers that have adopted it. Finally, it documents the development of local manufacturers and manufacturing networks that have been so instrumental in the diffusion process.

When the SAA-IITA agro-processing project began, relatively few organizations were engaged in the development of appropriate technology and local manufacturing capacity. Today, there is a growing consensus that value-adding enterprises like those described in this report are critical to poverty reduction in Africa and to agriculture-led industrial development. This project has been one that has helped to lead the way, with a growing set of activities in a half dozen more African countries.

I salute the many individuals who have contributed to this pioneering partnership—from IITA, SAA, national ministries of agriculture, especially in Ghana and Benin, other NGOs, farmers associations, and local equipment fabricators. I am proud to have played a small part in its establishment and evolution.

The information reported here will serve as an invaluable contribution to the development of small-scale agro-industrial development in Africa.

Christopher Dowswell
Director of Communications
Sasakawa Africa Association

ACKNOWLEDGEMENTS

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Members of the Manufacturers' Networks of Ghana and Benin;

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Development Partners from Non-Governmental Organizations (NGOs);
Other Community Development Agencies (CDAs);

The Staff of the SG2000 Africa Program;

The Management and Staff of IITA, Nigeria particularly the Postharvest Engineering Unit;

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and

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Leonides Halos-Kim & Toshiro Mado

ACRONYMS AND ABBREVIATIONS

AEATRI	*Agricultural Engineering Appropriate Technology Research Institute (Uganda)*
AESD	*Agricultural Engineering Services Department (MOFA, Ghana)*
AGECO	*Afro General Engineers & Contractors (Uganda)*
AGRO-ALFA	*Agricultural Tools & Equipment Rural Assistance Metal Works (Mozambique)*
APROMAH	*Association pour la Promotion des Materiels Agro-Alimentaires ét Hydrauliques (Benin)*
C.F.T.S.	*Centre de Formation Technique Mgr. Steinmetz (Benin)*
C.N.E.A.	*Centre National d'Equipment Agricole (Burkina Faso)*
CAMEMEC	*Construction-Ajustage-Menuiserie Métallique et Cloutérie (Benin)*
CARDER	*Centre d'Action Régionale pour le Développement Rural (Benin)*
CDA	*Community Development Agency*
CEFACOM	*Centre de Formation de Formation de Fabrication et d'Ajustage en Construction Metallique (Benin)*
COBEMAG	*Coopérative Béninoise de Matériel Agricole (Benin)*
DiFOV	*Direction de la Formation Opérationelle et de la Vulgarisation (Benin)*
EARO	*Ethiopian Agricultural Research Organization*
ENTESEL	*Engineering and Technical Services Ltd. (Ghana)*
Ets - AFM	*Atelier de Soudure-Fabrication Métallique (Benin)*
F.M.T.A.-Benin	*Réseau des Fabricants de Materiels de Transformation des Produits Agricoles, Réseau F.M.T.A.-Benin*
FAMEZIO	*Fabrication Metallique de Zio (Togo)*
GRATIS	*Ghana Regional Appropriate Technology Services*
I.M.A.F.	*Industrie Mali Flexible*
IITA	*International Institute of Tropical Agriculture*
IRCOD	*L'Institut Régional de Coopération –Développement*
MOFA	*Ministry of Fisheries and Agriculture (Ghana)*
N.V.T.I.	*Nakawa Vocational Training Institute (Uganda)*

NARS	*National Agricultural Research System*
NRC	*National Research Center (Agricultural Mechanization Research Division, Uganda)*
R.T.S.C.	*Rural Technology Service Center (GRATIS Foundation, Ghana)*
R & D	*Research and Development*
SAA	*Sasakawa Africa Association*
SAA-AP	*SAA Agro-processing Program*
SG2000	*Sasakawa Global 2000*
SOMATA	*Societe de Machinisme Agricole et de Technology Appropriée (Guinea)*
STVC	*Selam Technical and Vocational Center (Ethiopia)*
WIAD	*Women in Agriculture (MOFA, Ghana)*

CONTENTS

SECTION 1-

CHALLENGES FOR DEVELOPING AGRO-INDUSTRY IN AFRICA

The economies of most developing countries as in sub-Saharan Africa depend on agriculture. However, agricultural development seems to stagnate that agriculture alone is not able to support a reliable livelihood; neither secure the food requirements of the increasing number of farming families.

Despite the introduction of yield-increasing technologies in sub-Saharan Africa during the last 3 decades, subsistence agricultural production generally prevails, and processing at the family level dominates. Most farmers and agro-processors still use primitive tools and techniques. One of the constraints is the inability of the farmers and processors to invest on machinery, in combination with land and labor input that facilitates farming and postharvest operations.

A majority of the farmers cultivates small fragmented farms, which discourages investments on machinery. Increasing land area and land-use efficiency to increase productivity is often hindered by poor soil characteristics and the lack of tools to cultivate them. Manual labor input, usually by farm family members, is required but inadequate. To compensate for this labor shortage, there is a growing need to introduce labor- and drudgery-saving agricultural technologies.

Although some marked increases in production volumes were recorded in recent years because of the adoption of improved varieties and growing techniques, the payoff after harvest is still insignificant. This is because of costly losses, high labor requirements, inappropriate facilities and poor product quality resulting in poor harvesting and handling systems. The problems are aggravated by the fact that forces of supply and demand for these crops affect the marketable produce and the forms of products available for marketing or consumption. Without the proper infrastructure to process the crops in time, the production gains have less economic benefits.

Providing appropriate tools and equipment for production and post-production (postharvest) systems can result in better appreciation and sustained adoption of yield-increasing technologies. A challenge posed to research and development institutions is to develop machinery for production and post-production activities that requires minimum investment so that it can be built and purchased locally by individuals or small groups. Machinery development and production should involve different stakeholders linked to deliver the needed hardware to the farmers and agro-processors.

Improving the postharvest system will stimulate crop production because it facilitates processing and marketing of the produce. It also creates opportunities for developing agro-processing enterprises for the production of value-added products to enhance their competitiveness in the market. Agro-processing opens up venues that generate employment for the rural populace especially the women who provide approximately 60 per cent of the labor force in small-scale crop and food processing enterprise in sub-Saharan Africa.

The overall potential of agro-processing to transform agriculture to a profitable business is huge. It can reduce wastage, enhance food security, improve livelihoods for low-income groups, and empower women. Agro-processing is the key to greater commercialization of agriculture in sub-Saharan Africa. However, starting and developing agro-processing enterprise in Africa is constrained by uncertainty that exists over access to finance, advice and information, and reliable markets.

Developing the agro-processing enterprise involves multiple partners from development institutions, the agricultural and industrial sectors. However, these sectors are still weakly linked as seen by the gap of information and technology flow among farmers, processors, technology designers and manufacturers.

Many metal workshops are located in the urban areas undertaking mainly repair of machine parts, with only a few fabricating agricultural equipment. There is little information available to the manufacturers on the viability and profit-making potential of agricultural equipment. Agricultural equipment introduced earlier is often very expensive, complicated and difficult to replicate. Added to this is the lack of spare parts which limits their servicing capacity.

On the other hand, farmers and processors are in the rural areas, do not have access to the agro-metal manufacturers and do not know what kind of technologies and equipment are available. These farmers/processors have limited capacity and access to market and market information. This gap between the farmers and agro-metal manufacturers obstructs the integrated business development interests of both parties.

Various development organizations had little success bridging the gap between agriculture and industrial sectors. Government policies that support this linkage are not well understood, if existent. Extension work to fill the gap between agriculture and industry is therefore urgently needed.

SECTION 2-

THE SAA-AGRO-PROCESSING PROJECT

1- Formation and Organization

The Sasakawa Africa Association (SAA) based in Tokyo, Japan has been supporting programs aimed at combating malnutrition and poverty in Africa through programs that enhances production and increases income. One of the development areas identified by SAA is transforming agriculture into a profitable venture. SAA recognizes the challenges to the rural entrepreneurs to invest in this area as they are constrained by access to finance, information, and reliable markets.

SAA's approach is to improve the techniques the small farmers use to produce foods and then help them organize to get credit, acquire inputs and market their harvest more profitably. Following its successes in disseminating production-enhancing technologies through its SG2000 (Sasakawa-Global 2000) partnership' programs, SAA now looks at ways that will improve postharvest handling and processing of the farmers' crops in order to realize the grains brought about by improved production techniques. Improving this section of the production/postproduction chain will increase income and improve access to food in the rural communities of sub-Saharan Africa.

In 2003, SAA launched the Agro-processing Project (SAA-AP) to develop techniques and management skills to establish small-scale, appropriate and sustainable processing enterprises that are easily manageable and requiring little capital investment using simple equipment. For this purpose, SAA teamed up with the International Institute of Tropical Agriculture (IITA), Nigeria in 1994. IITA has been developing small-scale postharvest technologies to process most of the food crops in sub-Saharan Africa in order to reduce postharvest losses, reduce the drudgery of traditional processing done mostly by women, and expand the utilization potential of crops.

The SAA-IITA Postharvest Development Project was initially implemented in Ghana and République du Benin (referred as Benin in the succeeding sections). At the same time, SAA-AP is also investigating the opportunities for assisting agro-processing tasks in other SG2000 country programs including Ethiopia, Guinea, Uganda, Mali, Mozambique and Nigeria.

2- Project Objectives

The ultimate goal of the SAA-AP project is to increase the income and improve the well-being of rural

farmers and agro-processors, especially women who provide about 80 per cent of the labor required in crop and food processing. It aims to improve the postharvest handling and processing of the agricultural crops in order to reduce crop and food losses, eliminate the drudgery of traditional processing, add value to the products, and create income-generating activities for the rural populace.

The project concentrates on improving, adapting and introducing techniques and equipment appropriate for developing small-scale agro-business within the production areas reducing costs to both the producers and consumers, and on developing a support system to sustain the business.

In order to attain this goal, the project has the following specific objectives:

1. **I**dentify, develop and adopt crop harvest and postharvest technologies at the household and village levels;
2. **D**isseminate technologies with proven technical and socioeconomic impact;
3. **E**stablish model crop and food processing demonstration centers for the implementation of an integrated food production and utilization methods;
4. **A**ssess the technical, social and economic factors and consequences to technology generation and transfer;
5. **S**trengthen the institutional capacity of users and extension officers in the use and management of improved technologies through trainings and demonstrations in order to establish a support mechanism to manage and sustain the technologies.

The project not only aims to provide immediate benefit to the clients in the countries where they operate but also validate the approaches so that they could be replicated in other countries.

3- Project Funding

The Nippon Foundation, an independent non-profit grant organization based in Japan, is funding the project as part of its support to the SG2000 programmes in 12 African countries. The fund is to help small-scale farmers to produce more by introducing modern farming techniques, providing access to inputs and using existing local technologies more effectively.

Funding allocation for agro-processing project is provided each country (Benin, Ghana and Ethiopia) for administration and implementation of their respective programs. The funds pay for the salaries of local support staff, project coordination and monitoring.

A special project fund of $100,000 annually was paid out to IITA from 1994 to 2004 to enable IITA carry out adaptive postharvest researches and provide technical support to the

project. Part of the fund supported an International Staff position that provided the technical backstopping to the project.

An administrative fund is allocated for the management, coordination and monitoring of the project in all country programs and IITA. The coordinating staff was based in Ghana until 2003 when it has relocated to Ethiopia to facilitate project support to other SG2000 country programs.

On the average, the annual operational and management budget provided by the Nippon Foundation amounts to USD348,000. IITA shared additional funds-in-kind (such as salaries of support staff, use of vehicles, other facilities) equivalent to approximately 17 to 30% of the total annual project fund. IITA's contributions sustain its research and development objective of improving the postharvest systems that supports the technical requirements of the SAA-AP project.

Funding allocations to Ghana and Benin République has been reduced by the end of 2004 and re-structured to fund new country projects such as Ethiopia. In April 2004, funding to IITA was also stopped to increase support to collaborating national research teams to allow adaptations of selected technologies for continuing technology development, and fund project monitoring and impact assessment activities.

Over the years, the funds committed to the agro-processing project has been maintained despite the dwindling resources because of the urgency in improving postharvest handing and processing of agricultural produce in the region to secure food supply and increase income of the farmers and processors.

4- The Country Projects

The agro-processing project initially selected Benin and Ghana in West Africa where SG2000 project has been active in the last decade. The country projects were also selected because of their comparative advantage of having diverse agricultural production systems allowing technological adaptations for various environments which can easily be replicated in other countries.

The production and processing systems of food crops, and the potential for marketing value-added products were among the criteria for site selection. Other factors were availability of labor and raw materials, and access to major roads and markets.

In Benin, the project operated from the SG2000 project in Cotonou. In Ghana, the project operated from the Ministry of Agriculture in Ghana. In 2002, the project started its operations in East Africa operating from the Ministry of Agriculture, Addis Ababa.

A Project Logframe (Annex 1) was prepared in 2000 as a tool for project staff in monitoring the project activities and impact. The logframe served as a guide to improve organization and to focus the activities to attain the project objectives.

•Benin

Benin lies along the borders of Togo, Burkina Faso, Niger, and Nigeria in West Africa. More than half of its population depends mainly on agriculture and trade with the Sahelian countries, and Nigeria for their livelihood. Agriculture accounts for 38% of the gross domestic product.

Agricultural intensification varies distinctly from south to the north, as agricultural production depends on rainfall. The rainfall conditions in the South allow two cropping seasons per year. In the north, there is only one rainy season per year and has greater chances of drought which limits agricultural intensification. Maize, cassava, and yams are the most important food crops. Cotton is the principal export crop.

In 1993, the Benin Ministry of Rural Development identified five principal objectives for agricultural development: 1) to improve food security, 2) to increase rural incomes, 3) to enhance the contribution of agriculture to the balance of payments, 4) to consolidate the natural resource base of agriculture, and 5) to increase the efficiency of the government.

Various strategies are in place to implement the agricultural programs consistent with other national development policies of the government. For example, to achieve greater food security, the government works to improve the marketing of domestic staple foods and to identify options for regional trade, for example with the Sahelian countries.

Increasing rural income is a priority agenda of the government of Benin which has influenced its research policy. Benin is one of the few countries supporting research and development on postharvest and marketing of food crops. It is trying to identify enterprises with potential income improvements and encourages farmers to intensify their production systems for value-added products.

The SAA-AP project is helping the government of Benin achieve its goals of increasing income of the farmers and other entrepreneurs and attaining food security. Working hand and hand with its local partners, SAA-AP is able to reach clients even in remote areas, identified and trained metal manufacturers to make postharvest equipment available to entrepreneurs, and create a supportive environment for sustainable rural enterprises.

The work of agro-processing program in the next decade is crucial to the sustainability of the technologies and the small-scale entrepreneurs in Benin.

•Ghana

Agriculture is a major occupation in Ghana, as in other developing countries, and the population is directly, or indirectly affected by policy interventions in the agricultural sector. The primary responsibility for food security lies with the national authorities. The Government of Ghana has a non-traditional, export-led growth strategy propelled by the private sector.

Many policies support export more than domestic agriculture. For example, the policy of 1970 was to encourage large-scale commercial farming with mechanized systems. Several types of tractors were imported to support increased agricultural production; spare parts became a big problem. This policy failed to take into account the interest of the majority of farmers cultivating small farmlands. The government had little success introducing large-scale mechanization. The government then changed policy with emphasis on developing appropriate technologies instead of importing.

In support to the policy of developing commercial farming, the SAA-AP program, in 1994, teamed up with the Ministry of Food and Agriculture (MoFA) through the Women in Agricultural Development (WIAD), and the Agricultural Engineering Services Division (AESD) to identify and promote appropriate agro-processing technologies to the rural women and processors.

Among the first collaborative work is to review the policies on importation of agricultural machineries and identifying potential local manufacturers to be trained to supply identified technologies locally. Until 2003, SAA-AP program in Ghana disseminated various packages of technologies that allow value-added processing of food crops both for domestic and export markets. In 2004, the project activities concentrated on strengthening the manufacturing sector. GRATIS Foundation provided project coordination focusing on training of trainers, re-training of technicians, monitoring and servicing the agro-processing equipment used by processors, and strengthening product quality control and promotional activities.

The SAA-AP program trusts the government of Ghana will take over this initiative from the project from 2005.

•Ethiopia

Ethiopia is an agricultural country with 85% of the population dependent on agriculture for food and livelihood. With the assistance of the extension program of the Sasakawa Global 2000 (SG2000)

working in parallel with appropriate government agencies, production of food crops in the potential areas is increasing steadily.

The increasing production volumes made farmers more aware of the postharvest problems and demand for improved postharvest techniques is increasing. The SAA agro-processing program is addressing this issue. Since 2002, the program identified problem areas on teff and maize processing, storage and marketing. The program adopted some postharvest equipment such as the multi-crop thresher and wet-type grinder, which were introduced in Ghana and Benin République. The program also identified agro-metal manufacturers who are trained on manufacturing and servicing of the equipment. To increase awareness on the technologies, it had also been conducting field demonstrations for farmers, processors, manufacturers and policy-makers.

The agro-processing activities in Ethiopia are being conducted in collaboration with the Ministry of Agriculture, Ethiopian Agricultural Research Organization (EARO) through its Extension Department, and the national NGOs such as Selam Technical and Vocational Center (STVC). The project is being housed by the Ministry while STVC is providing a mechanical workshop and technical support to the project.

The continuing work of the agro-processing project in Ethiopia, and other SG2000 countries is being planned carefully and needs good support and monitoring.

The project continues to be implemented beyond 10 years, and beyond Ghana and Benin. Many more African countries, as shown by the dots in the map (Figure 1), are participating and benefiting. Project activities in these countries are replicated and implemented by the National Programs with technical backstopping from the SAA-AP project staff.

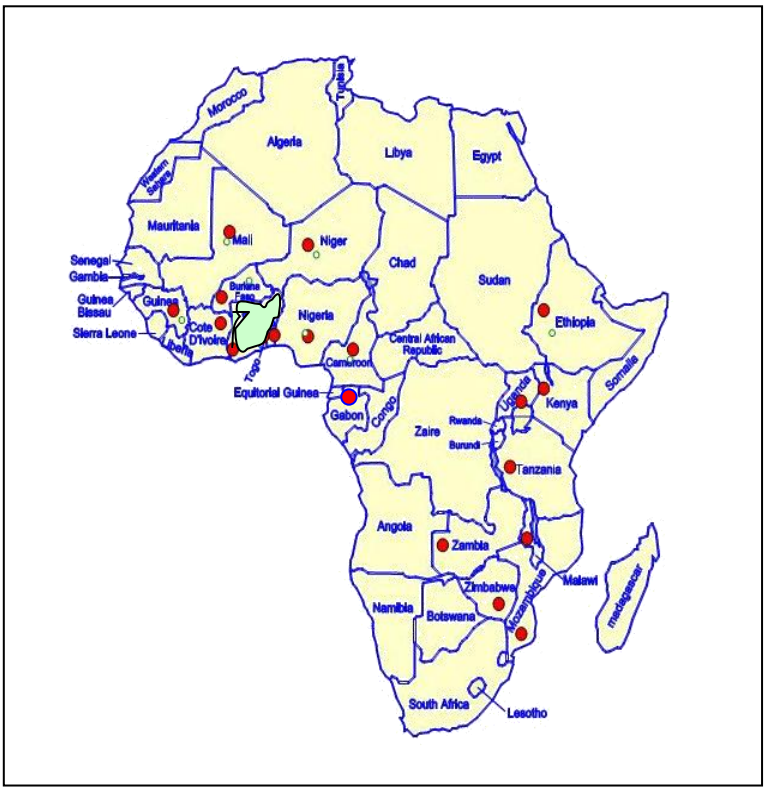

Fig. 1 - The SAA-AP project started in 1994 in Benin and Ghana. The adoption of improved agro-processing technologies is spreading throughout sub-Saharan Africa as shown by the red dots in the map

SECTION 3 -

IMPLEMENTING STRATEGY AND COLLABORATION

1- Implementing Strategy

The SAA-AP project is being implemented using holistic development approach described in Figure 2. It recognizes the postharvest system as part of a more complicated Community System. It assumes that the farmers and agro-processors within the Community System are able to internalize and solve their problems but needs some external assistance from the Resource System to verify their solutions, seek more and effective options and apply them.

The project's role within the Resource System is to provide solution to specific concerns on postharvest and agro-processing. It also links the community system to Remote Resources and involves as many stakeholders as possible to facilitate program implementation. The participatory development strategy has contributed to the full understanding of constraints and opportunities for improving the system. The model is a cyclic and dynamic process which enables all stakeholders to assimilate information, formulate, evaluate and adopt solutions for continuing developmental concerns.

2- Technology Development and Adaptation

Technology development and adaptation is a lead role by IITA. IITA advises the project staff on availability and suitability of agro-processing equipment sought for. IITA develops and adapts new technologies when available technologies are not appropriate for the target client. IITA works closely with the national counterparts on technology selection and evaluation. It relies on users' feedback on the adequacy and efficiency of the

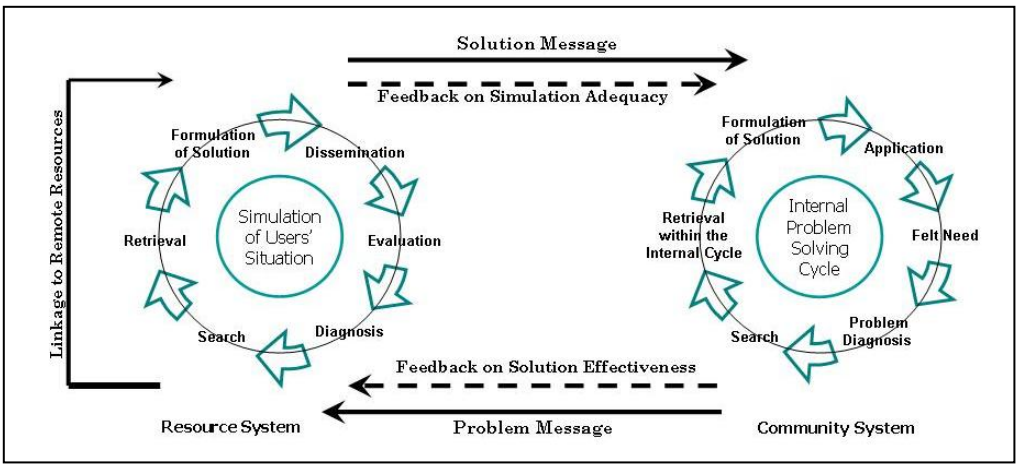

Fig. 2 - Model for the development and introduction of improved agro-processing technologies (Jeon & Halos-Kim, 1991)

technologies.

Because the bulk of the post-production activities are performed by women, small-scale crop and food processing technologies are vitally needed to help women, to at least cope with family food-processing requirements. However, the development of technologies should focus on food products that are sufficiently available and for which competitive markets exist so that families can both satisfy their own needs and increase their incomes. To accomplish this, the development approach needs to incorporate the mechanization aspect of the operation. This, however, is a short-sighted strategy if it overlooks the other factors in the system such as the economic capability of farmers and agro-processors and the nature of the farming system. These are the bases of the development goals shared by IITA and SAA Agro-processing project.

Analysis of constraints associated with postharvest operations, suggests that the introduction of appropriate tools and equipment, system arrangement[1], and investments in training of farmers and agro-processors could overcome the problems. Any technological innovation however should be enhanced with the farmers' traditional knowledge to ensure effective technology transfer. Farmers are likely to innovate and adopt readily if given the proper incentives. Adaptation of potential existing technologies will enhance their effectiveness and encourage users to invest in them. If this option is not existing, new improved technologies are selected and adapted as local conditions require.

3- Manufacturing and Servicing of Technologies

Micro- and small- scale manufacturing enterprises play an important role in the project. Their commercial activities give farmers and agro-processors access to industrial products and services when and where they are needed. As many of the technologies require local manufacturing and supply, the clients look to this informal sector for their livelihood opportunities.

Many small metal workshops and repair shops found in Africa operate in an informal, unregulated sector usually employing less than 10 informally trained technicians. They are vulnerable to rapid technological and market changes, but are less positioned to benefit since they have very little market power and may not have ready access to information, knowledge and skills required to identify and exploit new opportunities.

Some of the manufacturing enterprises are tied to regional,

[1] *Arrangement of component operations so that process and material flow are most efficiently handled with the least movement, therefore avoiding losses (due to spillage, etc.) and unnecessary delay.*

national and even international markets, and part of the supply chain. The expansion of global markets (globalization) may therefore create the potential for this sector and those dependent on them to benefit from any technological changes.

The SAA-AP project concentrates on improving techniques and equipment, but just as importantly, the information, knowledge and skills associated to their supply and adoption. The capacity to organize these effectively is a major activity of the project to help the small-scale manufacturers. The project assists collaborating manufacturers to:

Improve product design and production techniques

The project helps collaborating manufacturers in identifying technologies with promising market opportunities then training them on selected options. Training collaborating manufacturers helped them find ways to produce better quality goods with more added-value for the markets identified. In addition, it creates information services which can supply knowledge and understanding of new technology options and markets;

Increase their influence on markets and on relevant policies

The project assists manufacturers by building their capacity to organize and represent themselves in government programs. The project organizes the collaborating manufacturers and sensitizes them on the importance of their role in developing agro-processing enterprises particularly in the rural areas. Sources of raw materials for fabrication, and market outlets of products are constrained by lack of regulations in the delivery chain. The recognition of the manufacturers' network in each country will facilitate the formulation of appropriate policies to support the growth of local manufacturing;

Improve access to appropriate and affordable goods

The project provides multilateral linkages which sensitize partners on sources of information and technologies and identify market opportunities. Through networking, the manufacturers are able to recognize their individual strengths and compliment each other by sharing information and their resources;

Disseminate appropriate technologies across a wider scale

This includes supporting manufacturers of tools and equipment with information or technical assistance that can help them reach low-income markets. Technicians are trained to enable them provide the necessary skills to operate, demonstrate and service the machines. The project activities also provide information to target users on access to technologies creating direct linkage to manufacturers.

4- Training and Technology Transfer Activities

The method of introducing the technologies to the ultimate users is of vital importance, if adoption is to succeed, owing to the complex nature of the socio-cultural environment where the technology is to fit. The project designed and implemented training courses to enable the development partners to carry out the task of bringing the technologies to end-users effectively. The project also organized and conducted field demonstrations, and established model processing centers to improve the awareness and understanding of end-users on the availability and accessibility of technologies. The team also meets regularly to have a dynamic update on project activities and concerns, and to learn from each other on improve technologies, and new approaches to improve technology transfer.

• The Training Programs

Training is an important component of the project. Technologies, particularly machines, equipment and processes, require a special training for researcher, field technicians, local artisans and farmers/agro-processors. Training programs are designed and provided to development and extension workers as well as the end-users to enable them manage the project and sustain the adoption of the technologies. Different types of training are given for various groups of beneficiaries.

- Training on Design, Development and Management of Technologies

This training is given to partners who are responsible for demonstrating the technologies and in training operators and end-users. They are also expected to oversee the sustainability of the technologies in the transition from a project-base to a processor- or farmer-managed system.

The training is designed to impart understanding of strategies for generation and transfer of technologies, their design features and management requirements. It also provides trainees the necessary skill to operate the technologies. The training is an intensive specialized course which could last up to 3 months. After which, the trainees gain more experience through their continued participation in project activities.

- Training on Manufacturing and Servicing of Agro-processing Equipment

This training is aimed at enabling local manufacturers to meet the demands for improved agro-processing equipment. The training is designed to develop skills of fabricators to improve the quality to their fabrication, provide after-sales-service and quality control to sustain the functionality of the equipment. Consequently also, quality control task forces or teams are being organized and mobilized by participating manufacturers in an effort to maintain a high standard

quality of equipment being delivered. The training has been decentralized and conducted in-country to promote the local manufacturing industry. This is to encourage the use of locally available materials and services reducing manufacturing costs and eliminating importation costs, thus making the technologies more affordable to the users.

- Training on Operation and Management of Technologies

This training is intended for operators, farmers, and agro-processors to enable them optimize the utilization of the technologies in order to optimize the benefits they derive from the technologies. The training includes actual operation of the equipment, analyses of advantages and disadvantages of the technologies, and tips for successful agro-enterprise management. Extension workers and the manufacturers trained through the project usually conduct this type of training. Consequently, the extension workers increase their contacts with farmers and agro-processors, which improve their credibility. For the manufacturers, it is part of their product promotion and after-sales services to expand their market contacts.

- **Field Demonstrations**

Field demonstrations are conducted to promote awareness in improving the handling and processing of farm produce, and expose technological options available to potential users as well as to policy-makers.

The demonstrations provide an opportunity for extension workers and manufacturers to get direct responses from farmers and agro-processors on the suitability of the technologies being introduced. Farmers and processors are allowed to operate the equipment during the demonstration giving them immediate exposure to the technology. This process stimulates interaction and generates information on design, make and performance of the technologies which are communicated back to the designer. This feedback mechanism facilitates technology development and enhances the suitability and adoptability of the technology being promoted.

Involving policy makers and development agencies during demonstrations also allow for sensitization of rural development projects which could solicit support for funding, adoption and implementation.

- **Establishment of Model Processing Centers**

Parallel to the demonstration activity, model processing centers are established to showcase improved agro-processing technologies and their associated benefits. The set-up of the center is based on system dynamic in which factors affecting and affected by the technologies are present. Unlike field demonstrations, which are done

occasionally, the processing center operates under actual circumstances affecting operation efficiency, management and profitability. The center also serves as training venue for researchers and extension workers while providing more information on utilization potentials and constraints that are used to fine-tune the technologies.

The centers are established with the active participation of farmers and agro-processors in different agro-ecological environments. The sites are selected on the basis of crops and cropping patterns, volume of production, nature of crop processing and utilization, accessibility to markets, availability of extension services, etc. The sites are also selected for their potential for commercial activities and market expansion. The expressed willingness of the agro-processors to participate is also an important selection criterion.

The site in Ghana is located in Abodom Bomso Village, Eastern Region. In Benin the center is located in Agodenou Village, Atlantic Region. In both villages, the farmers grow and process mainly Cassava, Maize, Palm Oil, and Rice. Production is at the subsistence level. One reason identified is lack of processing capability for any increases in the volume of production. The nearest market is at least 2 km from the villages.

5- Multilateral Information Exchanges

Technology development and technology transfer processes take time and require multi-lateral information exchanges among agencies involved to optimize utilization of their limited resources. One key role that the project plays is to stimulate multilateral information exchange and cooperation that could create a consensus that developing an agro-processing industry must be a joint effort of several stakeholders, each one having a unique and complementary role to play. Collaborating institutions come together and share their resources and benefit from it. This linkage also promotes exchange of information and eliminates duplication of development efforts resulting in more efficient project management.

6- Role-Sharing and Capacity Building

The SAA-AP project is a collaborative effort among different stakeholders engaged in improving the postharvest handling and processing of agricultural crops in Africa. The stakeholders formed a team of committed collaborators and partners. The team consisted of representatives from international research center (IITA), the National Agricultural Research System (NARS) programs, non-governmental organizations (NGOs) and other community development agencies (CDAs), local manufacturers, farmers

and agro-processors of Ghana and Benin.

In Ghana, the project collaborates with the Ministry of Fisheries and Agriculture (MOFA), the Agricultural Engineering Services Division (AESD) and the Women in Agriculture (WIAD). In Benin République, the project collaborated with the Direction de la Formation Opérationelle et de la Vulgarisation (DiFOV).

This partnership on improving the postharvest/agro-processing system of food crops now extends to other African countries such as Ethiopia, Uganda and Mozambique. The collaborators have their specific and shared roles within the project based on their development mandates. This role-sharing activity is illustrated in Table 1.

The research centers, i.e. IITA, collaborate to disseminate its research results and provide technical backstopping to the project. IITA is responsible for technology identification, testing, development, and adaptation. It also conducts the training courses on development, fabrication and servicing of selected technologies.

The NARS oversees the implementation of project activities in their respective countries. They are responsible for most extension activities because of their comparative advantage of having physical presence and mandate for nationwide development.

SAA and the collaborating partners in each country project are responsible for the promotion of the technologies through demonstration, and developing partnerships and linkages with the appropriate sectors to make technologies available to the end-users.

The local collaborating partners also organize and provide training programs for users and clients on the operation and management of the technologies. Working closely with the NARS, the NGOs and other community development agencies provided the necessary contacts and logistics for most project activities. The NGOs and other CDAs play as facilitators and could provide funds to pursue their postharvest-related projects.

Field demonstrations are conducted involving the various stakeholders with interest on developing the agro-processing enterprise. They include the equipment manufacturers, material suppliers, development organizations and policy-makers. During demonstration, they are provided with information on the commercial opportunities of, and the rising demand for, processing equipment.

The farmers and agro-processors who are the ultimate beneficiaries of the project influence the development of rural agro-processing enterprises and support the manufacturing industry while increasing their own capacity.

Table 1- Role-sharing among the SAA-AP project stakeholders in training programs and field demonstration

STAKEHOLDERS	Training for Extensionist	Training for Manufacturers	Training for Users/Clients	Field Demonstration
◦ Ministry of Agriculture	Staff Appointment		Planning & Coordination; Monitoring	Planning & Coordination
◦ Ministry of Industry	Staff Appointment		Planning & Coordination; Monitoring	Planning and Coordination
◦ Agro-metal Workshops/ Manufacturers		Selection of Staff; Cost-sharing	Customer Service	Production; Quality Control; Promotion; Marketing
◦ Farmers and Processors			Technology Utilization; Feedback	Feedback
◦ IITA, Other R & D Institutions	Trainer	Trainer; Quality Control	Technology design, testing & adaptation; Monitoring	Technology design, testing & adaptation; Quality Control
◦ SAA	Coordination; Funding	Coordination; Funding	Monitoring; Feedback	Funding

Their participation and feedback on utility, adequacy, and profitability of the technologies are valuable guides for adapting the technology to the local environment. The various potential users (individuals, private entrepreneurs, women's groups, and community organizations) are encouraged to take part in demonstrations and field-testing. Their participation can stimulate their interest to invest in the technology.

The Program Officer coordinates and conducts a regular meeting of the Management Team consisting of the, the Country Program Coordinators and the representative of the respective country Manufacturers' Network and the Postharvest Engineer/ Specialist. The meeting is conducted quarterly to discuss matters relating to project implementation including status of each country project, technology development updates and funding.

As in many rural development projects in Africa, funding is very critical in order to tap and mobilize the potential human and material resources available in the region. Without proper funding, these resources could be wasted and could stagnate development. The role of SAA to coordinate the funding and the activities has been the key to continuing success of the project.

7- Project Monitoring and Impact Analysis

The SAA-AP project introduced improved agro-processing technologies in Ghana and Benin, and recently in Ethiopia. This is being complemented by trainings of individual owners, processors and manufacturers in order to enhance

their capability. Monitoring the project activities and impact is done regularly to provide technical backstopping, where necessary, and to determine the adoption pathway of the technological intervention.

The schematic diagram in Figure 3 provides a framework to analyze the impact of the project on the lives of the different beneficiary-groups.

The interventions are expected to bring about improvement in the welfare or quality of life of the stakeholders- the producers, processors, manufacturers, by enabling them to realize higher income, and being more equipped as an individual and as a member of the community.

A model to analyze the factors and consequences associated to postharvest technology development and introduction in Figure 4 indicates the impact indicators as a result of the project intervention.

- **Technical Factors and Consequences**

The features of the selected technologies are evaluated in terms of their suitability to users' requirements. The more important attributes being required are simplicity, affordability, mobility, transferability and replicability.

Appropriate technologies encourage farmers and agro-processors to adopt technologies to minimize losses in their operations and reduce the drudgery of traditional methods. Small-scale manufacturers are able to expand their business because they technologies are easy to fabricate and uses local materials to allow for efficient after-sales-services.

- **Economic Factors and Consequences**

Economic aspects to technology design and adoption are analyzed in terms of net returns to the limiting resources (capital, labor, etc), scale of operation, opportunity costs of inputs and outputs and the short-, medium-, and long- term benefits.

Policies and regulations such as tariffs, pricing, lending rates, etc. are also studied to formulate policies that is favorable for small to medium scale enterprises in processing and manufacturing.

Improved technologies should result in increase income and equity of ownership and benefits for all users of the technologies.

- **Social Factors and Consequences**

The social structures where technologies are introduced affect the adoption rate and sustainability of the technologies. Technology level and innovativeness facilitate adoption and increase social profitability from use of improved technologies.

Improvements brought about by use of improved technologies enhance the quality of life of farmers, agro-processors and local manufacturers.

A complete analytical model is yet to be devised to show the interrelationships of the variables. Where appropriate the following analytical tools are applied: (1) task analyses; (2) quantitative analyses; (3) statistical tools; (4) direct comparison; and (5) path analysis (for most social indicators and information flows).

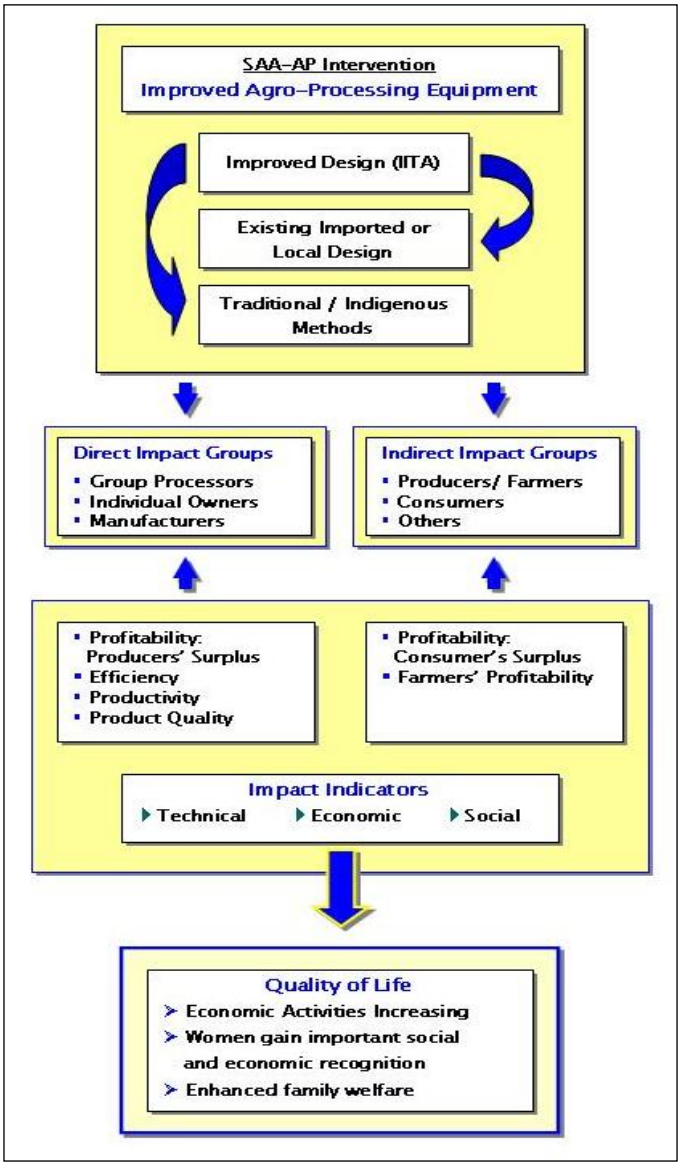

Fig. 3– Framework for the analysis of impact of improved agro-processing technologies

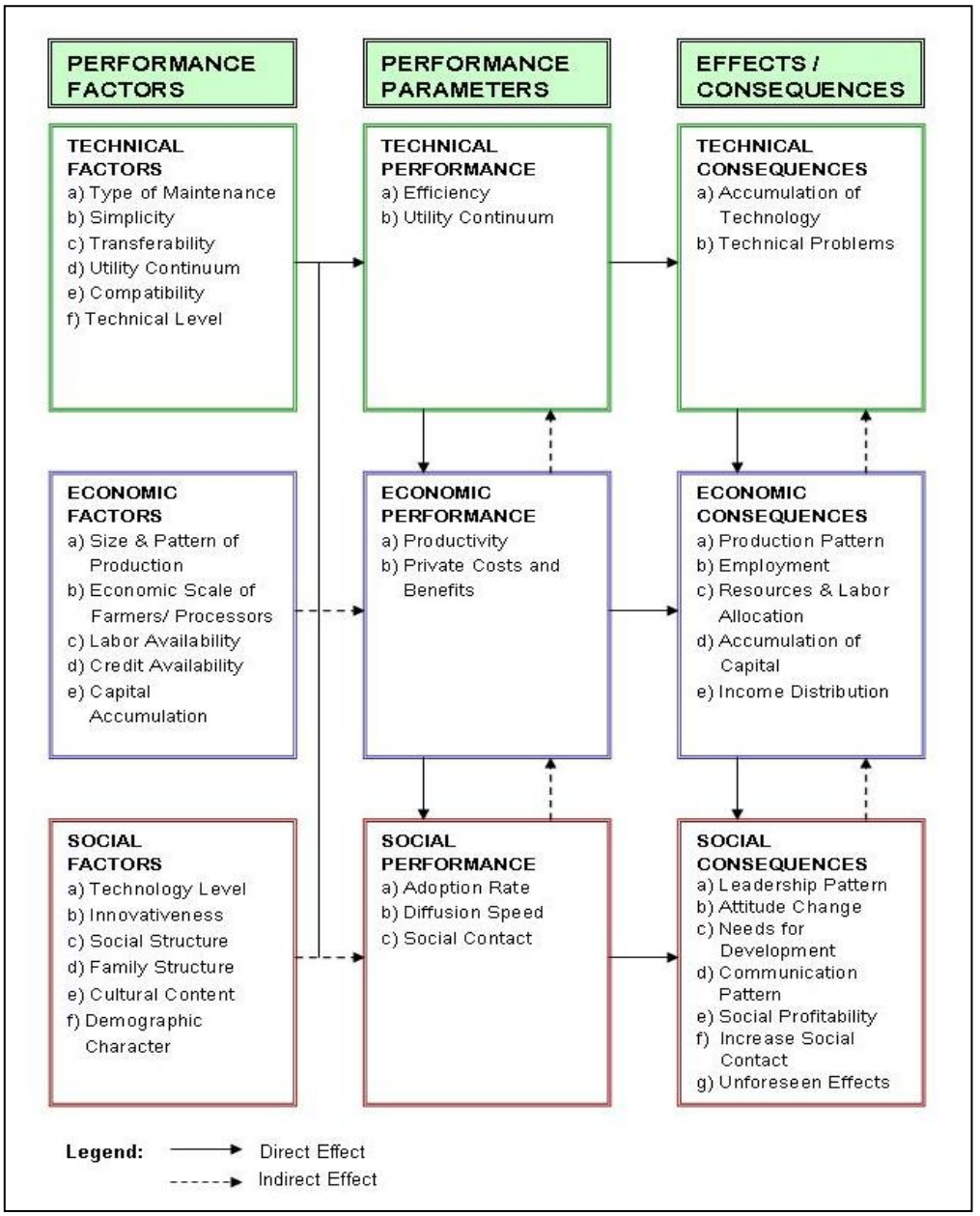

Fig. 4 - Model for analyzing the factors and consequences of postharvest technology development and transfer

SECTION 4 -

COMPONENT AGRO-PROCESSING TECHNOLOGIES

The agro-processing technologies introduced by the project in Benin and Ghana were selected from technologies developed at IITA-Nigeria, and from existing potential technologies from other sources.

The technologies were selected on the basis of their potential impact in overcoming excessive postharvest and processing losses, high labor input, and poor product quality. The technologies should create opportunities to increase income of processors and free some of their time to spend for other productive activities.

The pattern of crop production, the type and nature of food processing and consumption, the gender roles in crop and food production, the available resources, the technical and economic capability of the farmers, and the marketing opportunities are among important criteria considered in the selection of the technologies. The special requirements for specific food preparations, as well as the discriminating taste of the consumers, are yet other factors considered in the selection.

Technology packages for different levels of operations and targeted toward specific user-groups and their operational objectives were adapted and introduced as described in Table 2.

The family-based processing package consists of manually operated equipment designed for women and children responsible for family food preparations. This scale is particularly attractive to women since it can be carried out in the home concurrent with the other household activities. It is recommended for a hamlet[1]-based operation that three to five family units can use in turns.

The technology package for women's group processing is designed to reduce the drudgery of individual processing and to encourage women to invest collectively. It is partly mechanized to process family food and at the same time to provide opportunity for women to generate income. It is intended to be operated for food exchange, contract processing, and product marketing. The food-exchange scheme offered by the center relieves the women of individual household processing. The women can come to the processing center to exchange raw materials (cassava root) for processed

[1] *A hamlet is a settlement of kins forming a small community in the villages in the northern part of West Africa, farming and trading together.*

products. They gain time to work in the center and earn income.

The technologies for small- and medium-scale enterprises are more mechanized and designed for enterprising men's and women's groups, community associations, or private individuals, primarily to generate income.

Analyzing the overall technical and economic requirements for potential income-generating enterprise, the equipment chosen included cassava processing package (consisting of grater, chipper, press, fermenting racks, sifter, and improved stove), grain thresher and mill, wet-type grinder and oil processing machines.

A. Cassava, Other Root and Tuber Crop Processing Equipment

Cassava is a major food in the diets and livelihoods of many smallholder farmers. About 80 percent of the cassava is consumed by the producing household. Harvesting for consumption is usually done weekly, and processing is done throughout the year by women and children using traditional methods. Because most postharvest operations use slow traditional methods, they are time-consuming.

Table 2. Guide to selection of postharvest technology packages for different levels of operation

FEATURES	SCALE OF OPERATION			
	Family-based Processing	**Women's Group Operation**	**Small-scale Enterprise**	**Medium-Scale Enterprise**
Target User	- Family units: Women and Children	- Women's Groups (up to 30 members) - Cooperatives	- Women's Groups and Family units - Private Entrepreneurs	- Private Entrepreneurs - Community Associations
Recommended Operating Scheme	- Family Food Processing - Hamlet-base Processing	- Food Exchange - Contract Processing - Trading	- Contract Processing - Trading	- Trading - Custom-hiring
Design Capacity (Raw Material Input)				
- Cassava, Other Root and Tuber Crops	50 kg/day	1 ton/day	3 ton/day	Up 5 ton/day
- Grain and Legume	10 kg/day	200 kg/day	0.5 ton/day	Up 5 ton/day
Degree of Mechanization[2]	Manually-operated	30% Mechanized	50% Mechanized	80% Mechanized
Component Equipment				
- For Cassava, Other Root and Tuber Crops	Peeling Bay, Peeler, Fermentation Rack, Grater, Bagging Stand, Dewatering Device, Sifters, Chippers, Grinders, Transport Facility, Stove, Dryer			
- For Grain and Legume	Harvesters, Threshers, Bagging Stand, Winnowers, Sorters, Grinders, Polishers, Dryer, Storage Cribs			

[2] *Degree of mechanization describes the operations within the system using improved equipment or machines relative to the application of mechanical means.*

Harvesting and processing require the most labor. Women contribute 87 percent of the time required to process food for family consumption, and they are also involved in harvesting and handling.

Cassava processing equipment was packaged for both sites to enable them produce *gari*[3] initially, then diversify to flour and starch. The traditional process of *gari* production is mostly done manually involving peeling, washing, grating, fermenting, dewatering, sieving and roasting into the desired dry granular form, the *gari* (Figure 5). *Gari* is then cooled before it is packed for any intended use.

System analysis shows the critical operations in peeling, grating, fermenting, dewatering, sifting and roasting. The project introduced interventions for these unit operations as described by the improved process in the diagram. To enable processors to diversify their products as demanded by the market, the root crop chipping machine (chipper) was also introduced.

1- Peeling Bay and Cassava Peeling Tool

Manual peeling requires a labor force of 20 women processors to peel 1 ton of cassava roots in 1 hour.

Mechanical peelers are still not available, even at IITA. The development of mechanical peeler is constrained technically by the fact that the roots, even of the same variety, varies considerably in size and shape. Secondly, peeling is a major economic activity of many women and children in the cassava producing areas.

Peelers use a special knife, called '*okafi',* or the ordinary kitchen knife. It is tedious and presents danger of accidental bruises and cuts to operators. The peelers are paid by the volume or heaps of cassava they peel.

Immediate intervention focused on improving the ergonomics of the operation. Available options recommended are the peeling bay (Figure 6) and the cassava peeling tool (Figure 7) developed in IITA.

The peeling bay allows easy reach of the cassava roots by peelers who could seat conveniently while peeling even with their babies at their back. It also reduces contamination of peeled roots with soil saving an already scarce water resource. The cassava peeling tool could substitute for the knife in order to reduce accidental cutting to operator and wastage of cassava.

[3] *Gari is a popular cassava food in West Africa made by roasting grated and fermented cassava.*

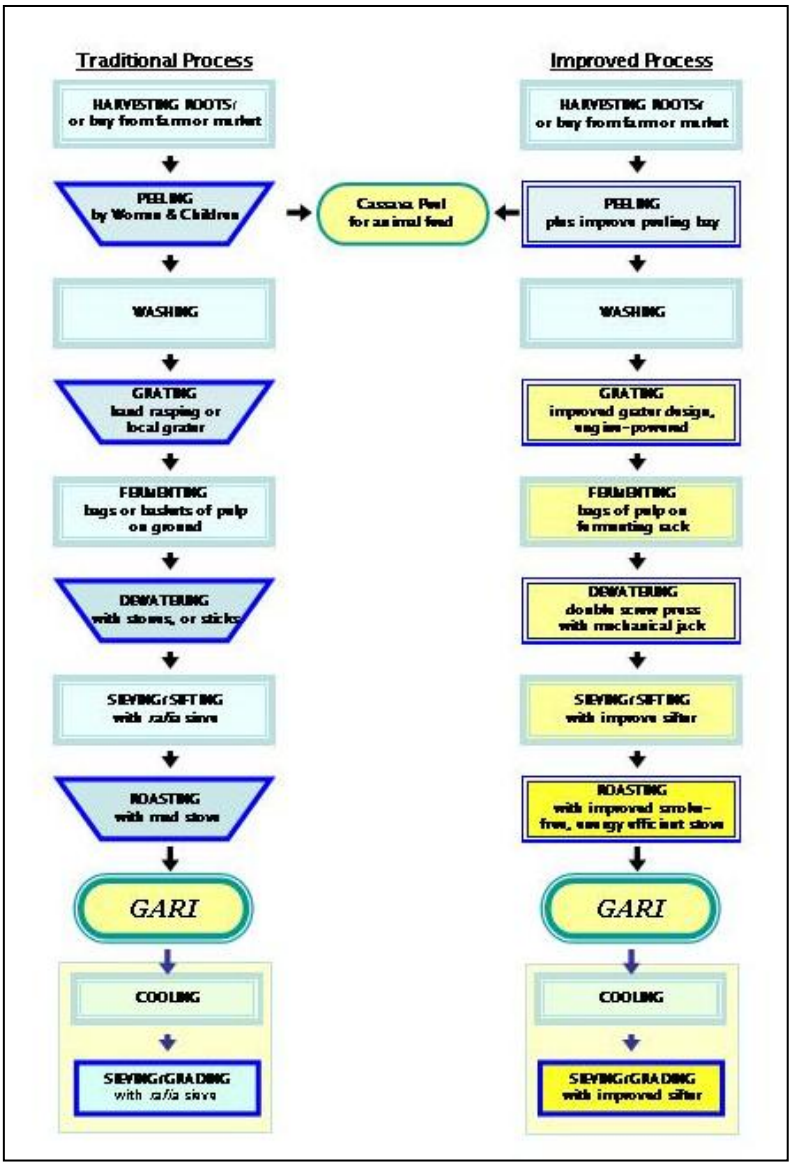

Fig. 4- Process flow chart: *gari* processing in Ghana and Benin

2- Mechanical Grater

Traditionally, cassava is grated manually using perforated tins. It takes one woman to grate 50 kg of cassava per day. The method is therefore suited only for processing food for family consumption.

Mechanical graters with Lister Diesel Engine were introduced as early as the 70s. Most of the installations provide grating services but are located far from the processors who are in the villages with poor road and transport system. To the operators, the lack of spare parts and high maintenance costs

hindered the growth of their business.

Considering improved efficiency, low investment cost, reliability and good product quality, the project introduced the IITA-designed portable grater with bagging stand, Figure 8. It is powered by 3.5 Hp petrol engine and has a design capacity of 1 ton per hour. It can be used for stationary or mobile operation.

3- Fermentation Rack

Fermenting is an important unit operation in *gari* production as it gives the characteristic flavor of the *gari*. Aerobic fermentation takes place after grating. The grated pulp could be bagged or heaped on the ground covered with nylon bag or leaves, and left to ferment. Fermentation period can vary from 1 to 4 days depending on consumers' taste preference.

During fermentation, the juice which drains out of the grated pulp spoils on the ground causing environmental pollution, thus health hazard. The juice that drains off the pulp immediately after grating contains most of the starch content of cassava. The starch could be collected and could be an additional benefit to the processor instead of an environmental nuisance. A fermentation rack (Figure 9) was introduced to facilitate the collection of starch from the grated cassava pulp before it ferments. It also allows better organization of the workplace.

4- Cassava Mash and *Gari* Sifter

Sieving the grated pulp before roasting or frying (to break the pressed pulp) and after frying (to grade the *gari) is* traditionally done using flat baskets with loosely woven base (similar to a sieve) made from *raffia*[4] or bamboo. It is locally available, and is well-adopted by the women. However, it is not very durable thus requiring frequent replacement. Because it is shallow, the losses due to spillage during sifting could be significant.

The project introduced the cassava mash and *gari* sifter developed at IITA (Figure 10) to increase efficiency in terms of durability, reduction of spillage, and time-saving. The sifter is made of wooden box where sifted grated cassava is accumulated, a platform to hold the bag of pressed cassava and a removable sifter box with base made of stainless mesh.

5- Double Screw Press

Cassava contains about 80 percent of water which needs to be removed during processing to reduce spoilage by microbial growth and contamination.

[4] *Raffia is feather palm of tropical Africa, Madagascar and Central and South America widely grown for commercial purposes.*

Fig. 6 – Peeling bay to improve comfort and efficiency

Fig. 7 – Cassava peeling tool to reduce accidents and wastages

Fig. 8– The portable cassava grater with bagging stand for improve efficiency and reliability

Fig. 9 – Fermentation rack facilitates collection of starch from grated cassava pulp

Fig. 10 –The Cassava mash and *gari* sifter with sliding sieving box

Fig. 11 – The double screw press facilitates dewatering, simple to operate requiring minimum repair and maintenance

The traditional process involves putting the grated pulp in bags of approximately 10 to 20 kgs, and then boulders, logs or other heavy objects are placed on top. Other method uses tree branches or sticks where the bagged pulp is compressed between two branches tied at both ends. With these methods, it takes 3 to 6 days to reduce the water content to a level suited for roasting (not more than 45% moisture on wet basis). In commercial-scale production, a single-screw press is being used, either manually operated or with the use of a hydraulic jack. The method is constrained by frequent breakdown of the jack and the screw.

Dewatering cassava is critical as it affects the efficiency of roasting and the quality of *gari*. If the pulp is still too wet when roasted, it results in discoloration and coarser granules. Improving the performance of the single-screw press, a double screw press (Figure 11) was adapted.

The design offers solution to screw breakdown due to non-uniform distribution of compressive loads, and requires less force to operate. Four to 6 bags of fermented pulp (approximately 250 kg) can be loaded per batch to reduce the moisture to 40% in 4 to 6 hours. The double screw press was further adapted to be operated with a mechanical jack to speed up the process.

6- Improved *Gari* Frying Stove

Stove made of clay soil fueled by wood-fuel is a common cooking facility found in most African households. For *gari* roasting/frying, the stove is constructed to hold the wide-based pan made of kiln-dried clay or aluminum. The women *gari* fryers sit directly next to the stove and are exposed to heat, smoke from burning fuel, and the evaporating fumes from the drying cassava. The process is tedious and presents health hazards to operators. Furthermore, the dwindling source of fuel wood limits the capacity of the operators.

The project introduced a more efficient stove with improved combustion efficiency to eliminate smoke, save fuel and to provide comfort to operators. The *gari* frying stove developed at IITA (Figure 12) was introduced, and existing fryers were modified by providing a chimney or by locating the fuel feed opening outside the frying shed.

7- Root Crop Chipping Machine

Cassava chips have regional and international demand for use in the production of bakery products, or as raw material in the formulation of animal feed.

Fig. 12 –Improved IITA *gari* frying stove (left) and one of the modified local stove (right) eliminate smoke, save fuel-wood and provide comfort to operators

In Benin, Ghana, and Nigeria fermented cassava flour called *lafun*[5] is processed and consumed by many rural families. Cassava flour is produced by cutting the cassava root into 1- to 2- inch chunks then dried under the sun. It takes 5 days, or more, to dry the cassava chunks resulting in quantitative and qualitative losses. The dried cassava is milled into flour.

The root crop chipping machine (chipper), Figure 13, was introduced in project sites where the demand for cassava chips and flour, was identified.

The chipper cuts the roots into smaller strips which could dry, or ferment (in case of production of *lafun*) faster resulting in good quality flour.

Fig. 13 - The chipper cuts root and tuber crops into thin strips for faster drying

B. Grain and Legume Crop Processing Equipment

Grain and legume crops are grown extensively in the dry Savannas of Africa. Seventy-five percent of the crop harvested is consumed by the producing household.

Maize is mainly grown as a cash crop, while sorghum, millet, and cowpea are grown for family consumption. Depending on available rainfall and inputs, they are planted once, sometimes twice, a year. Land

[5] *Lafun is processed by soaking the whole root to soften which could take 5 to 7 days. The process results in a certain degree of fermentation that gives a characteristic flavor liked by consumers but also discoloration sets-in. Softening also allows easy removal of the peel and central fiber. The softened cassava is sun-dried, and then milled.*

areas planted to these crops are still very small, irregular and fragmented making difficult to mechanize. Each crop has a brief harvest period, but the harvested crop is processed into food products in small quantities throughout the year. The average production of grain and legume crops by individual farm family is sufficient to feed the household for not more than 3 months.

Harvesting and other postharvest operations are constrained by the lack of labor during the peak harvest season when the farmers harvest their crops at the same time. Very often the harvest season coincides with rainy season when the crops could not be dried sufficiently for safe storage.

Timing of harvesting and consequent operations for grains and legumes is therefore critical because, for safe processing and storage, the crop has to be gathered quickly. This urgency places a heavy load on the women and children who contribute more than 60 per cent of the labor required for postharvest operations.

The SAA-AP project first focused on improving the primary processing of grains and legumes so that they can be gathered on time before qualitative and quantitative losses occur, and then processed into a more durable form that could be stored for further processing. For this purpose, the project introduced the shellers, multi-crop thresher, the wet-type grinder, the polisher, the single screw press and the rice mill. Other equipment were added as the processors begin to relate their process output to system efficiency.

8- The Manually-operated Shellers

The traditional methods of shelling maize are pushing off the grains from the cob with the thumb, or placing the cobs inside a bag then beaten repeatedly with a stick. Groundnuts are cracked between the fingers to release the nuts. These are done by women and children, are cumbersome and time-consuming.

The project introduced improved devices such as the manually-operated maize shellers (Figure 14), and the groundnut sheller (Figure 15) constructed from locally available materials.

The objective is to relieve operators of the drudgery of manual shelling, save time and allow for subsequent operation to take place for safe storage and marketing.

9- The Multi-crop Thresher

Farms in Ghana and Benin are planted to a mixture of crops, as in many African countries. Investment in machinery for individual crops can be very expensive and could not be justified by the present scale of operation.

Even as the volume of production of grains and legumes are currently, on the average, less than a ton per hectare, individual farmers could not cope with the required labor to harvest and thresh them. Hired and

shared labor is scarce as farmers are occupied in their own farms. Also, addressing the market demand for the crops, the capacity has to be increased. The multi-crop thresher and a cleaner/sorter, Figure 16, was introduced by the project initially for maize shelling, and then adapted for other crops as millet, sorghum, cowpea, soybeans and teff.

10- The Wet-type Grinder

Grinding is an important operation in processing African foods. Dry grinding is used when dry grains and legumes are ground to flour for further use. Wet-type grinding applies to grinding soaked materials, for example, maize to produce *mawe*[6], soybeans to produce milk, millet and sorghum to produce *tuwo*[7]. It also applies to grinding oil crops such as groundnut and shea nut for subsequent production of butter and oil.

A maize grinder introduced in the early 70s had been used for years to assist processors in their grinding needs until 1994 when the project introduced the wet-type grinder (Figure 17) to increase capacity, reduce operation and maintenance costs and improve product quality.

The wet-type grinder has been tested for maize, millet, sorghum, cowpea and soybeans. Recently, the grinder was also adopted to produce groundnut and sheanut butter.

C. Palm Oil Processing Equipment

Oil Palm *(Elaeis guineensis)* grows extensively in the tropical rain forest of West Africa running through the southern latitudes of Cameroon, Côte d'Ivoire, Ghana, Liberia, Nigeria, Sierra Leone and Togo.

Palm oil processed from oil palm fruit is an essential ingredient in many of the traditional West African foods. The traditional method of processing palm oil is simple, but tedious and inefficient. Technology for palm oil production is generally suited to village or a big plantation. Improvement on the system generally concentrated on reducing the drudgery from mashing or pounding stage (digestion), and improving the efficiency of oil extraction.

11- Palm Oil Digester

Small mechanical, motorized digesters (mainly scaled-down but unheated versions of the large-scale units), but without heat insulations and steam injections were introduced. The digestion efficiency was low, and the cost related to operation and maintenance was high.

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[6] *Mawe is a traditional food in Benin made by soaking maize for 2 to 3 days, ground, then sifted. The resulting granulated flour is dried. It is reconstituted with hot water then eaten as light porridge. This food is similar to 'ogi' or' koko' in Ghana and Nigeria.*

[7] *Tuwo is a traditional food in Nigeria processed from fermented sorghum or millet flour.*

Fig. 14 – Manually-operated maize shellers introduced by the SAA-AP project are simple, low-cost, reduces drudgery and saves time

Fig. 15 – The manually-operated groundnut sheller increases shelling rate by almost 90%

Fig. 16 – The multi-crop thresher and cleaner/ sorter allows quick field handling of crops for subsequent processing

Fig. 17 – The wet type grinder produces fine paste for more efficient extraction of oil or soymilk

A screw-type grain polisher developed at IITA was tested effective for palm oil digestion (Figure 18).

The kneading action exerted on the fruit mass helps to break down the palm oil component for ease of extraction. The machine is portable and is suited for many backyard oil processing enterprises.

12- Oil Press

Applying mechanical pressure using a press is the most common method of extracting oil out of a mixture of oil, moisture, fiber and nuts such as from digested palm oil, and from groundnut butter. Presses use either a screw thread or hydraulic mechanism. Hydraulic presses are faster than the screw types and powered presses are faster than manual types.

Many types of screw presses of the spindle type are used in palm oil and groundnut oil extraction. They vary in configuration and capacity. The single screw press developed at IITA (Figure 19) introduced by the SAA-AP project has a special load-bearing design to ease operation and reduce frequent breakdown of the screw. A bigger model is available for higher capacity.

Fig. 18 – The palm oil digester adapted from a grain polisher has transformed backyard palm oil processing into a profitable cottage industry in Ghana

Fig. 19 – The single screw press is easy to operate and maintain. Application: extraction of palm oil, groundnut oil, soymilk, others at the household level

SECTION 5 -

CAPACITY BUILDING, MANUFACTURING AND TECHNOLOGY ADAPTATIONS

For a decade, the SAA-AP has been collaborating with research institutions, national government agencies, communities, groups and entrepreneurs in Benin, Ghana and Ethiopia. During the project implementation, technology development, as well as transfer strategies are continuously adapted according to the feedback on technology and system performance where technologies are introduced.

A significant accomplishment of the project is the strengthening of linkages among the various stakeholders. The intended users know where to get information on technologies and market opportunities.

The project has disseminated different types of agro-processing equipment in Ghana and Benin. Several modifications were adopted to improve the technologies, or to develop new ones to suit users' requirements. Example cases are presented where feedback from beneficiaries was used as decision tools to improve on the attainment of the desired outputs.

Adopting the strategies from these experiences, SAA-AP is also assisting agro-processing programs of other African countries including Ethiopia, Uganda, Mali, Nigeria and Mozambique. New techniques are being devised while technologies are adapted and disseminated for adoption.

1- Capacity Building

Recognizing the comparative advantage of the local partners in dealing directly with the end-users, the project provided training to build up and strengthen the human resource base and their capability to implement, monitor and eventually manage the project.

The objective of the training courses was to transfer information and expertise in developing food processing and enterprise management skill. A vision shared by the project collaborators is to develop the local training capability to reduce project costs and empower the local stakeholders.

The direct involvement of the partners in the project is developing not only their skills, moreso, their association with their clients which helps build up trust and confidence. The project initially trained 4 project staff each from Benin and Ghana followed by specialized training of 5 more staff who are leading the training and monitoring activities in each country.

Trained staff of participating national and other rural development programs is now able to organize effective field

demonstrations and implement training courses on equipment operation and management. The partners also participate in designing and implementing monitoring surveys to assess the impact of the project.

The increasing demand for improved agro-processing equipment in different parts of sub-Saharan Africa has been mobilizing the local manufacturing industries. Training of manufacturers and coordinating their activities in order that technologies are supplied with the right quality where they are needed, is yet another output of the project. Manufacturers are trained to understand the design features of the equipment so that they could improve the quality of their products, do local adaptations and provide after-sales services to their clients. There are about a hundred technicians trained through the project (Table 3 and 4). Until the end of the 5th year, IITA provided technical backstopping to these trainings.

Training on quality control and after-sales-services, in addition to enhancing technical skills, enable the manufacturing industries to produce locally superior technologies which eliminate importation costs and its associated constraints on sustainability such as the lack of spare parts and services. The project also encourages manufacturers to take up the costs of field demonstrations as part of the manufacturers' promotional activities. Operators' training should in fact be considered manufacturers' care. Manufacturers should evolve their concept of business operations to include the cost of operators' training as a means of maintaining good relations with customers.

As requirements for technologies vary, many of the training courses have been de-centralized and implemented in-country in order that associated constraints are directly addressed and solutions formulated using local resources. Decentralization broadened the geographic spread of the technologies where users can now obtain equipment and services. Manufacturers in Ghana and Benin reported increasing business activities in fabricating agro-processing equipment, hence increasing their income.

Training also resulted in empowerment of individuals and groups, especially the women. Their activities are contributing to build the communities' capacity to develop. It is the women's access to important information, their social contacts, family authority and their wealth of relevant knowledge that form a strong foundation for family and community development. Their increasing economic activities contribute to improvement within the family circle which spillover to the community.

Further, the activities of the project have been influencing policy-makers

to improve the policy environment to encourage development of small-scale food processing enterprises. Several adoption decisions in each country resulted from benefits demonstrated by the technologies introduced by the project. In Ghana, the Ministry of Women and Children Affairs funded the dissemination of over 200 sets of *gari* processing package to women groups in the different districts in 2002 and 2003. This is backed by installation and training on operation and maintenance by the SAA-AP project collaborators.

The government of Benin is likewise extending full support to the project to promote the different agro-processing technologies and develop a support system to sustain these technologies. The government had requested the manufacturers' network of Benin to participate on planning the mechanization program of the country (personal interview with Mr, Whannou Erasme, November 2004).

2- Formation and Coordination of the Manufacturers' Network

A big challenge to the project is to encourage individual collaborating manufacturers to form into a network. By sensitizing the manufacturers, the project is able to institutionalize the linkage of the local manufacturing sectors with government support programs to ensure full support in terms of management and legislation.

The collaborating manufacturers in Benin and Ghana (Table 3) are working together to support the dissemination of improved agro-processing technologies. In each country, the collaborating manufacturers operate as a network without loosing their individual business identity. The network is intended to enhance their capability to supply good quality equipment and services. They operate on the basis of complementarity of roles in the supply of demanded equipment while maintaining competitiveness the driving factor in producing high quality products and pursuing their business objectives.

In Benin, the network (*Réseau des Fabricants de Materiels de Transformation des Produits Agricoles*, Réseau F.M.T.A.-Benin) formed by the alliance of the four collaborating manufacturers (COBEMAG, CAMEMEC, C.F.T.S. and APROMAH) won the recognition of the government to operate officially to supply the demand for improve agro-processing equipment. The network has been registered under the Ministry of Internal Affairs as non-profit association. One of the network activities embodied in their by-laws is the establishment of store room for spare parts which will be accessible to the members of the network and the technology-users. The store room has been set up and is stocked with spare parts such as grating sheets, pillow block bearings, aluminum pulleys, etc.

Table 3 - Collaborating manufacturers of agro-processing equipment in Ghana and Benin

Company Name / Location	Category of Operation	Number of Trained Technicians*	Agro-Processing Equipment Adopted
BÉNIN République			
▪ APROMAH / Bohicon Association pour la Promotion des Materiels Agro-Alimentaires ét Hydrauliques	Semi-private/ Cooperative (Partly funded by IFAD)		Wet-Type Grinder, Oil Press, Grater, Double Screw Press
▪ CAMEMEC Sarl / Godomey Construction-Ajustage-Menuiserie Métallique et Cloutérie	Private	4	Cassava grater, Double Screw Press, In-Field Cart, Multi-Crop Thresher, Chipping machine, Wet-Type Grinder
▪ CEFACOM / Azové Centre de Formation de Formation de Fabrication et d'Ajustage en Construction Metallique	Private (Funding support by Belgian Government)	2	Cassava grater, Double Screw Press, Multi-Crop Thresher, Wet-Type Grinder
▪ C.F.T.S./ Ouidah Center de Formation Technique Mgr. Steinmetz	Regional	6	Cassava grater, Double Screw Press, Multi-Crop Thresher, Wet-Type Grinder
▪ COBEMAG / Parakou Coopérative Béninoise de Matériel Agricole	Semi-private/ Cooperative	8	Multi-Crop Thresher, Grain Cleaner/ Sorter, Cassava grater, Double Screw Press, Rice Mill
GHANA			
▪ GRATIS Foundation / Tema Ghana Regional Appropriate Technology Services	Formerly, Government; Now a Foundation (since December 1999)	17 (include R.T.S.C. technicians)	Multi-Crop Thresher, Grain Cleaner/ Sorter, Cassava grater, Chipping Machine, Palm Oil Digester/Kernel Cracker
▪ ENTESEL / Tema Engineering and Technical Services Ltd.	Private	4	Multi-Crop Thresher, Grain Cleaner/ Sorter, In-Field Cart, Chipping Machine, Wet-Type Grinder, Palm Oil Digester
▪ R.T.S.C, GRATIS Foundation Rural Technology Service Center / Cape Coast, Bolgatanga, Ho, Koforidua, Mampong, Techiman, Takoradi, Wa	Private (IFAD-supported project) attached to GRATIS Foundation	36+ (conducted by GRATIS Staff)	Cassava grater, Double Screw Press, Bagging Stand, Fermentation Rack, Sifter, Chipping machine

**Approximate count based on records from 1995 to 2000 until the manufacturers are able to conduct their training*

In Ghana, the project trained the technicians of I.T.T.U. (Intermediate Technology Transfer Unit), now R.T.S.C. (Rural Technology Service Center), operating under GRATIS (Ghana Regional Appropriate Technology Industrial Services) Foundation, and their clients. The regional presence of GRATIS through the R.T.S.C. is facilitating a wider technology transfer.

GRATIS Foundation and its clients now form the Manufacturers' Network in Ghana. An active partner and client to GRATIS Foundation, ENTESEL (Engineering and Technical Services Establishment) is contributing significantly in standardizing and supplying equipment parts. The network's continuing support to the project include mobilizing the Quality

Control Fronts (QCF) in all R.T.S.C. and those of their clients so that equipment are fabricated with the correct specifications.

Trained technicians of collaborating manufacturers in both countries play lead roles in training other technicians of neighboring West African countries (Togo, Guinea, Mali and Burkina Faso) soliciting assistance from the project. These countries procured a number of agro-processing equipment from Benin and Ghana. They saw the potential of adopting the technologies and the technology transfer strategy to pursue their country programs on postharvest technology development and extension.

From 1998, the activities in Ghana and Benin also spread to East Africa (Ethiopia, Uganda and Mozambique). Project staff trained extension officers and women groups in *gari* processing using improved techniques, and trained local manufacturers in fabrication and servicing of equipment to supply the anticipated demand for improve equipment. Collaborating manufacturers in countries with trained technicians reached by the project (Table 4) reported continuing demand for, and sale of Cassava grater, chipper and thresher. Demand for other postharvest equipment is also reported to be growing.

Agricultural machinery manufacturing is starting to be recognized as a profitable business enterprise. Many metal manufacturers supporting industrial fabrication and repairs of parts in the construction industry are now involved in fabricating agro-processing machines. Until the end of 2004, sales records from Benin, Ghana and Ethiopia (Table 5) show interesting trend in the demanded and sold equipment. Based on the record it can be inferred that the cassava processing equipment is well accepted in Ghana and Benin; the palm fruit digester has good adoption in Ghana; the multi-crop thresher is well adopted in Ethiopia, and the wet-type grinder for sheanut butter processing was popular in Benin.

The concern of many manufacturers shared by the project is the sustained supply of spare parts for fabrication and servicing agricultural machines since many of them operate on a scale lacking complex machinery (such as lathe machines), and usually have technicians who barely have formal training. The network is helping the fabricators to bring the message to appropriate entities for a concerted support to strengthen this sector of the industry. The project supports the continuing operation of the trained manufacturers through further training and helping to create a link between them and the suppliers and clients.

Table 4 - Collaborating manufacturers with trained technicians in countries reached by the SAA-AP project

Company Name / Location	Category of Operation	Number of Trained Technicians*	Agro-Processing Equipment Adopted
BURKINA FASO			
▪ C . N . E . A . / Ouagadougou & B-Dioulasso Centre National d'Equipment Agricole	Government	2	Multi-Crop Thresher, Grain Cleaner/Sorter
ETHIOPIA			
▪ N R C / Nazareth National Research Center (Agricultural Mechanization Research Division)	Government	2	Multi-Crop Thresher Grinder, Polisher
▪ S T V C / Addis Ababa Selam Technical and Vocational Center	Non-governmental Organization (NGO) supported by Swiss Government	8	Multi-Crop Thresher, Grater Grinder, Polisher, Groundnut Sheller; Also provides technical support to the SAA-AP project in Ethiopia
GUINEA			
▪ SOMATA,/ Kindia Societe de Machinisme Agricole et de Technology Appropriee	Private	12	Multi-Crop Thresher, Grain Cleaner/ Sorter, Chipping Machine
MALI			
▪ I.M.A.F. / Bamako Industrie Mali Flexible	Government	2	Multi-Crop Thresher, Grain Cleaner/ Sorter
MOZAMBIQUE			
▪ A G R O - A L F A S.ARL, / Maputo Agricultural Tools & Equipment Rural Assistance Metal Works	Private	6	Cassava grater, Double Screw Press, Chipping Machine, Cassava Mash Sifter
▪ KANES Alfaias Agricolas, Sarl / Maputo	Private	6	Cassava grater, Double Screw Press, Chipping Machine
TOGO			
▪ FAMEZIO / Tsevie Fabrication Metallique de Zio	Private	2	Cassava grater, Double Screw Press, Chipping Machine, Multi-Crop Thresher
UGANDA			
▪ AGECO / Iganga Afro General Engineers & Contractors	Private	2	Cassava grater, Double Screw Press, Fermentation Rack, Cassava Mash and Gari Sifter
▪ AEATRI / Kampala Agricultural Engineering Appropriate Technology Research Institute	Government	2	Chipping Machine, Wet-Type Grinder
▪ N.V.T.I. / Kampala Nakawa Vocational Training Institute	Government (supported by JICA)	4	Chipping Machine, Wet-Type Grinder, Gari Frying Stove Hosts Manufacturers' Training in Uganda
▪ TONNET Enterprises / Kampala	Private	2	Cassava Grater, Double Screw Press, Fermentation Rack, Cassava Mash and *Gari* Sifter

**Approximate count based on records from 1995 to 2000 until the manufacturers are able to conduct their training*

Table 5 – Summary of agro-processing equipment manufactured and sold by collaborating manufacturers in Ghana, Benin and Ethiopia

Type of Equipment	Benin (1994-2004)	Ghana (1994-2004)	Ethiopia (2002-2004)	Total
Bagging Stand	24	264	0	288
Cassava Grater	235	367	0	602
Cassava Mash & *Gari* Sifter	44	266	0	310
Chipping Machine (Chipper)	4	34	0	38
Double Screw Press	186	374	0	500
Fermentation Rack	44	266	0	349
Groundnut Sheller	0	0	46	46
Multi-crop Thresher	76	24	47	147
Palm Oil Digester	6	77	0	82
Rice Mill	1	2	0	3
Wet-type Grinder	60	8	8	76

3- Field Demonstration

Field demonstrations proved to be useful strategy for introducing new technologies and techniques. The direct interaction among the various stakeholders during the field demonstrations creates the important link to pursue their individual business objectives.

The timing and venue of the demonstrations must be planned carefully to get a good participation from a wide cross-section of the stakeholders: trainers, operators, manufacturers, rural development and extension specialists, funding agents, others. Most recent, the government officials are invited to solicit their commitment to support the adoption of the new technologies in terms of funding and legislation.

The role of manufacturers in field demonstrations is helping them to promote their products and link them to the clients. Through the demonstrations, the processors gain confidence on the availability and accessibility of the technologies and their associated services.

Field demonstration is effective but expensive part of technology transfer. The stakeholders should share the costs and benefit from it.

4- Establishing Model Processing Centers

The model processing centers established provides a venue to demonstrate the utility and benefit derived from the use of technologies. The facilities are used directly by the beneficiaries under normal situations. This allows them to learn

and benefit from the improved technologies. The operation of the center is self-liquidating. The operating costs are paid through the income from using the facilities. In the center, the processors and other interested parties will observe directly the viability and profitability of the new technologies.

Besides the improvement of the processing system, one important aspect of operating in a center is the social construct which result from the association of the users. The center is a venue to earn money and meet people and discuss various family and community issues affecting their ways of life.

The establishment of a center will require a good management and regular supply of raw materials to sustain its functionality.

5- Adapting the Agro-processing Equipment

A gap between rated and actual field capacities of the agro-processing equipment introduced in Ghana and Benin was observed. Field capacity however increases with usage of the equipment as operator develops skill to manage it. In most cases, more intensive training on the operation and management of the machine, rather than re-designing the machine, will improve the operating efficiency. There are however many cases when the equipment or a component part needs to be modified to correct reported malfunction. Some of these cases are summarized in Table 6. A reliable feedback mechanism is helping to improve the technical performance of the machines as well as develop operating schemes to optimize their performance.

1- The Cassava Grater

The IITA-cassava grater with rated capacity of 800 to 1000 kg per hour was adopted readily by individual and women group processors. The utilization rate increased to 60% within the first year of introduction. Women were noted to have completely abandoned their traditional method of manual rasping. Increasing number of farmers and agro-processors involved in *gari* production was noted. Raw materials for the increasing processing capacity is supplied by farmers who had increased their farm area planted to cassava, or are procured from neighboring villages and markets.

Other uses of the grater were found such as crushing pineapple and ginger for juice extraction. Ghana processors are also using the grater to break loose the pressed cassava (instead of sieving) before it is roasted to *gari.*

The feedback from users helped to further the development of the grater to improve efficiency and to suit their technical and economic capacity.

Considering processors in the remote villages and the poor road system, the grater was modified to ease operation, to reduce weight, and to

Table 6. Rated and field capacities, and acceptability of agro-processing equipment introduced in Ghana and Benin.

Type of Equipment	Rated Capacity	Field Capacity		Acceptability / Users' Comments	Adaptation/ Other Comments
		Start of Use	After 1 Year		
- Cassava Grater, Engine-Driven	800 to 1000 kg/hr	240 to 300 kg/hr	720 to 800 kg/hr	- Very Good - Immediate adoption - Skill needed for engine operation	-Development of bagging stand to ease collection of grated mash and starch -Portable model developed to reach processors in remote villages
- Cassava Mash Sifter	1 bag (60 kg/hr)	1 to 2 bags/hr	1 - 2 bags/hr	-Very useful and durable; -High initial cost -Liked very much -Immediate adoption by women and children	-Size of sifting box changed to fit standard cut of wire mesh -Sifter adapted to fit the basin used by women to reduce cost of box
- Chipping Machine, Manually-Operated - Chipping Machine, Power-Driven	Up to 200 kg/hr Up to 1000 kg/hr	60 – 100 kg/hr Up to 1200 kg/hr	60 – 100 kg/hr Up to 1200 kg/hr	-Cuts efficiently -Chips dry faster -Chipping plate to replace worn out ones not easily available -Slow adoption	-Chipping plate moulds designed for local supply -Simplified fabrication by using cast aluminum feed cup and chipping plate holder
- Multi-Crop Thresher	Up to 1000 kg/hr	400 – 600 kg/hr	Up to 800	-Versatile machine -Pegs twist quickly -Separate cleaner cumbersome -Immediate adoption for maize	-Threshing drum rings and pegs re-enforced; -Incorporated cleaning system -In Ethiopia, donkey cart developed to carry thresher around to service customers
- Wet-type Grinder	Up to 50 kg/hr, wet material	Up to 20 kg/hr	Up to 20 kg/hr; higher for less pasty and oily material	-Very fine grinding but very slow -Product recovery very high; -Cumbersome to adjust and clean -Slow adoption before modification	-Re-designing the cover plate with fixed grinding stone -New design of feed auger to increase capacity -Manufacturers revised to increase utility-coupled with nut cracker
- Auger-type Grain Polisher <u>converted as</u>: - Palm Oil Digester & - Palm Kernel Cracker	120 kg/hr	Not used 250 kg/hr Not verified	Not verified 250 kg/hr Not verified	-Not accepted as grain polisher; found by users good effective for palm oil digesting -Immediate adoption -Could also crack palm kernel -Need to increase capacity -Need to be coupled with an efficient oil press	-Interchangeable auger designed for palm oil digesting and palm kernel cracking -Shafting re-designed to ease repair and maintenance

make it compact for easy, maneuverability within towns and villages. The modified portable grater model, Figure 20 could be loaded at the back of the motor cycle, or carried on wheelbarrows.

Further down-sizing of the grater was done to use a smaller engine such as that used in power sprayers which are available with many farmers in the moist savanna zone of Benin and Ghana. The mini-grater, Figure 21, was developed. It has a capacity of 200 kg of fresh cassava root per hour. The grater could be constructed with stainless steel sheet to prevent corrosion and contamination particularly when used for crushing pineapple.

2- The Cassava Mash and *Gari* Sifter

The cassava mash and *gari* sifter was adopted almost immediately. It has been one of the equipment most utilized by women and children; the sifting capacity increasing three-folds that of local flat basket and with minimum spillage. The sifter is designed for use in group operations, requiring users to take turns. However, users prefer to operate separately while frying *gari* and have full control of their schedule. To adapt to this situation, the sifter box was modified to fit into their own basins eliminating the wooden collection box, thus reducing investment cost.

3- The Fermentation Rack

The fermentation rack was introduced as optional accessory to *gari* processing equipment package to help improve the workplace for *gari* processing. It facilitates the collection of starch from bags of newly grated cassava packed on top of the fermentation rack.

The fermentation rack was appreciated and adopted immediately by processors. Based on this principle, those who could not afford to buy devised their system by making elevated platform from available materials such as logs, or wood planks. This keeps their workplace neater and drier.

4- Root Crop Chipping Machine

The chipper was an exciting innovation for the farmers as it is versatile and portable. However, the lack of market for dry chips in West Africa did not allow for wider adoption, until recently when there is a demand in the export market. Just so, the adoption of the chipper needs an efficient dryer to get products to the market; leaving it a challenge to the project. The production of chipping plate also hindered the wide adoption of the machine.

The availability of cassava processing equipment has indirectly influenced the implementation of cassava multiplication programs in Uganda, Mozambique and other East African countries, where cassava is not a major food crop. It encouraged

the sector to grow more cassava which can already be processed conveniently into more durable products such as starch and flour for which markets are now available.

5- The Multi-crop Thresher

In the grain producing regions, the multi-crop thresher coupled with grain cleaner and sorter was demonstrated. The thresher can de-husk and shell maize. It was also demonstrated effective for threshing sorghum, millet, soybeans, mucuna and teff.

Despite initial interest, the thresher was not adopted immediately because of the separate cleaning mechanism which, to users, is cumbersome and time consuming. This led to the development of the thresher with the cleaning mechanism, Figure 22, which is now generating demand very quickly. Because of the bulky straws of cereals and legumes and the lack of means to transport them, threshing is conveniently done on farms. The development of the donkey-drawn cart, Figure 23, facilitates moving the thresher from farm to farm.

The introduction of the thresher in Benin inspired farmers to grow more of the Quality Protein Maize (QPM), 'Obatanpa'. When QPM was first introduced, the farmers were happy because of the good quality and high yield. However, they were discouraged when they found out that it is hard to shell, until the introduction of the thresher. Farmers reported increasing adoption of QPM when the thresher was introduced.

In Ghana, the thresher was not popular for de-husking maize because the maize husk is being used as food wrapper. The maize is first de-husked manually before it is shelled with the thresher.

In Ethiopia, the thresher was adopted almost immediately, initially for threshing teff. In the last 2 years the number of farmers and entrepreneurs investing and utilizing the thresher is increasing. The thresher is now being demonstrated and tested for other crops such as maize, wheat, millet, sorghum. More work remains to improve the cleaning mechanism applicable for multiple crops.

The mobility of the thresher is a feature liked by farmers. It can be transported even to the remotest farm where threshing can be done eliminating the bulk which is otherwise transported to central threshing sites. Continuing demand and adoption scenarios are being observed in West and East Africa. Adaptations are done by trained local staff.

6- The Wet-type Grinder

The wet-type grinder was introduced to do most wet grinding required in many African food preparations such

Fig. 20 – The portable grater is giving good income to service providers who now can reach processors in remote villages

Fig. 21 – The mini-grater opens options to process cassava and other crops

Fig. 22 –The multi-crop thresher with cleaner eliminatethe need for a separate cleaner,is compact and movable

Fig. 23 – The donkey cart developed at STVC is helping to move the thresher to the farmers in their own farms

as *mawe* and *ogi*[8] from maize, and soymilk from soybeans.

Agro-processors were at first reluctant to use the machine for two reasons: (a) the capacity is low, and (b) it is cumbersome to adjust and clean. The machine was modified so that the stationary disc in now fixed with the cover. This eliminates the tedious loosening and tightening of bolts and nuts particularly when cleaning and the requirement that the grinding mechanism must be kept dry before storage.

The wet-type grinder was modified (Figure 24), better appreciated and adopted. The users were able to find other application such as for grinding sheanut and groundnut for butter and oil production. Sheanut processors in Benin adopted the grinder and increase their sheanut butter production. To facilitate grinding, a collaborating manufacturer, COBEMAG, coupled a nut crusher to the wet-type grinder using one engine drive (Figure 25). The nuts are chopped into smaller pieces before feeding into the grinder. This increased the processing capacity and marketability of the equipment. This example shows trained manufacturers are able to handle adaptations which improves the profitability of their business at the same time satisfying the customers.

Sheanut butter production enterprise is growing in Benin and Ghana but is still constrained by lack of efficient kneading machine.

A soymilk processor in Ghana claims that using the wet-type grinder, his soymilk recovery was doubled compared to his old system. In Ethiopia, the grinder is now a major component of the groundnut oil processing enterprise producing excellent butter both for direct consumption, and for further processing into oil.

Sheanut and groundnut processors in Benin, Ghana and Ethiopia claim 20% gain in oil production when using the wet-type grinder, over the traditional method.

7- The Grain Polisher Modified as Palm Oil Digester

The auger-type grain polisher (Figure 26) was demonstrated for rice milling and polishing. The users found it tedious because of low capacity and the need for a separate cleaning of milled rice. Through users' initiative however, the polisher was found useful for palm oil digesting and palm kernel cracking.

This feedback resulted in the design of the removable and interchangeable augers (Figure 27) for polishing and cracking, and for

[8] *Ogi is fermented maize starch. Maize grains are soaked, ground, sifted, drained and formed into balls.*

palm oil digesting and palm kernel cracking.

In Ghana, several units of polishers (digester) were bought and heavily used (10 to 14 hr per day) in 1998 and early part of 1999. During this period, the auger had worn out extensively, and the changing of the auger component takes time and delays their operation.

The shaft was re-designed to ease replacement with minimum costs. The adoption of the palm oil digester demonstrated that palm oil production which used to be a backyard operation could be a profitable family business as related by users in Eastern Region, Ghana.

Fig. 24 – The improved wet-type grinder (R)

Fig. 25 - The *complexe karité* with one engine drive

Fig. 26- The grain polisher found its way to palm oil processing yards in Ghana and Benin being used extensively as digester

Fig. 27 –Augers developed for cracking palm kernel (L) and for digesting palm oil (R)

SECTION 6 -
MONITORING THE ADOPTION OF AGRO-PROCESSING TECHNOLOGIES

Agro-processing enterprises have important role in meeting the food requirements of both the rural and urban populace of sub-Saharan Africa. Agro-processing must be facilitated to make food sufficiently available and reliable. To do this, improved techniques and new technologies must be introduced.

Investment in machinery is a critical economic decision for small-holder farmers with very limited economic resource; therefore any machines considered must be low-cost yet versatile so that returns to investment are realized in a short time. Agro-processing machines should be simple, easy to fabricate and repair by village artisans using local materials.

Interventions made by the SAA-AP project in the last decade generated different technological options to improve and facilitate agro-processing in the rural areas and to help proprietors to build up a sustainable venture by developing the linkages among the stakeholders.

Varied feedback from the project sites required verification of the technical, economic and social consequences affected by the interventions. While many of the technologies introduced were technically efficient, issues associated on their economic and social consequences were analyzed.

The analysis involved the study of the demographic characteristics of the users of the technologies and evaluating the profitability of emerging business enterprises based on selected cases. Economic decision tools are inferred from these analyses which could be used as guide to investment options.

A monitoring survey was conducted in places where improve agro-processing technologies were fabricated and sold. The areas were selected from available manufacturers' sales and servicing records, and project monitoring reports. The survey was conducted in six regions in Benin namely Atacora, Atlantic, Boyou, Oueme, Mono, and Zou. In Ghana, the survey was conducted in seven regions namely Greater Accra, Volta, Upper East, Central, Northern, Eastern and Western regions. The percentage of respondents from each region is given in Table 7.

Farmers and agro-processors, directly using the technologies, as well as farmers, who just have knowledge about the technologies, were interviewed using semi-structured questionnaire. At times the use of the structured questionnaire presented a problem as most of the respondents neither could read nor write.

Percentage distribution of respondents by region, Ghana and Benin

Ghana: REGIONS	Percent Distribution	Benin: REGIONS	Percent Distribution
1- Greater Accra	6.4	1- Atacora	3.1
2- Volta	23.4	2- Atlantic	18.8
3- Upper East	3.6	3- Boyou	19.4
4- Central	11.7	4- Oueme	12.8
5- Northern	4.5	5- Mono	29.6
6- Eastern	30.6	6- Zou	16.3
7- Western	19.8		

The enumerators depended on their skills to gather needed information.

One hundred ninety six (196) respondents from Benin and 111 respondents were interviewed in Ghana. Personal interviews were also conducted by the authors to verify issues related to project implementation strategy and technological adoption and impact.

1- Demographic Characteristics of Respondents

The demographic characteristics of any target group have been known to greatly influence their adoption of any technology. Relevant characteristics include gender, marital status, occupation, farm size and ownership, crops planted. These characteristics determine to a large extent their tastes, preferences and felt needs and the way they respond to outside interventions.

The respondents' genders, marital status, source of income and farming profiles are shown in Table 8. Gender plays an important role in the food production in sub-Saharan Africa. Traditionally, postharvest and crop processing is a job reserved for women and children.

More than 50% of the respondents are female (women), and mostly married. Since the selection was based on users of agro-processing technologies, it can be generalized that more women are involved in agro-processing. This could explain partly why investments in agro-processing machinery are low. Many of the women do not have the capacity to invest on machines and do not have the technical training to operate and maintain them.

However, their marital status, majority being married, signifies a level of responsibility and that they are stable and productive agro-processors that will necessitate being able to get access to any means of income to augment their main occupation and improve their quality of life.

The main occupation of respondents in Ghana is farming with agro-

Demographic characteristics of respondents from Ghana and Benin (percent responding)

DEMOGRAPHIC CHARACTERISTICS	Ghana: PERCENT	Benin: PERCENT
1- Gender		
a. Male	45.0	22.6
b. Female	55.0	77.4
2- Marital Status		
a. Single	17.4	2.1
b. Married	81.7	97.9
c. Others: Widow, Separated	0.9	Nil
3- Occupation (Main source of Income)		
a. Farmers	60.8	24.2
b. Agro-processors	14.0	70.1
c. Others; e.g. Traders, Hunters	25.4	5.7
4- Farm Owners	84.1	83.9
5- Farm Size		
a. < 1 hectare	20.9	24.9
b. 1 - 2 hectares	37.2	45.9
c. > 2 hectares	41.9	29.2
6- Crops Planted		
a. Cassava	43.2	35.2
b. Maize	33.3	59.3
c. Others: e.g. Sorghum, Millet, Oil Palm	23.5	5.5

processing as their secondary source of income. Many of the farmer-respondents are also involved in oil palm plantations. The majority of respondents in Benin are agro-processors, few others are farming. Cassava and maize are the major food crops cultivated by the respondents. Consequently, cassava and maize processing is a major income-generation activity in both countries. The bigger percentage of agro-processor respondents in Benin are due to the development of the Sheanut butter enterprise in the northern part of Benin when processing equipment became accessible.

Eighty four per cent (84%) of the respondents in both countries reported to own and manage their farms having an average size between 2 to 5 acres. The major crops planted by the farmers are cassava and maize which they either sell or process for family consumption or for marketing.

2- Crop Use and Marketing Practices

Farmers' production objectives are to produce enough for consumption and marketing. With the average crop production level at 3 to 5 tons cassava per hectare, and about one ton per hectare for most cereal grains, it is still difficult to have a surplus for marketing considering the food requirements of a farm family with an average of 6 members. Despite this scenario, the respondents reported that their produce is allocated for consumption, processing and marketing.

Table 9 shows the percentage of respondents' allocation of farm produce to the different production objectives. It is assumed that if the farmers could sell, or process and sell more than half of their production and still have the provisions for the family, they are better off than the subsistence farmers.

In Ghana, the farmers consumed a third of their produce, sell a quarter of it immediately after harvest and process part before selling. Processing is done before selling to take advantage of the higher price by value-adding. This trend suggests that farming and agro-processing in Ghana is commercially-oriented.

In Benin, many of the farmer-respondents still consume what they produce, seldom processing; characteristic of subsistence farmers. Implications are that production is still very low; that improve production techniques are not yet fully adopted; that agro-processing technologies are not known; or that convenient foods are available at lower costs.

In both countries, the quantity of crops and products stored is still very meager to give a high priority for development of storage facilities. Immediate intervention needed is to expand production and provide agro-processing technologies that will provide value-added products to improve farmers' productivity.

- **Reasons for selling farm produce and processed products**

Farmer-respondents do not see the relevance of the law of supply and demand as many of them sell their crops immediately after harvesting or processing when the supply is plenty and the prices are low. The farmers could not hold their crops to wait for a better market price. The primary reasons given by the respondents are the need for cash to buy other family provisions, or lack of storage and processing facilities (Table 10).

- **Marketing Channel**

The access to market is an important factor considered on deciding the type and quantity of products sold or bought. The lack of good road and transport system in the rural areas where most of the farms are located limits the options available to farmers and processors on market outlet for their produce.

The weekly market is the most affordable option for farmers and

processors to trade their produce. In many cases, farmers and processors depend on middlemen, traders and wholesalers who come to the village, especially during the week markets. They are also able to sell their produce to market vendors and retailers, and among fellow farmers and neighbors who buy for their immediate consumption (Table 11).

The access to good market will encourage farmer and processors to participate in market dynamics.

Percent of respondents allocating farm produce to different production objectives

PRODUCTION OBJECTIVES	Ghana	Benin
1- Consumed by family	35.2	83.9
2- Sold immediately after harvest	26.8	1.9
3- Processed and sold	36.6	9.3
4- Stored	1.4	4.9

Reasons for selling farm produce immediately after harvest, or after processing

REASONS FOR SELLING	Ghana	Benin
1- Need for cash	50.9	81.1
2- Buy other family provisions	42.4	15.9
3- Lack of storage and processing facilities	3.8	1.5
4- Others: low production, lack of market information, limited access to processing facilities	2.8	1.5

Percent of respondents using marketing channel for farm produce and processed products

MARKETING CHANNEL	Ghana	Benin
1- Middlemen: Traders and Wholesalers	45.8	45.1
2- Market Vendors (Retailers)	29.0	37.9
3- Neighbours; Other farmers, etc.	25.2	17.0

3- Labor Input to Crop Processing

In Africa, crop production and processing has always employed family labor. The participation of the respondents to crop processing activities was found to be very important particularly involving women and children.

Labor input by family members and hired labor for processing cassava, maize and palm oil is shown in Figure 28. The figures show that processing is a family venture where wife, children and husband help each other do the tasks. Hired labor is also employed. The wife has a particular task in any food crop processing and does the others with the help of the husband and children.

In Benin, the husband does not do any processing on his own but he supports the wife in the process. In Ghana, the husband has high involvement in maize processing, maize being a cash crop. Normally, the husband will harvest, thresh, dry and sell the dry grains. Subsequent food processing for family consumption is done by the wife and children.

The participation of the husband in palm oil processing in Ghana is due to the difficulty of the tasks, for example plucking the fruits (harvesting) and fruit separation, rather than the magnitude. In Benin, the wife helps the husband in fruit separation after plucking the oil palm fruit. The remaining process is done mostly by the wife and the children. Using the traditional methods, family labor is stressed limiting their productivity both for the process and for other activities.

4- Sources of Information on Agro-processing

When the SAA-AP project started, source of information on improve agro-processing technologies are not well-known to the users. This created a gap in the development of the agro-processing and manufacturing industries.

The field demonstrations and the model processing centers established by the project are proving to be good venues to inform the target-users of improve technologies, their uses and availability. Promotional activities of collaborating manufacturers provided information, and the hardware.

The number of buyers and users of the equipment within the project sites extended to the adjacent villages and even to other countries. In addition to the program's promotional activities, the respondents reported other sources of information on agro-processing developments and technologies (Figure 29). Respondents in Ghana and Benin differ in the frequency of using these channels which could be due to accessibility and the extension mechanism in their country.

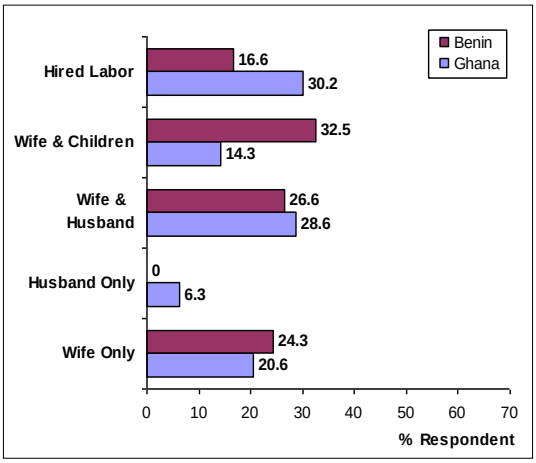

Fig. 28a – Labor input in cassava processing

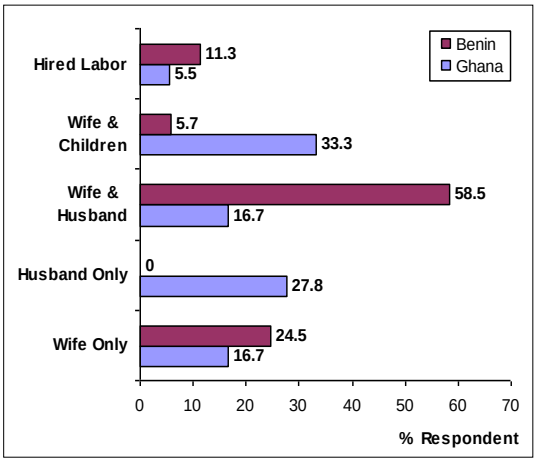

Fig. 28b – Labor input in maize processing

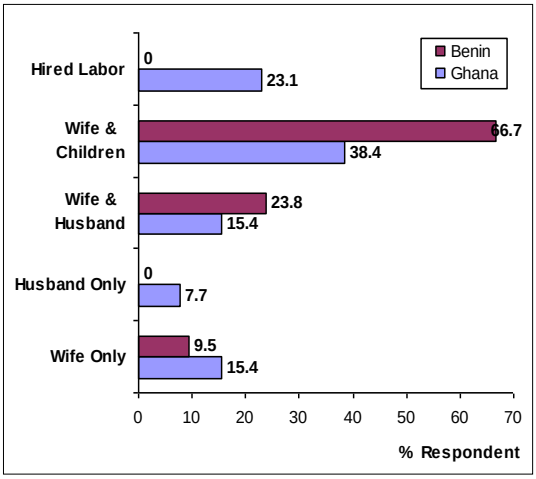

Fig. 28c– Labor input in palm oil processing

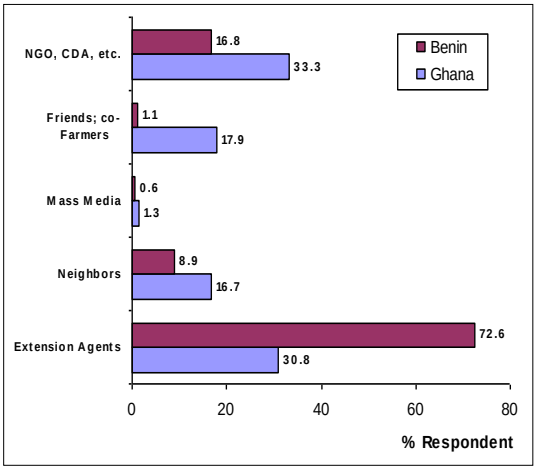

Fig. 29 – Sources of information on agro-processing

In Benin, the government extension agents are active in technology dissemination process, while the community projects, in addition to the work of the extension agents, is helping in information transfer in Ghana. Information is also passed on from farmer to farmer, and among neighbors and friends.

The use of mass media such as the radio, newspapers and television is still not popular. The lack of reliable power source in the villages could explain the poor use of the media. It could also be explained by the fact that written information on agro-processing is still scanty as it is only very recently given attention, not to mention that many of the farmers and processors are not able to read and write. Language is also a problem as there are many dialects

spoken even within a community. Developing extension materials will need the training of manpower to determine the type of media suitable for the different clients.

Farmers and agro-processors depend on community development programs, including the SAA-AP project, for information on developments on farming and agro-processing.

5- Adoption of Cassava Processing Technologies in Ghana and Benin

The SAA-AP project introduced the cassava processing equipment package developed at IITA and some selected locally-improved technologies. The package included the peeling bay, peeling tool, cassava grater, fermentation rack, double screw press, cassava mash and *gari* sifter and the improved frying stove. The past decade has seen increasing adoption of the technologies, either as a package or as separate component equipment, in Ghana, Benin and other West African countries.

Table 12 shows the percentage of respondents adopting improve technologies for *gari* processing. Harvesting is still very traditional using the cutlass, the project being unable to identify an efficient mechanical harvester. The improvement recommended for peeling, that is using the peeling bay, was not adopted. This can be explained by some social factors associated to the process, in addition to the cost of acquiring it. Peeling is a job done by women and children. Cassava roots are heaped, and peelers sit around the heaps to peel. They take this opportunity to discuss issues of common interest such as personal and community development issues. They are paid by the volume of cassava they peel.

Improve techniques for the critical unit operations of grating, pressing, sifting and roasting for *gari* processing were adopted. Improved graters have almost replaced traditional grating (rasper), which has increased the processing capacity of the processors. The double screw press was also well-adopted. The sifter was well-liked by women and children but had created conflict on its management. At one point it was abandoned by some processors in Benin. The project offered a solution by re-design the sifter for individual use.

Locally-improved technologies are available in Ghana even before the intervention of SAA. Ghana has comparative advantage over Benin in terms of the presence of more postharvest support programs both from the government and non-governmental development organizations.

In the 80's to early 90s, Benin's agricultural extension program concentrated on promoting

Adoption of improved techniques per unit operation in cassava processing

Unit Operations	Ghana			Benin		
	Traditional	Locally-Improved	IITA Machines	Traditional	Locally-Improved	IITA Machines
1- Harvesting	100	0	0	100	0	0
2- Transporting	79.5	20.5	0	90.7	6.98	2.3
3- Peeling	100	0	0	97.7	0	2.3
4- Grating	2.1	19.2	78.7	1.6	0	98.4
5- Pressing	26.1	0	73.9	3.4	25.4	71.2
6- Sieving	42.5	0	57.5	82.9	0	17.1
7- Frying	68.6	25.7	5.7	57.0	43.0	0

the production of cotton which supplied the export market. However, the demand for more food crops and processed foods shifted part of government's support to crop production and processing. Their collaboration in the project has been instrumental in bringing appropriate technologies to farmers and processors which encourage them to produce more food crops.

6- Adoption of Maize Processing Technologies in Ghana and Benin

The SAA-AP project introduced the multi-crop thresher and wet-type grinder to improve processing of maize and other cereal grains.

The first model of the thresher developed at IITA was provided with a separate cleaner/sorter. Farmers found the thresher effective in de-husking and shelling maize but the separate cleaner/sorter was cumbersome. The adoption was slow (Table 13) but the feedback was useful in the adapting the machine to users' requirements.

In Ghana, the thresher was not very popular for maize shelling because of the need to get the husk in good form to be used in wrapping food for cooking. In Benin, the thresher was better adopted.

The wet-type grinder was also introduced for maize grinding such as for the production of *mawe*. Because of the availability of locally-improved maize grinders, the wet-type grinder was not well-appreciated. However, the processors found the grinder more applicable and useful for Sheanut butter processing. It gained a widespread adoption in the northern part of Benin.

Adoption of improved techniques by unit operation in maize processing

Unit Operation	Ghana			Benin		
	Traditional	Locally-Improved	IITA Machines	Traditional	Locally-Improved	IITA Machines
1- Harvesting	100	0	0	100	0	0
2- De-husking	81.8	0	18.2	77.1	0	22.9
3- Threshing	52.2	17.4	30.4	55.6	0	44.4
4- Cleaning/ Winnowing	84.0	4.0	12.0	93.9	0	6.1
5- Drying	85.0	5.0	10.0	100	0	0
6- Grinding	5.9	76.5	17.7	7.7	92.3	0

7- Adoption of Palm Oil Processing Technologies in Ghana and Benin

Palm oil is a major source of edible oil in the rural areas especially in the moist savannah belt of sub-Saharan Africa. Small-scale processors using traditional methods are found in many villages of Ghana and Benin. Many cassava farmers have access to oil palm plantation and process their own palm oil for family consumption or for selling in the local market.

Working with the processors, the SAA-AP project was able to adapt a grain polisher for palm oil digesting and palm kernel cracking. This was introduced and tested in selected sites. An oil press was also devised and introduced with the digester. The digester and the press were adopted well in Ghana, Table 14. The respondents in Benin were not involved in palm oil processing although the digester and press were demonstrated in the village of Atok, South of Benin. Few processors adopted the package but did not become widespread. According to the processors interviewed the digester has low capacity and is difficult to feed because of the height of the hopper, Figure 30. Some modifications were recommended but there was no further follow-up on adoption.

Small-scale palm oil processing is still dependent on traditional methods although big scale processing industries are already operating in the region. Not many of the processors could get employed in the factories. They supply the local market requiring fresh oil in small quantities. Appropriate technologies for the small-scale processors are not sufficient to pursue their business. Palm oil processing technologies need to be developed and introduced to users in order to help shift the production to a commercial-scale.

Fig. 30 – Palm oil digester was tested in Atok Village, South of Benin. The difficulty in feeding was due to the height of the machine and inadequate training of operator

8- Utilization and Management of Agro-processing Equipment

The monitoring survey was carried out to find the extent to which project intervention is affecting the ownership and management of the equipment that could relate to who actually benefits from the process and the sustainability of the system.

The level of adoption of the technologies is encouraging. One contributing factor is the awareness created by the activities of the project and the linkages created among technology-users, the manufacturers and potential funding organizations.

• Equipment Management Scheme

The machines adopted are owned and managed by individuals, groups or institutions either for their own processing activities, or to provide services to processors, or both (Table 15). In both countries a higher percentage of equipment owners and processing group operate both own processing and custom hiring.

Custom-hiring or service-providing is becoming a popular practice to manage the equipment profitably. The processors in both countries patronize the practice since it allows them access to the facility when they could not afford to buy. Service providers in Ghana have up to 10 regular customers per day, during processing season. Smaller

percentage of processors avails of these services in Benin where processors prefer to own the machine and use it for their own processing, either individually or as a group.

Of the agro-processing machines introduced, those that have capacity to process at least one ton of raw material per day were found to have high adoption rate. These machines have high potential for creating an industrial-scale production. These are the more mechanized machines which involve high investment costs but have capability to generate income. Subject machines are the grater, wet-type grinder, palm oil digester and multi-crop thresher. Interestingly, the machines are purchased by different interest groups for distribution to their clients, or for demonstration and training.

It was found out that some individual entrepreneurs (including family enterprise) are already adopting the technology and that management of the technologies is mainly in the hands of these users.

Table 16 indicated that the grater and the multi-crop thresher are commonly owned by group of processors (women's groups, or community) either bought through loans or donated by development organizations. The group hires an operator and the machine is used to process the produce of the members, at times, used to provide processing services to non-members. Group ownership brings the users to invest collectively and benefit from it.

The wet-type grinder and the palm oil digester have been adopted by individual entrepreneurs or family business enterprises for processing their own produce and servicing other processors in their villages.

Institutions such as NGOs, and Universities also buy machines to: (a) generate income, (b) provide service to the community, and (c) demonstrate and train agro-processors on improving agro-processing operations.

In Ghana, NGOs and other development agencies are helping the SAA-AP project to promote the machines using their own demonstration units purchased from the project's collaborating manufacturers. The project staff, assisted by the technician supplying the equipment, provides them training on operation and management. Some agencies provide loan support to interested women groups to purchase improved agro-processing equipment.

Adoption of improved techniques by unit operation in palm oil processing

Unit Operation	Ghana			Benin		
	Traditional	Locally-Improved	IITA Machines	Traditional	Locally Improved	IITA Machines
1- Harvesting/ Plucking	100	0	0	100	0	0
2- Fruit Separation	100	0	0	100	0	0
3- Boiling	90.9	4.6	4.5	100	0	0
4- Digesting	13.6	4.6	81.8	100	0	0
5- Pressing	14.3	52.4	33.3	100	0	0
6- Kernel Cracking	42.9	28.6	28.5	100	0	0

Percentage of respondents reporting ways of managing the agro-processing equipment

MANAGEMENT SCHEME	Ghana: PERCENT	Benin: PERCENT
1- Own processing	30.6	70.6
2- Custom-Hiring / Service-Providing	24.2	7.8
a) Less than 5 customers per day (< 5)	14.0	54.8
b) Five to 10 customers per day (5 to 10)	67.4	41.9
c) More than 10 customers per day (>10)	18.6	3.3
3- Own processing and service providing (1 & 2)	45.2	21.6

Type of ownership of different agro-processing equipment in Ghana and Benin (per cent of recorded sale)

TYPE OF EQUIPMENT	INDIVIDUAL OWNERSHIP		GROUP OWNERSHIP		INSTITUTIONAL OWNERSHIP	
	Ghana	Benin	Ghana	Benin	Ghana	Benin
• Grater	36.7	34.5	40	62.1	23.3	3.5
• Wet-type Grinder	-	11.1	75.0	88.9	25.0	-
• Palm Oil Digester	53.8	50.0	38.5	50.0	7.7	-
• Multi-crop Thresher	38.5	35.3	46.2	58.8	15.4	5.9

9- Feedback on Recommended Improved Agro-processing Technologies

The users' feedback to the project team, through their local extension agents and country coordinators, allowed the project team to assimilate information to improve the performance of the technologies and adapt the technologies to local conditions for better adoption rate.

The respondents in Ghana and Benin gave their views on the advantages and disadvantages of the technologies over their current system and what they think is right for their operations based on their capacity. A set of recommended amendments to technologies was also given by the user-respondents.

- **Advantages of the agro-processing equipment**

The adoption of improved agro-processing technologies in Ghana and Benin can be attributed to the simple design, make and operational requirement of the technologies.

The respondents from Ghana and Benin have similar views on the advantages of the agro-processing technologies introduced by the project ranked by importance in Table 17. Respondents indicated that time-savings is the most important benefit they get from the use of the technologies. Equally important to processors is the availability of the machine, and associated services. This has been a big constraint in the adoption of technologies introduced earlier.

For many women processors, the ease of operation and maintenance is also an advantage, more than the cost. They can now operate the machines without much dependence on their husbands or operators which means that they can have full control of their own businesses.

Improve process allows them to add-value to their products that could demand better prices in the market. Good quality products from the improve process has definitely allowed them access to good quality food for the family and opened opportunity for them to compete in the market.

Social benefits, as increasing time with family, and participation in community activities, is being recognized as benefit derived from increasing agro-processing activity due to the adoption of improved technologies.

- **Disadvantages of the agro-processing equipment**

Equally important feedback from user-respondents is the disadvantages of the technologies which could hinder their full adoption. This information had helped the project team to stratify its activities and feedback to the technology designers to develop technologies that will be more adoptable to the target-users.

Technology user-respondents from Ghana and Benin ranked the

disadvantages of the equipment differently, Table 18. In Ghana, technology-users see that spare parts must be available in sufficient quantity at anytime, while it did not seem to bother users in Benin. The strong support of the government to the local manufacturing industry in Benin, through the collaborating manufacturers' network gave them confidence that spare parts can be source and made available accordingly.

The lack of some component equipment in a technology package, as for the package for the production of Sheanut butter, hinders the full development of agro-processing to a commercially viable income-generating venture. This will justify a continuing research and development project that could help to source and package appropriate technological options to processors.

High initial and maintenance costs should be looked into by further adaptation to make use as much as possible of all local materials, and sourcing the equipment locally. Breakdowns and maintenance problems should improve through continued training on operation and maintenance. Continuing usage will also develop the skill of the operators and improve the performance.

- **Recommendations to facilitate the adoption of agro-processing equipment**

The user-respondents forwarded three major recommendations (Table 19) to facilitate the adoption of the technologies introduce by the SAA-AP project. It is important to train users and operators in order that they can better understand the proper operation and management of the technologies. This will help them appreciate the technologies and use them to their full advantage.

The source of fund to finance establishment of agro-processing enterprises needs to be identified and made accessible to the processors. The farmers and agro-processors are still economically constrained to invest in machinery. Financing institutions will help them to start their businesses.

Mobility of the technologies is a feature that is liked most by the technology-users. Crops are produced in remote farms and villages where the road and transport system is still not developed. Secondly, agricultural products are mostly bulky and perishable. Processing should therefore be done at the production sites. An important lesson of the SAA-AP project is to develop machines that could go to the target-users, hence most of the technologies developed and recommended are compact, light weight allowing mobility but not sacrificing the capacity and quality. Problems on operation, repair and maintenance reported by users such as proximity of services, lack of training on proper operation and management of the equipment are guiding the project team to re-orient its training

strategy. Result of the survey underscores the importance of regular monitoring visits particularly by the manufacturer to check on the conditions of the machines and provide necessary repair and services. There are cases where machines are being moved from one site to another because of availability of raw materials. This makes reconciling sales record from manufacturers with utilization record difficult.

Respondents' view on the advantages of the agro-processing equipment introduced by the SAA-AP program

ADVANTAGES OF THE MACHINES	Ghana		Benin	
	Rank	%	Rank	%
Saves time	1	23.6	1	21.5
Good quality of products	2	22.6	5	13.3
Locally available	3	15.1	2	20.0
Less worry to deterioration losses	4	11.3	4	14.4
Encourage increased production	4	11.3	8	3.6
Ease of operation and maintenance	5	7.6	3	15.4
Allows production of other marketable products	6	3.8	6	6.7
Fosters co-operation among family members and the community	6	3.8	9	1.0
Low investment costs	7	0.9	7	4.1

Respondents view on the disadvantages of the agro-processing equipment introduced by the SAA-AP program

DISADVANTAGES OF THE MACHINES	Ghana		Benin	
	Rank	%	Rank	%
Spare parts not readily available	1	21.7	7	2.1
Lack of package component	2	21.7	3	15.9
High investment costs	3	16.1	2	19.5
Frequent breakdown	4	16.0	6	8.2
High cost of maintenance	5	13.2	4	15.4
Limited capacity	6	10.4	5	9.2
Cumbersome to operate and maintain	7	0.9	1	29.7

Respondents' recommendations to improve the adoption agro-processing technologies introduced by the SAA-AP project

RECOMMENDATIONS	Ghana		Benin	
	Rank	%	Rank	%
Increase capacity	1	32.1	2	8.7
More training on operation and maintenance	2	28.3	1	47.7
More access to funding and lending institution	3	23.6	3	7.9
Reduce capacity to reduce investment	4	7.5	5	1.6
Limiting the number of users	5	5.7	4	2.6
Improving mobility of equipment	6	2.8	6	1.5

Thanks to the inputs of Ms. Bose, IITA Research Associate (Agricultural Economics) in collating the survey data.

SECTION 7.1 -
ADOPTION AND UTILIZATION OF IMPROVED AGRO-PROCESSING TECHNOLOGIES-CASES IN BENIN

Fig. 31 - Sheanut butter processing using the *complexe karité* has been developing into a profitable business enterprise in Benin

Agro-processing is gaining recognition in Benin when income from cotton farming could not provide for the food demand. Farming food crops was encouraged by the availability of improved technologies through the work of the SAA-AP project.

Since cassava is a major food crop, processing it is a main activity especially for women who use traditional methods which are slow and cumbersome. Maize is another food crop for which not many processing technologies are available. The project also observed that rice is becoming an important staple in the diets of the people of Benin. Although rice production is still small and specific to a region, it was necessary to help farmers with improved postharvest equipment to encourage them to grow more and supply the requirements in the local market.

Sheanut butter processing is a family business using traditional methods. Sheanut butter has a big market potential. The demand for Sheanut butter in Africa as well as Europe is increasing. Improve techniques will enable the processors to supply the market with the right quality and quantity

The work of the SAA-AP program provided options to farmers to expand their food crop farming and enable value-adding to their crops through processing to more durable and marketable forms. Technology-users, processors and manufacturers were interviewed to learn of the benefits they derived form adopting the improve technologies (refer also to Annex 2).

1- Benefits from Improved Agro-Processing Technologies

In general, the women and other processors claim that the improve processing reduce the drudgery of the once cumbersome processing. The

processors appreciate better the benefits from processing because they are able to earn money in addition to providing good quality food for the family.

The introduction of improved cassava processing equipment in the villages of Benin presented good opportunity to improve strategy for technology design and transfer. The benefits are varied depending on situations and objectives of the processors.

• **Increasing Capacity and Income**

The model processing center established by the SAA-AP project in Agodenou Village, Carder Atlantic is being operated and managed by the *Gbezealo* Women Group. The women claim *gari* processing pays. The facility is helping the community process their food and provide them a major source of income.

The former operator of grater of the *Gbezealo* group saw the increasing demand for grating services. He invested in a grater privately while continuing to assist the *Gbezealo* women. He now provides grating services to the other processors and is able to improve his family's living standard from his income.

Adopting the IITA-designed rice mill, Mr. Amadu provides milling services to customers competing with the other 4 conventional rice mills in the village. In less than one year, he is servicing up to 30 customers per day operating at least 2-3 days in a week. This translates to an average milling capacity of 1.0 to 1.5 tons milled rice per day or an average income of CFA10,000 (approx $20 per day) for Mr. Amadu. Many customers are availing of the services because of the good quality of resulting milled rice.

Sheanut butter processors likewise expressed their satisfaction with the improved machines, the Sheanut Complex (*complexe karité),* introduced by the project and are happy of the direct benefits that come to their families. The machine in Baká now keeps the women busy. The women realize that what they used to do manually is now an income- generating activity. They process Sheanut into butter twice a week and still have more time to spend with their families, or process more. The facility is teaching the women how to earn income. In addition to the Sheanut Complex, the group plans to purchase cassava processing machines and also learn methods of processing *dawa-dawa* (a fermented condiment from locust beans).

The increasing income from processing Sheanut butter enable them to feed their families, send their children to school and provide better medical care for the family. They also get additional capital to buy raw materials during the peak harvest season. They could now process and store their products to wait for a good price in the market.

The maize thresher proved to be very useful in maize farms in Atomey and Lokokoukoume Villages in Ouémé Department. What farmers used to

thresh for 5 months could now be threshed in 2 months, though still constrained by cleaning. With the thresher, they can now program their operations to wait for a favorable market price.

- **Value-Adding and Improving Quality of Products**

Processing adds value to the product which can command higher price in the market. The *Gbezealo* Women Group takes pride of their good quality *gari*. The President of the Group, Mrs. Abassi Houton, says 'our good quality *gari* made us famous. Many customers from the neighboring villages and, as far as Cotonou, come to the center to buy our *gari*. We charge higher price for our first class *gari*. The customers are satisfied.' Hence, improving and maintaining the quality has been the focus of their processing since 2003.

Sheanut processing by women groups in northern Benin had developed to a more commercial scale after the adoption of improved technologies. During peak harvest season, the women buy as much Sheanut as they can which they store to keep their business going during the lean months when the price of Sheanut butter is also higher.

The women are happy with the quality and quantity of butter produced from the machines. The butter is very fine which easily yields oil reducing the kneading time and increasing oil recovery. Other processors, who are non-members, also come to use the facility because of the good quality of butter.

- **Employment Generation and Job Creation**

Using traditional methods, the scale of processing could only cater to family food production. Adoption of improved technologies makes processing an attractive enterprise that creates job and employment for the rural populace.

A new cassava processing center is being established in Toui Village along the Cotonou-Parakou Road. It is equipped with a grater, two double-screw presses and a frying shed for four operators. The center employs 6 women who fry *gari* daily. Additional workers are hired on casual basis to harvest and bring cassava to the site.

Mr. Hessou George is a retired civil servant turned farmer- entrepreneur. He farms cassava, maize, and oil palm in Hinvi Village, Atlantic Department. He realized that farming is not good without processing. He put up his *gari* processing facility within his farmstead equipped with 6 frying stoves, a grater and a press. He hires workers to fry *gari* for him which his family sells in the local market. In order to optimize the use of the grater to increase his income, he moves it around the village to service other processors who could not bring their cassava to his farmstead.

The former grater operator of the *Gbezealo* group in Agodenou village saw the increasing demand for grating services. He invested in a grater privately while continuing to assist the *Gbezealo* women. He now provides grating services to the other processors and is able to improve his family's living standard from his income.

Women groups operating the *complexe karité* for Sheanut butter processing employ an operator to assist in operation and maintenance of the facility. The operators are paid for the services rendered.

- **Group Members Invest Collectively**

Considering the limited resources of processors, collective investment provides them opportunity to own and manage improved agro-processing machines. In 1998, six women processors in Eni Village grouped to avail of a loan to acquire a package of cassava processing equipment provided through a rural development project by IRCOD, a French NGO. The members put up their share including water and gravel towards the construction of a store and a machine shed, and the land where the facility will be installed. The new facility had helped them to increase their capacity. They get raw materials from farmers in the village and even from markets as far as 4 km away.

The *Bobonsou* Women Group realized that farming cassava does not pay unless it is processed. In 1998, the group bought grater, press and sifter to enable them to improve their processing methods. The facilities allow them to process the produce from their farms and still buy more cassava from the local market. The processing business proved to be profitable; other processing groups were formed following the success of the initial group. In 2002, they acquired a 2nd grater through a loan from a government program.

- **Enhanced Leverage to Development Funds**

Improved agro-processing has shown increasing capacity and income to processors. However the expansion could not be sustained unless sufficient fund to purchase improve equipment is made available. The SAA-AP program linked the processors to institutions that could provide funds to interested groups. Many adopters were noted to have been granted loans because of their self-help and initiative to improve their operations.

IRCOD, a French NGO, supports projects for the improvement of women agro-processors which started in 1993. The support consists of a loan to enable women to purchase their needed equipment. IRCOD developed a working relationship with COBEMAG as a result of the field demonstrations conducted by the SAA-AP project. Groups applying for funds are introduced to COBEMAG for equipment selection.

In 2000, IRCOD, provided credit to the *Taki-Sari* Women Group in

Sirarou Village to buy a 2nd grater and press set because they demonstrated interest and hard work. The group was provided by the SAA-AP program a grater and sifter, on loan. The women used the facilities and saw the business was good. It encouraged them to work harder and in one year they were able to repay their loan.

The Ministry of Rural Development also donated to the group a single screw press to the group in recognition of their hard work.

Other groups, the *Borignindou* Women Group in Tourou Village and *Sodom'se* Women Group in Koroborororou Village were provided loans by IRCOD to acquire and install relevant processing equipment. The women worked hard and were able to payback in 14 months. Because of their good repayment record, IRCOD recently donated a bread-baking facility to the group.

The *Dagbe Bamide* Women Group in Avakpa received a generous donation of rural infrastructures including agro-processing machines from the African Development Fund (ADF) in 1999. A social worker from the Ministry of Women Affairs in Allada identified the group and recognized their hard work and self-help development initiative recommending them for the ADF benefit. The group was provided with processing shed, 1 grater with petrol engine, 4 double screw presses, frying stoves and water well. They use the facilities for their own processing but also extend grating and pressing services to the processors within the village and the neighboring villages.

The *Massitohou* Women Group in Aligoudou Village is a beneficiary of a government program helping women to increase their income. The program taught the women to improve *gari* processing and introduced them to processing fritters from cassava starch. They were also given a cassava grater, on credit. As the women adopted *gari* processing using the improved techniques, they requested the CARDER program to provide them an additional grater, for which they were given the IITA-designed grater. In addition they also received a double screw press and a fermenting stand which they found very useful.

The rice millers of Boké walked 2 km to the next village to wait for their turn to mill their rice. When lucky they could return to their village with their milled rice within 4 to 6 hours. Else, they have to go back the next day, or use their mortar and pestle. This was the scenario not long ago before they acquired their own rice mill.

The *Nanayé* women group of Boké village realized that their rice processing activity, although small in scale, is giving them more income and has good potential to develop into a business. Through the help of a Missionary Nun of a Catholic Church from France, the *Nanaye*

women group acquired a rice mill. Besides milling their rice, 10 to 15 customers and processors come to use the mill on Fridays, day before the market day.

The *complexe karité* in Baká was donated to the community by the Catholic Relief Church (CRC), an American-based NGO dealing with Health and Social Welfare. The *Antisua* Women Group is the primary beneficiary of the machines. The women first saw the machine in Koroborourou Village, about 3 km away, which they informed the social-worker from CRC. The community helped to put up the housing for the machines as their contribution.

In 1997, the CREP of Atomey with about 300 farmer-members acquired a thresher with a manually-operated grain cleaner/ sorter for use by the group and the other maize farmers in the community. Atomey Village in Mono Department is reached only through a very rough road almost un-passable on rainy days.

The thresher was very useful to the farmers which saved their crops from deterioration such that two other CREP groups in the nearby villages bought the thresher with cleaner. One individual entrepreneur also bought one thresher which adds up to the threshing capacity in the village, yet they need more.

- **Private entrepreneurs helping to provide access to improve technologies**

Women processors who do not have the capacity to pay for the machine depend on private entrepreneurs who can provide services in their own yard. The number of private entrepreneurs providing agro-processing services is increasing and benefiting from it. The women prefer this kind of arrangement. It frees them from the problems of machine operation and maintenance keeping them focused in their processing.

An entrepreneur from Savé Village, central Benin, comes to provide grating service to the women group in their processing site along the Cotonou-Parakou road from 4:00 o'clock in the afternoon. When done, he leaves the grater in the site but bring home the engine. Machine fabricators provide the same services as part of their promotional activity.

Mr. Boni Hubert, an auto-mechanic in Borone Village, Tchaourou Town, invested in a portable cassava grater demonstrated by the SAA AP. He does not process *gari* himself but saw it as an opportunity to help the people in his village while at the same time earn his income.

Mr. Boni carries his grater around the village at the back of his motorbike. He can service for up to 35 customers or a service capacity of up to about one ton cassava per day. Providing grating service had improved Mr. Boni's social status and has earned him sufficient

income. Likewise, the women benefit from the arrangement as it allows them to program their *gari* and *tapioca* production effectively.

A young entrepreneur bought one unit of the multi-crop thresher from COBEMAG. Because of the mobility of the thresher, he thought he could help the farmers by providing threshing services. He started to move around the farms and villages with his thresher. The farmers patronized the threshing service which provided good income and popularity to the owner-operator. The maize farmers come to him to schedule their operations. He maintains his thresher and engine regularly keeping it in good condition all the time.

Based on this experience, another 5 units of the thresher were bought by other entrepreneurs about 250 km North of Parakou and are being used to provide service to farmers and processors.

2- Conflicts and Management Issues

Agro-processing is starting to emerge as a profitable business but needing a lot of expert advice to make it sustainable. Most processors do not have formal training on business management and also lacking technical training to operate the machines efficiently.

Funding is a big constraint as investment on machinery is a big economic decision for the small-scale processors wishing to start the business. The lack of funds among the processors however encouraged them to invest collectively on improved technologies to help in their operations. Group ownership of processing equipment could create management conflict. The conflict, if not resolved, could result to abandonment of the facility and waste of investment. Group management requires a good supervisor who will guide the farmers and processors in their farming and processing activities and help them to understand the profitability of their activities.

During project monitoring visits, processors are often concerned with conflicts and management issues more than the technical performance of the machines.

A cassava processing group in Savé (a village in Central Benin) received a grater and a press from a rural development NGO. They however could not cope with the operation and management requirements causing them to give up on the machines. A service-provider helped the group to carry-on their processing business. The arrangement freed the women of the troubles of managing the machines which enabled them to concentrate in their processing activities. Other groups hire a man to operate the grater and to help them to keep track of their processing activities, but keeping the business under their control.

Draining the effluent from cassava processing created an environmental

concern and could result in conflict among villagers in Sirarou Village, Boyou Department. Many processing sites with increased capacities experienced the difficulty of draining the effluent. This could contaminate the source of water supply, example a deep well, close by, or affect the plant cover where the effluent water drains. A serious mitigation case happened in Sirarou Village, Borgou Department (Benin) where a deep-well close to the processing center was abandoned due to contamination. Locating the cassava processing center is critical and requires a good drainage system.

Group management of thresher in Atomey Village presented the following constraints:

- Conflict in scheduling of work,
- Decision-making is slow, and
- Repair and maintenance is not done on time.

These constraints are not confined to thresher-use. Other groups reported similar incidences which resulted from poor coordination and weak management.

However, using the Sheanut Complex by the *Borignindou* Women Group in Tourou Village did not present the same problem. They hired an operator although the members themselves are able to operate the machine. They share their benefits to the other processors who are non-members by allowing them access to the machines. They see the business very promising with increasing demand for machine services and prefer to keep the ownership and management of machine to their group. They plan to buy a second unit which they can put up in the nearby village so that they can help the processors save time in carrying their crops to their village for processing.

The Manager of the CREP of Atomey, Mr. Aklan Justin, informed that their group trained and employed 2 operators who are paid from the proceeds of threshing services provided. They also appointed a management committee to manage the facility. The farmers found the profitability of agro-processing and encouraged to increase production and processing of food crops. CREP plans to give loan to individuals instead of the groups to buy agro-processing equipment.

Increasing production also created a problem to find market. For Sheanut butter, IRCOD is helping to advertise their clients to advertise their products by displaying and selling their products in Boutique la Qualité in Parakou.

The rice mills in Boké and Mani Villages although found very effective, has not been operational because of conflict in management. In each village, the women group operated the machines for three months but they stopped when the operator left. The group is now making arrangements to find a new operator. This can happen with lack of training and know-how on the part

of the owner when they become dependent on outside help to manage their resources. For most women, this hinders their capacity to expand their businesses.

3- Equipment Manufacturing and Servicing

The increasing demand for improved agro-processing equipment in Benin necessitates that they are locally available and the associated services are accessible. The manufacturers' network, Réseau F.M.T.A is now the main supplier of agro-processing equipment in Benin. Other local manufacturers are also copying the machines and selling them.

The role of local manufacturers is very crucial in the success of the operation of improve agro-processing technologies. The women are not worried about machine breakdown. The presence of the manufacturers makes them confident that any needed repair and maintenance is easily attended by their technicians. They are willing to pay the costs of these services.

- **Réseau F.M.T.A.**

Whannou Erasme, President of Réseau F.M.T.A. and General Manager of COBEMAG relate the benefits gained by the network members as partner of the SAA-AP program. The program provides information on design of reliable post-harvest and agro-processing equipment appropriate for local processors. It provides associated training on manufacturing and servicing of the same machines. The trainings improve the skills of their technicians who now provide good training for operators on machine operation and maintenance.

The recognition of the government given to the Manufacturer's Network (Réseau F.M.T.A.) formed among the collaborating manufacturers in Benin, shows the government's commitment and confidence for the supply of good quality locally-made machines. The Ministry of Industry supported selected technicians of the network to undergo refresher training in Tunisia in 2004 to upgrade their skill. Recently, the network has been tasked by the Ministry to participate in planning the Mechanization Program of the country which is to be funded by Food and Agriculture Organization (FAO).

Mr. Erasme added that the program's monitoring activity had help them realize the importance of after-sales service to maintain good customer-relation and help processors optimize the use of their machines. Through this activity, COBEMAG, as well as the other members of the network, gained a reputation as 'manufacturer of good quality equipment'. 'Policy-makers and major government and non-government rural development programs come to us for advice for the supply of required equipment', he added.

Their involvement in the project also enabled them to participate in local,

regional and international trade fairs opening up to more markets and earned them various recognitions and awards for quality fabrication.

In the case of COBEMAG, the linkage to potential customers through the project increased their sales and income. The sales of agro-processing equipment which used to be 10% of the total income of the company now contribute at least 30%.

The program had also sensitized COBEMAG management to make modifications on machine designs to adapt to local conditions. COBEMAG now puts more emphasis on product development to improve their business. For example, when the wet-type grinder was introduced for Sheanut butter production, they noticed that the processors need to crush the nuts into smaller pieces for more effective grinding. They then adapted a nut crusher with the wet-type grinder. This increased the adoption of the system, now known to processors as the *complexe karité* (Sheanut Complex). As they continue to relate with the customer, they are now developing a kneader to be included in the Sheanut processing complex.

CAMEMEC supplies a major portion of the demanded *gari* processing equipment and benefits from providing repair and maintenance services to equipment-users. C.F.T.S. which used to be a vocational training institute recently added a fabrication unit for agro-processing machines. Fabrication and sales of agro-processing equipment were added to their mandate which augment the company's financial resource. C.F.T.S. is active in the production of cassava processing equipment, multi-crop thresher and palm oil processing equipment.

APROMAH equipped with information from technology users has been developing new technologies, for example the groundnut sheller and recently palm oil processing equipment, helping the project meet requirements for appropriate technologies.

The activities of the manufacturers' network are well recognized. The project continues to seek more alliances to strengthen the network in terms of sharing information and resources. A manufacturer, CEFACOM (Centre de Formation de Fabrication et d'Ajustage en Construction Métallique) joined the network in 2003. It has a well-equipped workshop which could support fabrication of complicated machine parts and training of technicians.

The biggest challenge now faced by the collaborating manufacturers is funding the activities of the network. Mr. Erasme observes that agricultural machinery business is difficult because farmers and processors can't afford to buy them. Agro-processing and the introduction of improved equipment are new in Africa and therefore we need to work

harder in terms of reaching the customers.

• **Roadside Fabricators**

A grater similar to IITA-design was spotted in front of a roadside mechanical workshop operated by the 'Welder from *Kere*' on the Cotonou-Parakou Road in Glazoué District. His son returned from training in C.F.T.S. and fabricated a grater and a double screw press which he used to demonstrate to processors and provide grating services in the village. This promotional activity is helping the processors and has boosted his business.

Located farther up the Cotonou-Parakou Road, in Savé District, the Atelier et Service de Formation (SOCOMÉ), lines up its agro-processing machines for sale. Not in the line of prototypes on display, but seen on the billboard, are the drawings of the IITA-designed grater and double press. The owner, Mr. Homer Onidje, a welder turned entrepreneur, is a former staff of COBEMAG and then of Songhaï, an international NGO for rural development. Encouraged by the sales of agro-processing machines he saw in COBEMAG, he established his own workshop. He now sells the IITA- designed grater, and adapted the double screw press to be more portable and affordable. The modified press sold quickly. He keeps his business running by fabricating anything the customers ask.

His experiences in COBEMAG help him to adapt designs thru association with the customer and testing. He said the business is good but the processors do not have the cash to pay for machines.

To the East of Benin along the national road, a metal workshop in Hagoumé, Dogbo, the Ets – AFM, displays small-scale agro-processing machines such as graters which look like a down-sized model of the IITA-designed grater. The owner, Mr. Vlavo Job, is a welder trained in Azové and in Parakou. He copied the IITA-graters which were brought to his shop for repair because of the increasing demand. He has also adopted the screw presses in his product line which was initially repairing door and window grills. He resorted to downsizing the machines to keep the cost low so that the customers can afford them.

4- Technology Design and Development

The regular monitoring of the adoption and utilization of improved agro-processing technologies provided useful design information to adapt the design to users' needs, as well as improve technology transfer.

Mr. Boni's operation has provided a good feedback on the design and utility of the portable grater resulting in a simpler grater with the collapsible legs so it can fit conveniently at the back of the motorcycle, or carried with wheel barrows. His mobile grating service

also developed a strategy for private entrepreneurs to make grating a profitable farm enterprise.

The experience of Mr. Amadu has confirmed the technical viability of the rice mill. Based on this, COBEMAG, in collaboration with the local manufacturers in Guinea fabricated and successfully demonstrated 3 units of the rice mill in Guinea. This has remedied the problem reported on the IITA-design which was introduced there earlier.

Sheanut butter production using the wet-type grinder only did not appeal much to the processors. This highlighted the need for a system-approach to technology development, and packaging technologies for specific production objective. COBEMAG was quick to adopt a nut crusher to couple with the wet-type grinder which facilitated the adoption of the improved technique. The immediate concern of the group to improve their kneading operation is being addressed by collaborating manufacturers.

SECTION 7.2 –

ADOPTION AND UTILIZATION OF IMPROVED AGRO-PROCESSING TECHNOLOGIES: CASES IN GHANA

Fig. 32 - Palm oil processing enterprise using improved techniques is a growing agro-business in Eastern Region of Ghana

The Ministry of Agriculture in Ghana has been supporting programs on agricultural machinery research and development through its Agricultural Engineering Services Division (AESD) and advocates the improvement of women's welfare through the Women in Agricultural Development (WIAD). Its programs include introduction of food processing and postharvest technologies, among others. The presence of international development organizations in the country also helps to disseminate information on improve technologies.

In Ghana, current enterprises providing income to farmers and agro- processors are *gari* processing, maize production and palm oil processing. Increasing the scale of production using improve techniques could make these enterprises more profitable.

The SAA-AP program introduced agro-processing technologies for the very discerning clients. Adoption cases for different machines highlights impact on income, women empowerment, technology design and sustainability. A case of improving social status due to increasing processing activities is highlighted by a processor in Eastern Region. Other cases of technology adoption in Ghana are found in Annex 3.

1- Benefits from Improved Agro-Processing Technologies

The SAA-AP program established the model processing center in Abodom Bomso Village in Kade District, Eastern Region of Ghana because of the opportunity to demonstrate multi-crop processing. It is located in the humid savanna zone where a variety of crops are grown. The village is accessible to main roads and major markets.

The model processing center served as a showcase for improved processing and value-added products. It was equipped with the *gari* processing equipment package (grater, press, fermenting rack,

sifters and improved stoves), the multi-crop thresher, wet-type grinder (to process maize, beans and soybeans), and a palm oil digester.

The *gari* processing package was well-adopted. The other processing equipment was not fully adopted because they did not match well with the users' current needs and requirements. Farmers and processors are yet to be sensitized on the economic importance of value-adding for the other crops because of lack of market or lack of access to it.

• **Increasing Capacity and Income**

The women in Abodom Bomso Village adopted the *gari* processing package and developed their *gari* business which used to be a backyard process for family consumption. Marketing the processed cassava (*gari*) gave them additional income which enables them to support their children in school and other family needs. They now supply a big proportion of the *gari* requirement in Kade District and partly in Greater Accra.

With increasing processing capacity, the women now require a bigger capacity machines. In addition to *gari*, the women also process cassava dough. Recently, it has acquired a palm oil digester and started processing oil.

Mrs. Rose Osei, sells various provisions and operates grinding machines providing services to women coming to Mampong market to process food for their families. She and her husband, decided to add a grating machine in their utilities for rent when they saw the compact grater demonstrated by the SAA-AP program.

Grating service in the market is not very common and therefore quickly attracted the attention of many women and processors. Since then, at least 20 regular customers come to grate cassava daily. Each customer could bring from 5 to 500 kg cassava at any one time. Mrs. Osei said that about 50% of her daily income is contributed by the grating services.

In less than a year, Mrs. Nkuduo is producing *gari* more than enough to sell in the local market using her grater and press. She expanded her market by supplying a school in Kumasi and started to send some of her *gari* to markets in Mali. She plans to explore more the potential of this market.

Gari processing is now a main business of the Adade family in Mampong. Before, Mrs. Lydia Adade used to go to the next village to grate a small quantity (approx 50-60 kg) of cassava then bring back to her house for further processing to *gari*. Now the processors come to her place to grate and work for a fee. With her time saved from bringing her cassava to the next village and queuing to use the small grater, she now has more than double her processing capacity. She used to bring her *gari* to sell in Mampong market but now people come to her place to buy it.

Mrs. Adade also uses her facility to provide grating service to other processors in the village. Mrs. Adade's yard has since been very busy particularly from 4:00 o'clock in the afternoon daily and the whole day on Saturdays when women bring their cassava not only for grating, but for peeling, pressing and even frying. There are at least twelve customers who come regularly to grate and press cassava in Mrs. Adade's place. The Adade's relationship with the people in the village as well as their social status had improved. Mrs. Adade is being helped by her husband and children. The daughter is identified in their school with good *gari.*

Agro- processing business is picking up which brings increase income to the farm families their way of life. Processors adopting improve techniques report that they are now able to send their children to school, provide for better food and have more time to together.

- **Value-Adding and Improving Quality of Products**

Many processors and their customers claim that *gari* produced using the improved process has superior quality. The customers are willing to pay for the cost of good *gari.* The *gari* produced by Mrs. Adade's grater sells quickly because 'it tastes fine, not pasty, well dried and light', she claims.

Customers in Badua Village, Eastern Region also expressed preference for *gari* produced at the St. Michael Processing Plant because it is fine, has less lumps, and well roasted therefore can keep longer, and also swells better than other *gari* produced in the village. Because of the good quality of *gari,* the plant is supplying *gari* not only to individuals but also to the national prison and the schools in the community.

The Yawso Women Group, who recently acquired a *gari* processing package, noticed that good *gari* attracts buyers. They don't need to bring their *gari* to sell in the market because customers come to buy from them directly. Some farmers also contract their services to process their cassava to *gari* or other forms of food products such as flour or dough. With the new machines, they are now able to connect to the market.

Cassava processors using grating service in Mampong market are very happy with the fine mash produced by the IITA-designed grater. This quality is preferred for *gari* production. If the cassava is to be processed to dough, the grater facilitates the process. The grated cassava is passed through the hammer mill which saves about 50% of the time required using the hammer mill alone. Furthermore, the texture of the product is superior.

- **Employment Generation and Job Creation**

Mr. Paul Amoah is an innovator and technician. He developed and operated a portable cassava grating machine powered with a 1-Hp diesel

engine which he got from a backpack sprayer. He provided grating services to the processors in his village and neighboring villages. He either goes around the village with his machine mounted at the back of his bicycle, or customers come to their house to grate.

Mr. Amoah's contribution to the *gari* processing business is noble and innovative. He said that providing access to machines to small-scale *gari* processors is one way to help them grow their businesses. At the same time it gives him income.

The St. Michael Catholic Church' Processing Plant in Bodua Village was established to provide good food for the church members. It is equipped with 2 sets each of grating machine with bagging stand, double screw press, sifters, concrete washing and fermenting tanks and improved stoves/fryers producing *gari* and tapioca regularly. It employs 12 regular staff: 2 men operating the machines and 10 women doing other unit operations such as peeling and frying.

Processors around Abodom Bomso village were given access to the *gari* processing facilities in the center. Women are now engaged in processing ands sells *gari* which is now their regular source of income. One processor in the nearby village purchased a set of the same equipment and provides processing services in her village which is providing regular income for her family.

Mrs. Janette Jima Kesse, a retired bank officer, invested on processing machines she witnessed in one of the field demonstrations by the SAA-AP project. She now owns and operates the Josma Agro-processing Ltd. in Wuraso Village, Mampong District, Mampong District, Ashanti Region. The plant is processing cassava into *gari*, starch and flour and employs a work force of 25 staff from the village.

Mrs. Abena Nkuduo is processing *gari* since she was young. She depended on grating services provided by some operators in town until she saw the grater and other agro-processing machines demonstrated by the SAA-AP project staff in 2003. She thought the machines are small, portable and affordable enough to own. She bought the grater and the double screw press and added 4 traditional frying stoves. Her *gari* frying facility is located in her backyard near the market. She processes her own *gari* for sale and provides grating service to other processor in the community. The business is now the family's major income source which they use to buy their family provisions and pay the school fees. It is also providing regular employment to 4 women processors and additional helpers who are hired during peak season.

Gari processing is now the main business of the Adade family in Mampong. Before, Mrs. Lydia Adade used to go to the next village to grate

a small quantity (approx 50-60 kg) of cassava then bring back to her house for further processing to *gari*. After she bought her grater, the processors come to her place to grate and work for a fee.

- **Group Members Invest Collectively**

The *'Ekwafo Angfa Amma Yebuada'* Women Group in Yawso Krobo Village, Mampong District, Ashanti Region formed to avail of a bank loan to purchase cassava processing machines to increase their *gari* processing capacity. The *gari* processing equipment package they acquired includes a grater, double screw press, fermenting stand and sifter. The machines were installed in an open shed provided by the leader of the group. Five traditional frying stoves were also constructed in the same shed. With continuing use and more training, the women will be able to use the facility to their full benefit.

- **Enhanced Leverage to Development Funds**

The Ministry of Women and Children's Affairs of Ghana, collaborating very closely with the SAA-AP program, adopted the *gari* processing package being promoted by the program. It contracted the GRATIS Foundation in 2002 to manufacture 200 sets of *gari* processing machines for 13,000 women farmers' groups in the country. Each group was given loans by the Ministry to expand their *gari* business.

To facilitate delivery, GRATIS Foundation assigned fabrication to its regional branches. The Technical Team of the GRATIS Foundation provided demonstration and training to operators and users of the machines upon delivery.

- **Private entrepreneurs helping to provide access to improve technologies**

Mrs. Adade provides grating services to processors in her village. Mrs. Boatima Aduwa is a *gari* processor and a regular customer to the Adade family. She lives in the next village but prefers to grate in Mrs. Adade's compound because of the good quality of grated cassava and she enjoys the social atmosphere in the compound while processing. Mrs. Aduwa favors the arrangement because she could not afford to buy her own machine. She said that she will continue to patronize service-providers because it keeps her business steady and worry-free from operational management of the machines.

Mr. Emmanuel Obeng Pare is a retired civil servant proving to be a successful farmer - entrepreneur. After retiring from his office, he bought an oil palm plantation where, in 1999, he also set-up medium-scale palm oil processing plant in Apremso Village, Aburi Town, Akuapim South District, Eastern Region. The plant is equipped with palm fruit digesters and double screw presses of the IITA-design. In addition, improved oil-

separation pits, stoves and boilers were also put in place.

The plantation and processing plant is known to villagers as the `Nana Koffi Pare Farms' which provides regular employment to 7 workers. Additional casual labors are employed during peak harvest season. The oil processing plant produces 200 gallons of palm oil every 3 weeks. During the lean season, he allows other processors from the nearby villages to use the digester and presses for a fee. This adds up to his income.

Mr. Peter Yeboah is an entrepreneur who bought one unit of palm oil digester he used to provide service to palm fruit processors in his village, the Old Abirim Village in Brim North District, Eastern Region. Backyard palm oil processing used to be the main source of income of the residents. Many processors patronized the machine, abandoned their mortar and pestle and even increased their palm oil production. The capacity of the machine was good for their household operation.

2- Conflicts and Management Issues

St. Michael Processing Plant was supplying a school and the National Prison with *gari.* The instability of the market in the last 2 years discouraged the management to continue the regular supply of *gari* to their customers, nor expand and compete in the market. The plant could not compromise the quality of *gari* for the low market price. It however continues to operate to serve the church members and the community.

A processor in Mampong once allowed processors to rent out her grater. This had given her management problems as many of the customers don't know how to operate the machines. She ends up spending more for repair and maintenance than the fee she collects. The grater is now used in the compound only for her own *gari* business.

Another processor from Mampong is not bothered by machine breakdowns. She says that it is a good relief to know that local manufacturers are accessible. 'You can depend on them for assistance at any time'.

Government–assisted projects tend to lag behind privately-managed projects. Constraints identified were late delivery, lack of training, equipment package not matching users' needs among others. In Saviefe Village, the *gari* processing package is yet to be appreciated by the women processors. Before these machines were delivered in Saviefe Village, the group has access to 4 other local graters powered by a Lister Diesel Engine. The women hope that the arrival of the facility will reduce their time queuing for use of the village' graters, gaining them time to increase their processing capacity. However,

because of familiarity, the processors still use the services of the 4 graters.

Among the facilities, it was found that the double screw press was liked most by the users because it is small and portable. It has reduced their de-watering process by 90% and eliminated the drudgery of stooping when using rocks and logs resulting in back and waist pains. The grater is still scarcely used; however users noted the fine and smooth texture of grated pulp which they prefer. The sifter and the fermenting rack are still idle. The women are yet to appreciate the benefits from the package before full adoption. Meantime, the community is organizing their marketing group and improving the process in the production of dough (which is further processed to '*banku*'), another important food product from cassava in Ghana.

Before the introduction of the SAA-AP recommended technologies, the only available grater in Mampong is a modified portable grater. The grater service became very popular, the women has to wait for a long time for their turn. Also since the fees are not fixed, negotiations became the language of the trade which resulted in exaggerated fees. With time, the grater started to develop faults making more difficult to schedule their operations. Despite this, the women continued to patronize the service because of convenience; it has reduced the drudgery of manual rasping, until the portable grater from IITA was introduced by the project.

Ghana processors are sensitive on social and environmental impact of technologies introduced in their societies. Example case is the effect of adoption of palm oil digester in Old Abirim. The rapidly increasing backyard oil processing created a conflict in the village. The village became messy and the chief ordered that the palm oil processing be done in a central location in the outskirts of the residential block. Bigger investors bought high powered-digesters and presses and installed in the processing block. This affected the Mr. Yeboa's operation as people now turned to use the bigger machines. In order to compete in the market, Mr. Yeboa bought the bigger digester and added 7 screw presses using his earnings from the small digesters. At the same time he hired two operators and sent the IITA-designed digesters to the adjacent village. Mr. Yeboa is not discouraged. He knows that many more remote villages need the small digester.

3- Equipment Manufacturing and Servicing

- **Ghana Manufacturers' Network**

GRATIS (Ghana Regional Appropriate Technology Industrial Service) Foundation located in Tema hosts the Ghana Manufacturers' Network with members from its regional centers, and its clients.

GRATIS Foundation is an active partner of the SAA-AP program. During the last 5 years, it had participated in the project's promotional activities such as field demonstrations and trainings. The activities of the foundation create regional linkages to promote adoption of locally-made agro-processing machines.

Mr. Kwabena Darfoor heads GRATIS Foundation. He advocates the strengthening of the local manufacturing industry to support the growth of mechanization to enhance agricultural development in the region. His policies, and that of GRATIS Foundation, emphasize technologies for farm-gate processing to create rural enterprises and rural employment.

GRATIS Foundation is strengthening its after-sales services which are being done by competent staff of the Gender and Marketing Unit in cooperation with the Design and Testing Unit.

Mr. Darfoor represents the interest of small- to- medium scale enterprises in the country and at regional forums he has been pushing for policies that will promote the growth of agro-business industries in Ghana. Mr. Darfoor observes that the region needs more development work on packaging of agricultural produce, and on competitive marketing.

Mr. Francis Divine Asare, Manager of Mampong RTSC, Ashanti Region, makes sure that he visits their customers personally and monitors the performance of the machines they are selling. He said that the repair and maintenance services of Mampong RTSC, and that of GRATIS Foundation, is helping to develop the confidence of their customers which increased their sales of agro-processing machines. He added that the SAA-AP program linked us to our customers and trained our technicians to be competent in providing these services.

Mampong RTSC is now a major supplier of agro-processing machines in the Ashanti Region. They have trained other local manufacturers who support them to supply the increasing demand for improved agro- processing equipment and provide the associated repair and maintenance services.

Mr. Asare is thankful of the benefits from the SAA-AP project. He said that the training component has been very useful especially for technicians. The training helps them to understand the importance of supplying the appropriate machines to customers and emphasize on quality control. He recommends that the project continue to strengthen this area of collaboration.

Ho RTSC Regional Director, Mr. George Baddoe said that the agro-processing machines introduced by the SAA-AP project had been popularly appreciated in the Volta Region because they are neither

bulky nor expensive. They are continually finding ways to assist processors to acquire their own machines. For example, the company offers an easy payment scheme with low down payment and provides one year free repair and maintenance. They are strengthening their promotional and marketing activities through participation in regional and national exhibitions and conducts occasional in-field demonstrations. Mr. Baddoe hopes that the processors will improve their operations through access to these simple but versatile technologies.

- **ENTESEL Establishment**

ENTESEL Establishment (Engineering and Technical Services Establishment) is one of the 'clients' of GRATIS Foundation and has been an active member of Ghana Manufacturers' Network. ENTESEL works with GRATIS Foundation and most Ghana-based NGOs in rural industrialization and poverty alleviation.

Mr. Sam Quaye, Managing Proprietor and Chief Executive Officer of ENTESEL, invested in this business in 1982 to provide mechanical engineering services to established industries through plant installation, commissioning, maintenance and modification. In 1986, his establishment started the production of replacement parts to service their maintenance activities as a matter of necessity.

In 1993, ENTESEL, through GRATIS Foundation, sent technicians to be trained by the SAA-AP project. This boosted his business allowing him to expand his product lines and his clients. From 1996, ENTESEL is one of the major producers of agro- processing machines supporting the project. He now says more than 30 percent of the company's income is derived from sales of agro-processing machines introduced by the project. The project enables them to reach the customers improving their marketing activities, and understanding customers' real needs and resources.

Mr. Quaye is particular on the quality of machines they produce. Therefore they strive for excellence in their manufacturing process. A rigorous quality control is done on all pieces of products they produce. He follows-up on the machines they sell to make sure that customers are making use of their investments properly. With the help of the SAA-AP project, this was feasible until 2004. Mr. Quaye is concerned on how to sustain this initiative since it involves additional financial and human resources. He hopes that the Manufacturers' Network could be well-coordinated and strengthened and that collaboration with national agencies continues to support them to carry out this important task.

4- Technology Design and Development

The Josma Agro-processing Ltd. in Wuraso Village, Mampong District, Ashanti was initially equipped with the package of cassava processing equipment based on IITA design. Within 6 months of operation, the processing capacity increased demanding for higher-capacity machines. A local conventional grater with an 8-Hp petrol engine was added. At the same time, RTSC Mampong doubled the length of the double screw press expecting to increase its capacity.

The users noted the IITA grater produces finer mash than the local grater. However, the feeding system discourages the operators from full adoption for fear of accidental injury to fingers and hand. Minor modification and training on correct feeding had solved the problem.

The original design of the double screw press was now appreciated better because they can press faster than the expanded design. Loading is done in several batches for pressing, instead of one time.

The bigger press is now used for preliminary removal of moisture from grated pulp then the bags are transferred to the original double screw press for final de-watering.

The introduction of the auger type grain polisher in Ghana is an example of technology transfer where the technology does not suit the users' requirements. Fortunately, the introduction was made in the palm oil producing region where there is current need for palm oil digester.

The polisher was tested efficient for palm oil digesting as well as for palm kernel cracking. The machine was modified into a palm oil digester with interchangeable auger for palm kernel cracking. The modified machine was well adopted by backyard palm oil processors particularly those processors in the remote villages with poor road and transport system.

To sustain the requirements for the commercial level processing, he recommends that the digester be modified to increase the capacity but keeping its simple make.

SECTION 7.3 -
ADOPTION AND UTILIZATION OF IMPROVED AGRO-PROCESSING TECHNOLOGIES: CASES IN ETHIOPIA

Fig. 33 - The multi-crop thresher in Ethiopia is changing the scenario where threshing of grains used to be trampling by donkeys or bulls

The SAA-AP program in Ethiopia which started only in 2003 present success stories on transfer and adoption of improved agro-processing technologies. With strong support from the Ministry of Agriculture's Extension Program, the SAA-AP program is gaining momentum in moving the improve technologies to target-users.

The case of Ethiopia presents new challenges to the SAA-AP program on technology identification, sourcing and transfer considering differences in farming systems and cultural practices that of West Africa. Current work on technology introduction is selective and will require a lot of sensitization among the stakeholders. This technology transfer experience could be beneficial to the other East African countries.

The program identified teff, maize, and groundnut as the priority crops for technology development. Traditional threshing of teff and other grain crops is still prevalent and is done by a gang of 6 to 8 oxen or donkeys driven around the pile of crop by 2 to 3 men. It takes 8 hours to thresh 2 bags of approximately 120 kgs of grains using this method.

Farmers harvest their crops at the same time making difficult to thresh immediately after harvest. Crops are left piled in the fields up to one month which could result in deterioration and crop losses. Other grain crops such as maize, millet and sorghum are also threshed with this method. Handling and transport of crop is also a big problem in grain harvesting. More adoption stories in Ethiopia are found in Annex 4.

Few units of combine harvesters are operating in the area but are used mostly for wheat; are not easily accessible and wastes straws and fodders. The practice of crop-livestock farming system necessitates that straws and fodders be made available for livestock feeding.

Groundnut is a main source of edible oil planted in big scale in Eastern Harar. It is considered as a cash crop, are sold raw, eaten boiled or roasted, or processed into butter and oil. Groundnut is processed using traditional methods. With the traditional method, groundnut oil production is a cumbersome process and is still done at the household level. The process involves shelling, winnowing, roasting, de-skinning, and grinding.

Butter and oil are commercial products from groundnut which could develop to a cottage industry. Groundnut butter and oil production requires special grinder to make smooth flowing paste for efficient oil extraction. Kneading the butter is yet another step in oil processing but is constrained by lack of facility.

Because of the growing concern on aflatoxin-contaminated groundnut and its products, the process needs to be facilitated if nuts and oil are to be free of microbial contamination. Projects to introduce improve techniques and teach the processors improve the process are required.

The SAA-AP program is introducing the multi-crop thresher, the manually-operated groundnut sheller, the wet-type grinder and a simple screw press to help improve the system. Adoption stories are found in Annex 3.

1- Adoption and Utilization of Multi-crop Thresher

The multi-crop thresher without cleaner and powered by a 7 Hp petrol engine was introduced in Ethiopia to help solve the drudgery of threshing teff, the staple food crop of Ethiopia. Between 2002 and 2004, seven threshers had been purchased and being used in Shashemene Province to provide threshing services to processors in the village and the adjacent villages.

The multi-crop thresher has a field capacity of 500 to 600 kg per hour and had significantly reduced the time and drudgery using the traditional method. Adaptation work was done by the SAA-AP project in collaboration with STVC by developing the donkey cart where the thresher could be mounted for transport. This enables operator to conveniently move the thresher around the farms.

Mr. Ayele is the first farmer who invested on the thresher after he saw a field demonstration by the SAA-AP project staff. He now owns 3 units of the threshers in Shashemene which he operates with 5 hired workers. Providing threshing service has

become his family's main source of income.

Encouraged by his success, his brother also bought the thresher. He now owns 2 units of threshers and employs 5 operators.

A third owner, Mr. Takele, also learned of this booming thresher enterprise in Shashemene. He bought the thresher with the cleaner and started to provide threshing services in the villages with his 2 hired operators. He sees that the thresher will help the farmers a lot and at the same time give him a good income.

The number of farmer-entrepreneur is steadily increasing which is not a bother to existing operators. There is more than enough crop to be threshed. The system is working well and immediately adopted by the farmers for teff threshing. The thresher does not only save time and crop losses but also produces slightly crushed shorter straws which are found suitable for animal feeding in terms of handling and digestibility, or even as soil conditioner or fertilizer when plowed back in the field.

The farmers are now evaluating the thresher for maize, wheat, barley, sorghum and millet. Feedback is encouraging and recommendations for improvement are now being addressed by the SAA-AP project team while continuing demonstration and technology awareness campaign is being done in other parts of Ethiopia

2- Adoption and Utilization of Groundnut Processing Machines

The groundnut sheller was proven to increase shelling capacity and improve time-use efficiency. Processors quickly adopted the sheller but the adoption was not sustained. The resulting broken nuts, even small percentage, was not acceptable to processors and consumers who used the shelled nuts for other purposes or for processing later. According to the users, the bruises in the nuts result in discoloration, both in nuts and in oil, which make it unattractive in the market and could not keep long in storage. This feedback, including the need to increase capacity, will be used to further improve the groundnut sheller.

The wet-type grinder had contributed to improved efficiency of grinding and is adopted by the processors. The butter obtained was smooth and renders for easy oil extraction. A simple oil press is being used to extract oil from the paste.

The JICA project supported the *Babile* Groundnut Processing Cooperative to set-up a processing center and is helping to develop their market for peanut butter. The processing center is equipped with the wet-type grinder, and the packaging paraphernalia for butter.

The improved technologies allow processors to diversify their products and increase production efficiency. The SAA-AP project continues to look into ways of further improving the system.

3- Manufacturing and Servicing of Improved Agro-processing Technologies

The growing demand for improved technologies necessitates that the machines are available and accessible to farmers and processors. The SAA-AP project is working closely with the Extension Department of the Ministry of Agriculture, and Selam Technical and Vocational Center (STVC).

The Ministry's mandate is to continue to link the farmers and processors to technology-resource system; STVC is responsible for the production, sales and servicing of machines demanded.

They have an important role in adapting and modifying the agro-processing machines for introduction to the Ethiopian farmers as required by their environment. STVC is also home to the SAA-AP project in Ethiopia. It provided a metal workshop and an office, and granted a special privilege to access and use of its other facilities and services to the project team.

Working with an established institution like STVC to help improve the welfare of the small-scale farmers and processors facilitated the extension work in Ethiopia.

SECTION 8.1 -
PROFITABILITY OF *GARI* PROCESSING

The importance of cassava as a staple food crop and source of income in Africa continues to grow because of its agronomic advantage. The adoption of high-yielding varieties of cassava as well as improved growing techniques resulted in increased production but at the same time created problems on postharvest handling and processing. The high perishability of cassava and the presence of hydrocyanic acid (HCN) in cassava require immediate processing into more stable and safer products. Processing reduces the level of HCN in the crop and improves the palatability of the food products.

In Africa, cassava is traditionally processed into different food products. They include cassava flours, granulated roasted cassava (*gari*), granulated cooked cassava (*attieke, kwosai*), fermented cassava pastes, sediment starches, and medicines. Over 50% of the villages in Africa have some form of cassava processing center.

Gari is an important commercial cassava food product in West Africa and is finding market in the Region, and in Europe. Many small-scale processing establishments are found in the villages of Ghana and Benin using either very traditional methods, locally-adapted imported machines, or the improved system introduced by the SAA-AP project. Mainly women, working in groups, carry out *gari* production, like any other traditional cassava processing.

The traditional *gari* processing method is costly in terms of time, labor and wastage, and often has low grade quality. The SAA-AP project introduced improved technologies developed at IITA to many of the unit operations in order to increase the capacity, efficiency of *gari* processing and improve the quality of *gari*. The package consists of the peeling bay, IITA-designed grating machine with power drive, double screw press, fermenting rack, cassava mash and *gari* sifter, and improved stove. It is installed under a shed provided with a room to secure the equipment and engine, and to improve the working conditions of the processors.

Over the last decade, adoption of the technologies is seen in the increasing number of sales of *gari* equipment package by manufacturers, and the number of users across the villages. Group processors normally invest in the whole package. In some cases, only the grater and the press are used particularly in providing services to processors.

The intervention is proving to be useful in transforming the once a family-based food processing scale to a market-oriented business

enterprise (Figure 34) increasing cassava product availability and reliability, stabilizing prices and facilitating export. *Gari,* as well as flour and starch, are now properly packed, being sold along road sides and in the supermarkets. Women processors go to centers to work and get paid instead of processing in their backyards.

Users reported increasing income and opening of more market opportunities. The profitability of the improved processing package at different utilization schemes was analyzed and discussed in the accompanying sections.

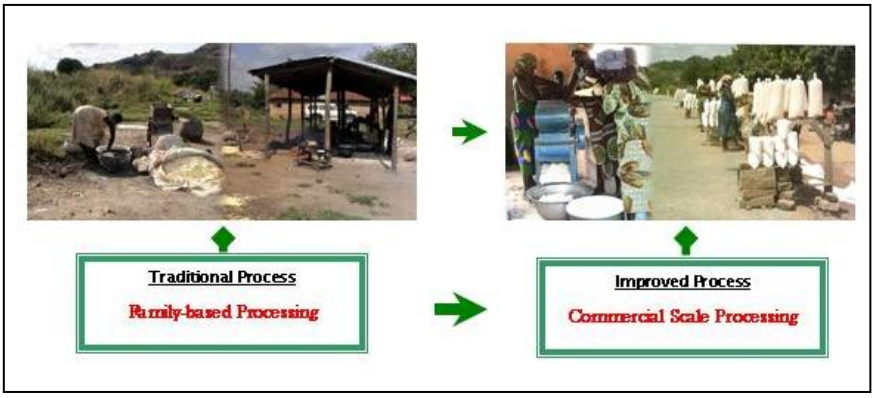

Fig. 34 – Improve processing techniques allows processors to expand their scale of operation from family-based to commercial-scale processing

1-Profitability of *Gari* Processing System

The improved *gari* processing system was compared with existing facility consisting of a locally-adapted grater, the single screw press, *raffia* sifter, and the stove. A comparison of the economic profitability of the *gari* processing systems was done to provide a guide to processors and entrepreneurs on the level of operation their investments will pay off. Since a major component of cost of the *gari* processing system is the grater; any cost inferences in this analysis refer to grater operation.

Table 20 indicates that using either of the methods, *gari* business is generating income and is profitable. Operating at 3- to 2-day cycle per week, the improve system can process up to 9 tons fresh cassava per week. At this capacity, the improved *gari* processing system gave an annual net income of USD 60,216 from 432 tons of fresh cassava tubers. This corresponds to an income of USD 139.40 per ton of fresh cassava processed. The annual total variable cost was USD 90,946. It is important to note that only less than 1% was paid to women and children labor who did the peeling, washing, bagging, sieving, and

frying. The return to total cost was 64%, while the return to variable cost was 66%.

The breakeven analysis showed that the processing would be able to recover all its expenses as long as it can process 278.5 tons of fresh cassava roots per year. Every ton added to this volume would mean an increase in profit by USD 139.39.

The net income from the improved system was higher by around USD 15,000 compared to the locally-designed equipment.

This can be attributed to higher *gari* conversion rate, minimal rejection rate, efficiency of the system and lower labor cost.

The efficiency of the system is being manifested by the high profitability of the system as indicated by a profit of more than USD 30 per ton of cassava processed. Further, the return to total and variable costs of the improved system were higher by more than 15% compared to the locally designed *gari* processing equipment.

It was also noted that as the system becomes more mechanized and organized, the income and benefits are increasing.

The adoption of the improved system, therefore, means additional profit for the group, more efficient operation and labor-saving on the part of women working in the center. The time saved can then be devoted to other economic and social activities as well as spend more quality time with their families.

2- Profitability of Improved *Gari* Processing System at Varying Capacity

The operating capacity described in the preceding section is currently the normal capacity and approximately only about half the designed (or full) capacity of the improved system. As the processors become more adapted to the system it is expected that the capacity will increase as a result of improving skills, better organization and management. A sensitivity analysis shows an increasing trend in profit from *gari* processing as a result of increasing capacity, Figure 35. The analysis was based on actual practice where the fixed cost is composed only of depreciation, which was so small and no other overhead cost, such as monthly wages for labor, was included. All operation costs are dependent on the volume processed.

The improved *gari* processing system processing at least three tons cassava per week (or 144 tons per year) would give the processors a net income of around USD 20,000 per year. This is about USD 5,000 more compared to the locally-adapted grater. The difference in profitability gets much larger with increasing capacity. The breakeven volume of improved processing equipment was around 280 tons per year. With proper management, the investment could be recoup within a year.

Table 20 -- Comparative economic analysis of improved gari processing package and existing local grater operating at 144 days per year

COST ITEMS	Improved Process	Existing Local Grater
1. Capital Costs (USD)	1,617.00	1,274.00
2. Fixed Costs (USD per year)	1,011.69	798.58
3. Variable Costs (USD per year)	90,946.80	94,899.60
4.. Total Cost (USD)	93,575.49	96,972.18
▪ *Women & children labor cost*	758.16	1,375.92
5. Gross Revenue (USD per year)	153,792.00	143,424.00
▪ *Gari*	145,152.00	134,784.00
▪ *Peel (sold for animal feed)*	8,640.00	8,640.00
6. Net Income (USD per year)	60,216.51	46,451.82
▪ *Net profit per ton cassava (USD/ton)*	139.39	107.53
▪ *Return to total cost*	0.64	0.48
▪ *Return to variable cost*	0.66	0.49
7. Breakeven Volume		
▪ *Ton of gari*	77.98	80.81
▪ *Ton of cassava*	278.50	310.81
8. Breakeven Costs ($/Ton)	773.61	863.36
▪ *Cassava input (tons)*	432.00	432.00
▪ *Gari output (tons)*	120.96	112.32

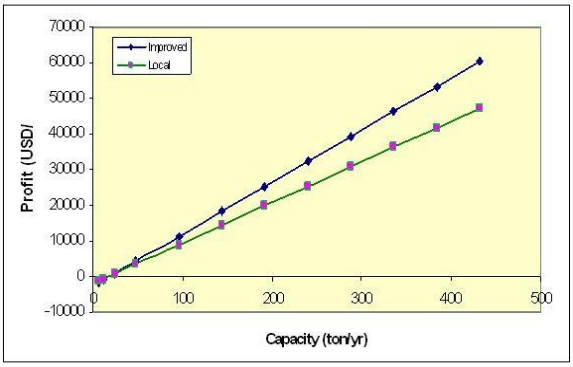

Fig. 35 –Change in profit with changing processing capacity

The economic indices when the improved system is operated at the normal capacity (9 tons per week), and at the design or full capacity (18 tons per week), is given in Table 21. The analysis assumed that that the supply of raw material (i.e. fresh cassava roots) would not be a constraint in increasing capacity. As could be expected, doubling the capacity could also double the variable costs, such as the amount of materials and labor. The net income, however, had more than doubled as a result of increasing scale of operation. Further, the profitability of processing cassava increased by more than USD 3.00 per ton and the return to costs also increased considerably.

3-Economic Analysis of Custom-Hiring the Grater

As *gari* processing continues to prove to be profitable, more and more people are involved in processing, or in providing services to the processors. The key to this growing business practice is the provision of the needed access to appropriate technologies. The package of technologies introduced by the project was identified to suit various situations and operational levels required by processors.

Depending on the level of operation, the grater and the rest of the components can be rented by non-members. This is an additional income for the group. In this case, the processors bring their materials to the center and pay for the use of the facilities. This scheme is referred as the 'stationary' custom-hiring. One constraint to providing stationary grating service is that processors have to carry the bulk of the watery grated pulp back to their family compounds for further processing. Hence operators added the pressing service using a double screw press to enable them to de-water the grated pulp before they are returned to their home yards. This arrangement invited more customers.

Where processors could not come to the center, owners/service providers could bring the grater on motorbike around the villages to service those processors. This scheme will be referred in this discussion as 'mobile' grating.

Table 22 shows the economic comparison of the two custom-hiring schemes. With an investment of USD 920, the grater and press combination (stationary grating service), and the grater on motorbike (for the mobile grating service), economic analysis had shown that the two schemes is generating important income to service providers.

For stationary grating, the facility is available to processors anytime when the group members/owners are not using them. Mobile grating capacity was calculated based on daily service schedule from 4 to 5 hours in the evening as the motorcycle is used for

Table 21 - Comparative economic analysis of increasing the capacity of improved gari processing package

COST ITEMS	At Normal Utilization Capacity	At Full Utilization Capacity
1. Capital Costs (USD)	1,617.00	1,617.00
2. Fixed Costs (USD per year)	1,011.69	1,011.69
3. Variable Costs (USD per year)	90,946.80	181,893.60
4.. Total Cost (USD)	93,575.49	184,522.29
▪ *Women & children labor cost*	758.16	1,516.32
5. Gross Revenue (USD per year)	153,792.00	307,584.00
▪ *Gari*	145,152.00	290,304.00
▪ *Peel (sold for animal feed)*	8,640.00	17,280.00
6. Net Income (USD per year)	60,216.51	123,061.71
▪ *Net profit per ton cassava (USD/ton)*	139.39	142.43
▪ *Return to total cost*	0.64	0.67
▪ *Return to variable cost*	0.66	0.68
7. Breakeven Volume		
▪ *Ton of gari*	77.98	153.77
▪ *Ton of cassava*	278.50	549.17
8. Breakeven Costs ($/ton)	773.61	762.74
▪ *Cassava input (tons)*	432.00	864.00
▪ *Gari output (tons)*	120.96	241.92
Processing capacity (tons per week)	9.00	18.00
Number of days processing per week	2 – 3 days	6 days

other purposes during the day. The time is also convenient for the processors as they have to harvest and peel the cassava before the grater provider arrives.

At the current service capacity of 100 to 150 kg per day, the schemes had shown good returns on investment. For stationary set-up, custom-hiring alone provides an important income to the operators. The return to total cost was 39%, while the return to variable cost was 58%. These values are both higher than the opportunity cost of money which is 25%, indicating that investment in the improved *gari* processing equipment is financially feasible. At the given operation, the investment in the equipment can be fully recovered in 1.5 years.

Table 22 - Profitability of providing grating services to cassava processors

COST ITEMS	STATIONARY	MOBILE
1. Capital Cost (USD)	920.00	920.00
2. Service Capacity, kg per day	150	100
3. Total Fixed Cost per Annum (USD)	506.00	506.00
4. Total Variable Cost per Annum (USD)	1,050.00	750.00
5. Total Cost per Annum (USD)	1,556.00	1,256.00
6. Gross Income per Annum (USD)	2,170.00	1,550.00
7. Net Income per Annum (USD)	614.00	294.00
8. Return to Total Cost (%)	39.00	23.00
9. Return to Variable Cost (%)	58.00	39.00
10. Payback Period (years)	1.50	3.13
11. Breakeven Volume (tons)	25.00	20.00

Basic assumptions for economic analysis: Repair & maintenance cost is 10% of purchase price (PP); Tax, insurance & shelter cost is 2% of PP; Useful life of machine, 5 years; Interest on investment, 25%.

The breakeven volume was 25 tons per year or 100 kg per day for 250 days a year operation.

For the mobile grating service, the average service volume of 100 kg per day, would give a net income USD 294 per year. The return to total cost was 23% while the return to variable cost was 39%. The return to total cost is still low compared to the interest on capital, hence there is a need for the owner to intensify promotion of his unit in order to increase service volume and raise the return to total cost above 25%. At the given operation, the investment in the equipment can be fully recovered in just 3.13 years.

The breakeven volume was 20 tons per year or 80 kg per day for 250 days a year operation. Increasing the service volume will increase the income and the payback period could be shortened.

4-Other Benefits of Improved Cassava Processing Equipment

Besides the economic benefits, groups and individual users and service providers identified the following perceived benefits from using the improved *gari* processing system:

1- It strengthens the credibility of groups enabling them to leverage more funding support for their activities. For example, in Benin, the *Takissari* Women' Group was able to convince the French NGO, IRCOD (L'Institut Régional de Coopération –Développement) to

subsidize the purchase of a second set of processing equipment and build a store for their product. Similarly, the *Agodenuo* Women' Group was able to get CARDER (Centre d'Action Régionale pour le Développement Rural) Atlantique to help them buy grater and Lister Diesel Engine, and the government to install a bore hole as potable water source.

2- The improved system minimized the drudgery specifically in grating and pressing. The adoption of labor-saving equipment like mechanical graters and double screw press reduces the time required to do the tedious operations, which women used to do manually. The time saved can be devoted to other productive economic activities, social participation and spend more time with their families

3- The improved system improved the quality of *gari* in terms of color, volumetric weight and uniformity of grits. Moreover, the group reported that the high-quality *gari* draws customers to them thereby saving them time and transport costs in bringing their produce to the local markets.

4- The improved grater gave better quality *gari*. Processors claimed that their products are selling at higher price and reaching the export markets

5- Individual entrepreneurs like Boni Hubert of Borone Village, Tchaourou Town, Benin, operating a mobile grater said his grater made him an important man in the community

6- Cassava farmers also benefit from adoption of improved *gari* processing equipment. With widespread adoption of improved *gari* processing, there is increasing demand for fresh cassava roots, bidding up prices and farmers increasing areas planted to cassava production

5-Benefits to Manufacturers

Collaborating manufacturers recorded a continuing increase in the sale of agro- processing equipment. A summary of sales record of *gari* processing equipment in Benin and Ghana from 1994 to 2004 as reported by collaborating manufacturers is given in Table 23. The increasing sales of agro-processing machines show that more processors have more access to technologies needed to pursue their businesses.

The collaborating manufacturers also reported that the increase in the sales of the agro-processing equipment is due to the after-sales services they provide. The processors have reduced risks in their investments and are buying the machines.

The pattern of sales of the mechanical grater and press, showed a sales growth of 6% per annum for the grater, and 23% for the press (Figure 36).

Table 23 - Number of *gari* processing equipment sold by collaborating manufacturers in Ghana and Benin, 1994 – 2004

Type of Equipment	Benin	Ghana	TOTAL
• Grater	235	367*	602
• Double screw press	186	374	560
• Fermentation Rack	44	266	310
• Bagging stand	24	264	288
• Sifter	44	266	310
• Chipper	4	34	38

*Does not include additional 300units ordered in 2003 by the Ministry of Women and Children Affairs.

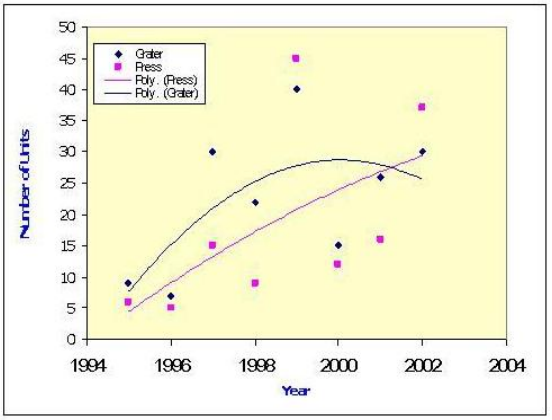

Fig. 36 –Trend on sale of grater and press in Benin and Ghana,1994 - 2004

The collaborating manufacturers also reported that the increase in the sales of the agro-processing equipment is due to the after-sales services they provide. The processors have reduced risks in their investments and are buying the machines.

A downward trend in the sale observed in the sale of graters could be explained by the saturation of graters in the area where the manufacturers are operating. This indicated that the manufacturers should expand their markets and look for other outlets. The higher rate of sales of press could be explained by the fact that the press is cheaper and is bought mostly by individual processors for their own use. The grater requires higher investment. Processors prefer to pay for the grating services provided by owners/operators.

At the selling prices of USD 800 for grater, and USD120 and press and a manufacturer's margin of 25%, the net income to the manufacturer was only around USD 5,000 per annum. Even so, the manufacturers commented that the agro-processing equipment created a more reliable market and had helped them augment their income. Increasing the number of sales and their service area will help to improve the economic contribution of the equipment to the manufacturers' income.

6-Benefits to *Gari* Consumers and Cassava Farmers

Given the importance of *gari* to Ghana and Benin and the efforts exerted to mechanize *gari* production, it is expected that the adoption of the mechanized production technology would become widespread. This would mean that more and better quality *gari* will be produced and be available in the market. In effect there would be more supply, and if the market forces are operating normally, this would drive the price of *gari* down. Consumers would then benefit in terms of savings due to lower *gari* price, hence increase his welfare which can be quantified in terms of changes in consumer surplus due to price changes.

Similarly, cassava farmers would also benefit from adoption of mechanized *gari* processing equipment. With widespread adoption of mechanized *gari* processing, there would be increased demand for fresh cassava tubers, bidding up prices and farmers increasing acreages planted to cassava.

SECTION 8.2 -
PROFITABILITY OF WET-TYPE GRINDER FOR SHEANUT PROCESSING

Grinding is a basic operation in processing most indigenous African food products. Mortar and pestle is common household equipment found in all houses, especially in the rural areas. In the sub-urban and urban areas, mechanical maize grinders powered by Lister Diesel Engines could be found, providing services to customers. Over the years, people have learned to appreciate the machine easing their operations.

Adding value to the crop with the introduction of new products to improve the nutritional attributes, marketability and storability present a viable opportunity to farmers and agro-processors to increase their income.

The SAA-AP project recognized the need to improve production of wet food products from maize, soybeans, sorghum, millet, and butter and oil from groundnut. Wet products are prone to microbial contamination. More efficient processes to make the product more durable and safe for consumption are needed.

The project also identified the emergence of export market for Sheanut butter which is produced in small quantities in the rural areas. The current production capacity could not supply the quantity and quality required by the market because of lack of processing machine.

The wet-type grinder was introduced in the project sites in Benin and Ghana where it is widely adopted for Sheanut butter processing. The nature of grinding allows faster extraction of the fat and also produces very fine paste which renders it easier to knead.

The grinder is being adopted in Ethiopia for the production of groundnut butter and oil.

1-Sheanut Butter Processing

Sheanut, also known as the African Butter Tree, grows in the Savannah regions of, mostly West, Africa. Sheanut butter, a product processed from Sheanut, contains saturated and unsaturated fatty acid extracts from Sheanut. In Africa, it is used traditionally for skin care, for relief of rheumatism, muscle and joint pain, also for prevention of stretch marks and for baby care. It is a source of Oleic acid, Vitamin E, pro-vitamin A and often used in cosmetic products, particularly for dry and allergy-prone skin. The African Sheanut butter is sought after in the world market.

Traditional Sheanut butter processing is a long tedious process consisting of various unit operations often done manually (Figure 37).

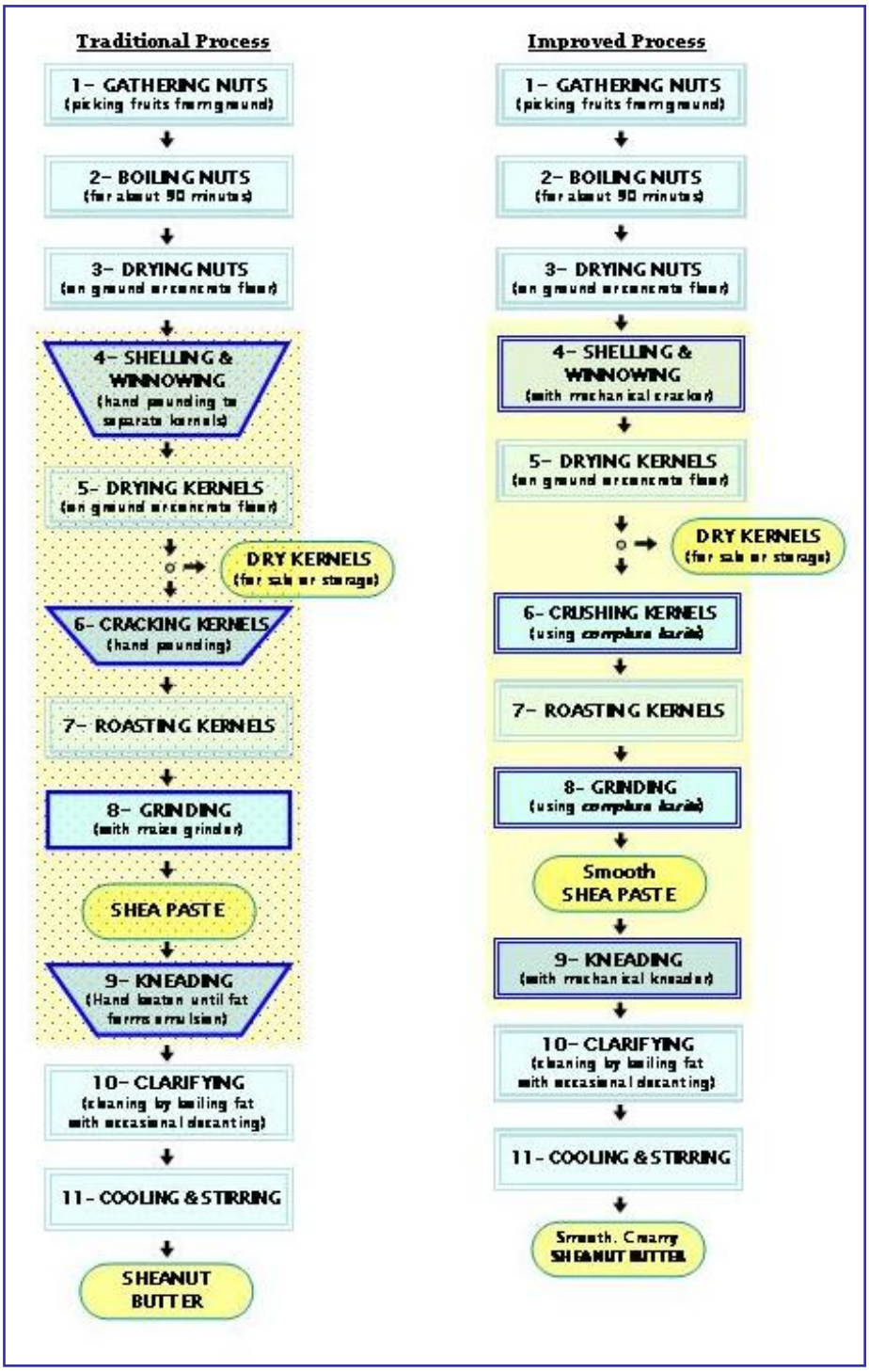

Fig. 37 - Process flow chart: Sheanut butter processing in Benin and Ghana

The fruits/nuts fall on the ground where they are collected by women and children. The women process individually before the machines (crusher and grinder) were introduced. The introduction of the machines (improve process) enables them to process in groups of 3- 5 women members. The machines facilitated the Sheanut butter production, resulting in time savings, increase capacity and improve quality of Sheanut butter.

2-Profitability of Wet-type Grinder

The critical operations in Sheanut butter processing are the production of paste and kneading the paste to extract the fats. The SAA-AP project introduced the wet-type grinder (developed at IITA) and the nut crusher (developed by COBEMAG) which has become known to processors as the *complexe karité*. As the adoption of the machine spreads in Ghana and Benin, the development of a kneader has become necessary which is now a priority development area by the collaborating manufacturers in Benin.

An economic analysis of improved Sheanut butter processing using the *complexe karité*, which is composed of Sheanut crusher and wet-type grinder, *vis-à-vis* traditional method was undertaken to determine the benefits to owners, to individual processor, to group processors, and to consumers. This was compared with the traditional method which uses a locally adapted maize grinder. Table 24 summarizes the basic information and assumptions used in the analysis.

This fixed cost of the improved Sheanut processing equipment was substantially higher than that of traditional method (Table 25). This fixed cost includes depreciation of equipment, engine and shed, interest on capital, tax and insurance and repair and maintenance. The operator' wage was not part of the fixed cost of the traditional method and was assumed to be built in into the service fee collected. On the contrary, the variable cost of the improved system was about 10% lower than the traditional process. The gross income was 15% more that of the traditional system. This could be attributed to the higher efficiency of the improved system, resulting in saving in time and fuel.

The breakeven analysis showed that at the existing price of Sheanut paste of USD850 per ton and assumed paste recovery, the improved system would be able to breakeven (no profit or no loss), if it could process 13.88 tons of Sheanut per year. Similarly, if the total processing capacity of 40 tons per year would be kept constant, the Sheanut paste processing would breakeven at a price of USD624.65 for the improved system while it would be USD705.96 for the traditional method.

Table 24 – Basic information and assumptions used in the economic analysis of wet-type grinder for Sheanut butter processing in Benin and Ghana

ITEMS OF COST	Associated Data/Costs
1- Cost of improve equipment: *complexe karité* (crusher and wet type grinder including diesel motor engine)	USD 3,500
2- Cost of traditional equipment (maize grinder including diesel motor engine)	USD 1,800
3- Shed for improved processing equipment	USD 300
4- Economic lifespan of equipment and engine	5 years
5- Economic lifespan of shed	15 years
6- Salvage value of equipment, motor and shed	10% of Acquisition Cost
7- Interest on capital representing the opportunity cost of money	25% per annum
8- Repair and maintenance cost	20% of Capital Cost
9- Tax and insurance	2% of Capital Cost
10- Wage rate of women worker (opportunity cost of women labor)	USD 0.65 per day
11- Volume processed by the group annually	40 tons of Sheanut, approx. 200 kg per day
12- Operating days per year	200 days

The investment made in acquiring and setting up the processing system could be recovered within its assumed economic life of 5 years, in either of the following modes of paying investment would be done:

Custom service fee is used for payment of capital - Under this scheme, a service fee equal to USD12 and USD32 per ton for crushing and grinding should be charged.

Twenty per cent of net income of group (3-5 members) goes to payment of investment - Under this scheme; each member would set aside 20% of her income from processing to pay for the capital used in setting up the equipment.

3-Profitability of Custom-hiring the *Complexe Karité*

Because of the high acquisition cost, many more farmer/processors could not acquire the machine for their own use. Some entrepreneurs had invested on the machine and provide the needed crushing and grinding service to those who could not buy the machine. Economic analysis of custom hiring the *complexe karité* was done.

At the prevailing service fee would not be enough to make the business profitable as shown in Table 26. At the present annual capacity of 200 tons, the business venture would be losing USD1,230 per year. This result implies that there is a need to either raise the service fee to members, or members should set aside certain percentage of their net income from sales of paste to pay for the capital invested in acquiring the equipment within its economic life span of 5 years.

On the contrary, if the equipment would be used to provide custom service to non-members, the assumed volume of 4,000 customers and service fee would give the center a profit of USD1,170 per year. This profit would just be enough to pay for the capital invested in acquiring the equipment. If the business is to be profitable, it is recommended that the service fees should be at least USD12 per ton for crushing and USD32 per ton for wet grinding for members. Allowing non-members to use the facility will add to the income.

4-Benefits to Individual Processors

The economic benefits of improved Sheanut processing to individual processor are summarized in Table 27. At the paste recovery rate of 49%, an individual processor with 100 kg Sheanut will have corresponding gross sales of USD41.65 and a net profit of USD18.40, if she pays all the labor and processing costs. On the other hand, if the individual continues to use the traditional Sheanut processing method, she will only get 41.65 kg of paste, which is 15% lower than what was obtained from the improved method, with net income about USD6.70.

The return on investment of the processor using improved method was around 60% higher than the traditional method. The increase income is due to the higher paste recovery due to machine efficiency and that the processors are able to increase their processing capacity. This translates to higher profitability, and higher return per dollar invested in Sheanut processing.

5-Benefits to Group of Processors

At the group processing level, the same observation can be noted. The gross income from improved processing system was more than USD2,000 higher per year compared with the traditional system (Table 28). This is mainly due to the higher paste yield from the improved system and with a comparable processing cost between the two methods. In effect the improve system gave higher net income for the group. Further, the net income per ton of Sheanut processed was higher in the improved processing method.

6-Benefits to Consumers

Consumers would also benefit from the improved system of Sheanut paste processing. This could come either from improved quality of paste or lower product prices due to lower production cost and higher paste yield. At this point, however, these are not quantified in this report because of the absence of field data.

Table 25 – Comparative economic analysis of ownership and utilization of improved and traditional Sheanut butter processing equipment. All costs are in USD unless otherwise specified

Cost Items	Improved Processing	Traditional Processing
1. Fixed costs	2,674.00	1,386.00
2. Depreciation of component machines	648.00	540.00
- Shed	18.00	-
- *Complexe karité* (grinder & crusher)	630.00	-
- Maize Grinder	-	540.00
- Nut Crusher	-	
3. Operator / Labor	240.00	-
4. Interest on capital	950.00	450.00
5. Tax & insurance	76.00	36.00
6. Repair & maintenance cost	760.00	360.00
7. Variable costs	9,569.08	10,474.15
- Oil & fuel	542.67	1,020.80
- Raw materials	7,200.00	7,200.00
- Roasting	130.00	130.00
- Shelling	27.08	27.08
- Crushing	336.00	364.00
- Grinding	640.00	928.00
- Kneading	693.33	804.27
8. Total Costs	12,243.08	11,860.15
9. Gross Income	16,660.00	14,161.00
10. Net Income	4,416.92	2,300.85
11. Net profit per ton of Sheanut	110.42	57.52
12. Return to total cost	0.36	0.19
13. Return to variable cost	0.46	0.22
14. Breakeven volume:		
- Tons of Sheanut paste	6.80	6.59
- Ton of Sheanut	13.88	15.69
15. Breakeven price per ton	624.65	705.96
16. Payback period, years		
- if custom fee is used for payment of loan	3.89	1.94
- if 20% of net income is used for payment	4.30	3.91

Table 26 - Comparative economic benefits from using the improved processing equipment *(complexe karité)* for custom services by client group

Items of Cost	Client Group	
	Service-User	Service-Provider
1. Fixed costs per year		
- Depreciation	684.00	684.00
- Interest on capital	950.00	950.00
- Repair & maintenance	380.00	380.00
- Tax insurance & shelter	76.00	76.00
- Labor cost	240.00	240.00
- Total Fixed cost per year	2,330.00	2,330.00
2. Total Variable Cost	7,700.00	7,700.00
3. Total cost per year	10,030.00	10,030.00
4. Volume processed* per year	200,000	200,000
5. Gross Income per year	11,200.00	8,800.00
- Crushing	3,200.00	2,400.00
- Grinding	8,000.00	6,400.00
6. Net Income	1,170.00	(1,230.00)
7. Return to total cost	0.12	(0.12)
8. Return to variable cost	0.15	(0.16)
9. Payback period, years	3.25	(3.09)
10. Breakeven volume	3,582.14	4,559.09

*Operating period is 200 days at 20 customers per day with 50 kg to be serviced;
Cost of improved processing unit *(complexe karité)* = USD3,800

Table 27 - Comparative economic analysis of individual processor using service of improved and traditional methods of Sheanut paste processing

Cost Items	Improved Processing	Traditional Processing
1. Variable Costs		
- Raw materials (100 kg Sheanut)	18.00	18.00
- Roasting	0.33	0.33
- Shelling	0.07	0.07
- Crushing	1.12	0.91
- Grinding	2.00	2.32
- Kneading	1.73	2.01
2. Total Cost	23.25	23.63
3. Output (kg paste)	49.00	41.65
4. Price (USD/kg paste)	0.85	0.85
5. Gross income	41.65	35.40
6. Net Income (USD)	18.40	11.77
7. Return to total cost	0.79	0.50
8. Breakeven volume		
- kg of Sheanut paste	12.90	13.30
- kg of Sheanut	26.33	31.67
9. Breakeven price (USD/kg)	0.47	0.56

Table 28 Comparative economic analysis of group processors availing services of improved and traditional Sheanut processing equipment

Cost Items	Improved Processing	Traditional Processing
1. Variable Costs	9,298.42	9,453.35
- Raw materials	7,200.00	7,200.00
- Roasting	130.00	130.00
- Shelling	27.08	27.08
- Crushing	448.00	364.00
- Grinding	800.00	928.00
- Kneading	693.33	804.27
2. Total Cost	9,298.42	9,453.35
3. Output (kg paste)		
4. Price (USD/kg paste)		
5. Gross income	16,660.00	14,161.00
6. Net Income (USD)	7,361.58	4,707.65
7. Net Profit per ton of Sheanut	184.04	117.69
8. Return to variable cost	0.79	0.50
9. Breakeven volume		
- tons of Sheanut paste	5.17	5.25
- tons of Sheanut	10.54	12.50
10. Breakeven price (USD/kg)	474.41	562.70

SECTION 8.3 -
PROFITABILITY OF MULTI-CROP THRESHER IN ETHIOPIA

Teff is the staple food crop of Ethiopia. Ethiopia also produces maize, wheat, sorghum and millet. Cropping season is at least once a year covering a period of 3-4 months from seeding to harvesting. The average production of grain is less than a ton per hectare. Farmers have very limited incentive to increase production. For one reason, they lack the capability to handle additional increase in production because of lack of tools and equipment. Harvesting and threshing are done using traditional/conventional methods with animal power (Figure 38) and with family and exchange labor. Using this method, it could take one to two months to bring the grains from the farm to safe storage.

The time the crop is out in the field could mean significant qualitative and quantitative losses due to microorganisms and physical losses due to poor handling and predators.

In 2001, the SAA-AP project introduced the multi-crop thresher (Figure 39) to help farmers thresh their crops quickly after harvest to enable them to save their time and losses to crop. The thresher generated a lot of interests. A farmer immediately bought one unit and uses it to service the farmers in his village.

The project continues to work closely with the Extension Department of the Ministry of Agriculture to conduct more promotional activities, and with Selam Technical and Vocational Center (STVC) to adapt the machine to local conditions.

Fig. 38- Traditional threshing of teff and other grains using a gang of bulls, or donkeys

Fig. 39- The multi-crop thresher promoted by SAA-AP program is being adopted rapidly

The thresher has become popular among farmers who now depend on threshing services provided by owners. At the same time, SAA-AP project in collaboration with STVC has developed a donkey-cart to help with the mobility of the thresher. By 2004, there are 7 individually-owned threshers going from farm to farms providing threshing services. Testimonies of these early adaptors indicated the usefulness and potential of the thresher to increase farmers' income.

The thresher gave outright advantage over the traditional method in terms of time and costs savings as described in Table 29. The multi-crop thresher is providing a viable option to farmers to help them thresh their crops on time and important income to owner/operators.

1-Profitability of Custom-hiring the Multi-crop Thresher

Custom-hiring is a business practice whereby machine owners provide access to services, which are otherwise remote, to farmers and processors. In practice, this involves machines which are necessary for small-scale operations but are found to be too expensive for individual ownership. The multi-crop thresher is one of the machines now operated under this entrepreneurial practice in Ethiopia and Benin.

Using the business records provided by the owner-operators of the multi-crop threshers in Ethiopia, a cost and return analysis was done to know whether the acquisition and ownership of the multi-crop thresher was financially viable based on the economic lifespan of 5 years. The analysis did not consider the opportunity costs of money which is equivalent to the interest rate of borrowing money from a commercial bank. The analysis was made for individual records.

Results of the analysis show that custom-hiring the thresher is giving an important income to the owners/service providers, as shown by the positive net income (Table 30). The return on investment is fast. At the current service fee of Birr 26 per hr (decided by the service provider), operating the thresher for at least 276 hours in a year, the operation of the thresher will break-even in less than one year as demonstrated by Thresher A1. This has encouraged more individual entrepreneurs to invest on the next units of threshers as demand for threshing services continue to increase within, and around the neighboring communities.

Increasing the service hours of the thresher will improve the profitability of the thresher. If threshing material is limiting, service providers may increase the service fee to at least Birr 30 per hour (Birr 120 per ton) to recoup the investment in the same year, as is the case for the newer thresher units C, D and E. Custom-hiring the thresher is a flourishing business in the rural areas of Ethiopia.

Table 29 - Features of traditional and improved threshing in Ethiopia

Descriptor	Traditional Threshing (Trampling by Animals)	Improved Threshing (Multi-crop Thresher)
• Method	Trampling by animals: four or more Donkeys, or Oxen	Mechanical thresher with 7 hp Petrol or Diesel Engine
• Number of workers	Up to 20 adults and children	For thresher with cleaner: 3-4 helpers
• Capacity	300 kg in 6 hours	250 kg per hour
• Time to thresh 1 ton of teff, or maize	20 hours (or 3 working days)	4 hours
• Threshing fee (Birr, B)	Animal fee: B25.00/day per oxen + Labor fee: B5.00/day	Machine fee- B25.00/hr + Operator's fee: B2.00/hr

The profitability will depend on the marketing promotion by owners/service providers as more entrepreneurs are investing

2-Sensitivity Analysis of Thresher Operation

A more thorough analysis which included the depreciation and opportunity costs of investment on multi-crop thresher looks into the sensitivity of income and payback period with changes in operating periods and custom-hiring rates. Results give a guide to rates of charges and corresponding operating hours to recoup the investment within the economic life of the thresher, assumed 5 years.

Result of analysis showed that any increase in threshing service hours will give the owner higher incomes, and the return to investment is faster. Since the rates of service fees also have direct correlation with income, it is recommended that the owner-operator has to check on conditions of the local market and the economic capacity of the farmer to pay, when deciding on fees to charge.

- **Economic Indices when Custom-hiring at 2% of Output**

At a custom-hiring rate of 2% of output (or Birr 30 per hr), and considering the cost of capital and depreciation, the ownership of thresher could only be profitable if the thresher could be operated for 350 hours per year. The net income would be Birr 187 per year. Under this income level, however, the owner would not be able to recover his/her investment within its life span as the return on investment (ROI) was only 2% (Table 31). This is very low compared to the opportunity cost of capital invested in acquiring the machine. Increasing the service hours from 375 to 500 per year will

make the thresher more economically viable and financially feasible.

At this operating level, the owner would be able to recover his/her investment in less than five years.

The trends in gross income, total cost and net income are shown in Figure 40. The graph shows the breakeven point (BEP) at 338 hours. At this point the owner is able to pay the associated costs including fix costs (interest on capital, depreciation and repairs and maintenance) and variable costs.

- **Economic Indices when Custom-hiring at 2.5% of Output**

At a custom hiring rate of 2.5% of output (or Birr 37.5 per hr), ownership of thresher would only be profitable if the thresher could be operated for 250 hours per year. The net annual income would be Birr 512, Table 32. Under this income level, however, the owner would still not able to recover his/her investment. Also the ROI was only 6%, which is much lower than the opportunity cost of capital invested in acquiring the machine.

At 2.5% custom-hiring rate, the ownership of thresher would be economically viable and financially feasible if the thresher can be operated for at least 350 hours per year. At this operating level, the owner would be able to recover his/her investment in less than 5 years.

Figure 41 presents the trends in gross income, total cost and net income. The breakeven point is when the thresher is operated at 228 hours per year. Any increase in operating capacity will give the owner more income.

- **Economic Indices when Custom-hiring at 3% of Thresher Output**

At a custom hiring rate of 3% of thresher output, (or Birr 45 per hr), ownership of thresher would only be profitable if the thresher is operated for 200 hours per year. The net annual income would be Birr 862 (Table 33). Under this income level and return on investment at 11%, the owner would not be able to recover his/her investment at the projected life span.

At an assumed custom fee of 3% of output custom hiring rate, ownership of thresher would be economically viable and financially feasible if the thresher can be operated for a period of 250 hours per year. At this operating level, the owner would be able to recover his/her investment in less than five years, the assumed economic life span of the machine.

Extrapolating from Figure 42, the breakeven point is at 178 hours. Operating the thresher more than 178 hours would mean profit for the owner. The operating costs decrease giving higher net incomes

Table 30 - Economic indices of multi-crop threshers providing services to teff and maize farmers in Ethiopia (All costs are in Ethiopian Birr unless otherwise specified; 1USD = Birr 8.60)

UNIT	Year Acquired	Acquisition Cost	Cumulative hours of operation	Number of users	Service fee per hour	Gross Income	Total Cost	Net Income	Period to break even, Months	Service fee to break even, Birr per hr	Service hours to break even
•Thresher A-1 (w/o cleaner)	2002	9,000	1,031	380	26 (12 – 26)	13,400	7,181	6,218	1.40	13.93	276.21
•Thresher A-2 (w/o cleaner)	2003	11,756	863	324	23 (12 – 26)	9,925	7,457	2,467	4.80	17.28	324.22
•Thresher B-1 (w/o cleaner)	2003	11,756	288	85	28	8,064	5,913	2,157	5.50	20.52	211.17
•Thresher B-2 (w/ cleaner)	2003	13,430	348	100	25	8,700	6,343	2,355	5.70	18.23	253.71
•Thresher D (w/o cleaner)	2004	10,450	73	26	29	2,117	3,016	(-)	-	41.30	104.00
•Thresher C (w/ cleaner)	2004	12,650	123	39	31	3,813	3,735	69	-	30.44	120.49
•Thresher E (w/ cleaner)	2004	14,885	239	66	30	7,170	6,536	638	-	27.33	217.88

Table 31 Changes in income as service hours vary at custom-hiring rate of 2% of thresher output (Income and costs are in Ethiopian Birr unless otherwise specified; 1USD = Birr 8.60)

Service Hours	Gross Income	Total Cost	Net Income	Payback Period, Months	Return on Investment
200	6,000	8,138	-2,138		
225	6,750	8,500	-1,750		
250	7,500	8,863	-1,363		
275	8,250	9,225	-975		
300	9,000	9,588	-588		
325	9,750	9,951	-201		
350	10,500	10,313	187	63.3	0.02
375	11,250	10,676	574	20.6	0.05
400	12,000	11,038	962	12.3	0.09
425	12,750	11,401	1,349	8.8	0.12
450	13,500	11,763	1,737	6.8	0.15
475	14,250	12,126	2,124	5.6	0.18
500	15,000	12,489	2,511	4.7	0.20

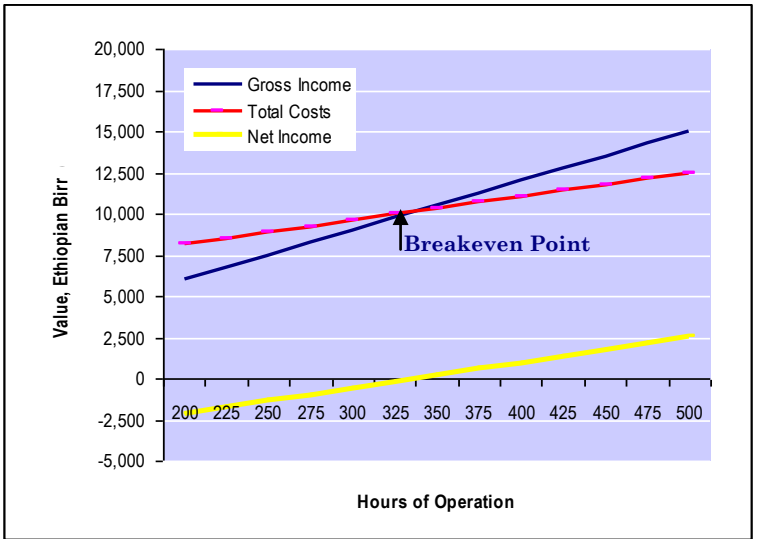

Fig. 40 - Trends in gross income, total cost and net income at varying operating hours at custom-hiring rate of 2% of thresher output

Table 32 - Changes in income as service hours vary at custom hiring rate of 2.5% of thresher output (Income and costs are in Ethiopian Birr unless otherwise specified; 1USD = Birr 8.60)

Operating Period	Gross Income	Total Cost	Net Income	Payback Period, Months	Return on Investment
200	7,500	8,138	-638		
225	8,438	8,500	-63		
250	9,375	8,863	512	23.1	0.06
275	10,313	9,225	1,087	10.9	0.12
300	11,250	9,588	1,662	7.1	0.17
325	12,188	9,951	2,237	5.3	0.22
350	13,125	10,313	2,812	4.2	0.27
375	14,063	10,676	3,387	3.5	0.32
400	15,000	11,038	3,962	3.0	0.36
425	15,938	11,401	4,537	2.6	0.40
450	16,875	11,763	5,112	2.3	0.43
475	17,813	12,126	5,686	2.1	0.47
500	18,750	12,489	6,261	1.9	0.50

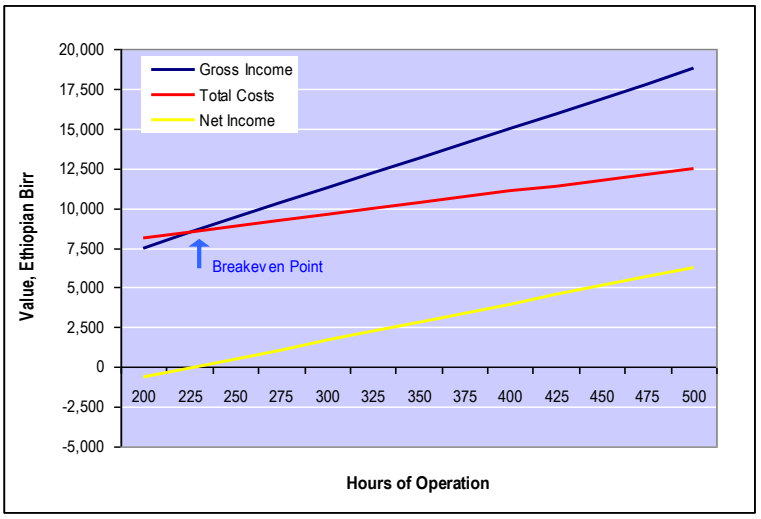

Fig. 41 -Trends in gross income, total cost and net income at varying operating hours at custom-hiring rate of 2.5% of thresher output

Table 33 Changes in income as service hours vary at custom hiring rate of 3% of thresher output (Income and costs are in Ethiopian Birr unless otherwise specified; 1USD = Birr 8.60)

Operating Period	Gross Income	Total Cost	Net Income	Payback Period, months	Return on Investment
200	9,000	8,138	862	13.7	0.11
225	10,125	8,500	1,625	7.3	0.19
250	11,250	8,863	2,387	5.0	0.27
275	12,375	9,225	3,150	3.8	0.34
300	13,500	9,588	3,912	3.0	0.41
325	14,625	9,951	4,674	2.5	0.47
350	15,750	10,313	5,437	2.2	0.53
375	16,875	10,676	6,199	1.9	0.58
400	18,000	11,038	6,962	1.7	0.63
425	19,125	11,401	7,724	1.5	0.68
450	20,250	11,763	8,487	1.4	0.72
475	21,375	12,126	9,249	1.3	0.76
500	22,500	12,489	10,011	1.2	0.80

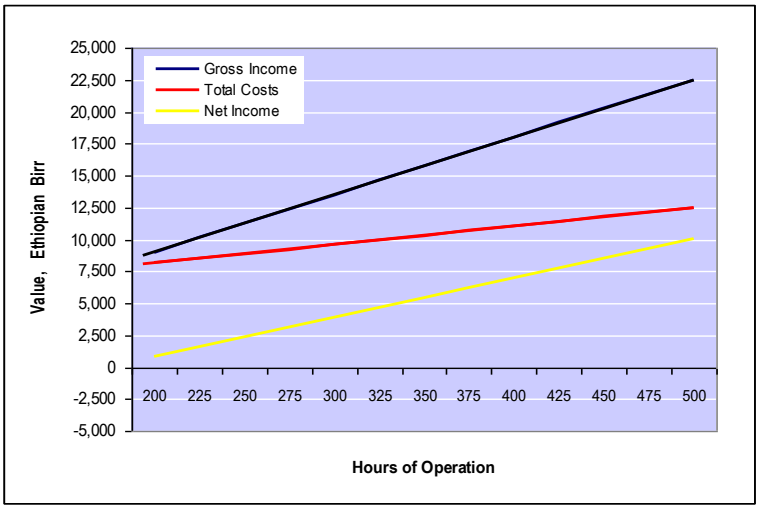

Fig. 42 - Trends in gross income, total costs and net income with varying operating hours at 3% of thresher output

3-Benefits to Farmers

Farmers also benefit from the use of the multi-crop thresher in terms of time and costs savings as indicated in Table 34. As grain (teff and maize) harvesting and threshing are done almost at the same time by the farmers in the community, the unavailability of both animal and human workers often causes delays. Using the thresher, the threshing costs were reduced significantly and threshing can be done at any appointed time with the service providers. The high threshing capacity enables the farmers to bring home their crops on time minimizing the risks to damage and losses which could result from prolonged field storage.

Farmers also gain time to do other productive jobs.

The bulk of the job is done; farmers glean and clean the threshed materials which were thrown out with the straw.

Despite the fast adoption of the multi-crop thresher in Ethiopia, the SAA-AP project continues its adaptation work on thresher design to optimize its capacity and cleaning efficiency. This should enhance its performance and could further reduce costs to both manufacturers and farmers.

Table 34 - Costs associated to teff and maize threshing using traditional threshing and multi-crop thresher

Features	Traditional Threshing	Multi-crop Thresher
1- Costs associated to teff threshing		
• Capacity	15 kg per man-hr	250 kg per hr
• Manpower requirement	20	3
• Time required to thresh 1 ton of teff	8 days and more	4 hrs
• Cost to farmer, Birr per ton	Birr 900	Birr 120
2- Costs associated to maize threshing		
• Capacity	10 kg per man-hr	250 kg/hr
• Manpower requirement	15	3
• Time required to thresh 1 ton	12 days and more	4 hrs
• Cost to farmer, Birr per ton	Birr 1,038	Birr 120

SECTION 9 -
LESSONS LEARNED AND RECOMMENDATIONS

- **Project Strategy**

Over the last 10 years, the SAA-IITA Agro-processing Project has disseminated different types of machines for processing different farm produce in Ghana and Benin extending to other African countries such as Ethiopia.

The successful implementation of the project is due to good project management and team work among the stakeholders. The project staff has direct interaction with the target-users and partners to link the gap that hinders the development of agro-processing industry in the region.

A project logframe is a necessary tool for the proper monitoring and implementation. Projects must endeavor to develop a program relevant to the needs and environment of the target-clients.

Project implementation strategies applied that proved to be useful are: 1) on-farm demonstrations that provides first hand information about the technologies and a quick evaluation of the technology in terms of investment viability; and 2) the establishment of model processing centers that demonstrates the utility and advantages of the improved technologies.

Field demonstrations are conducted at a strategic time and venue to reduce associated costs to reach as many clients as possible. The presence of technology resource group such as designers, manufacturers, rural development agents and policy-makers during demonstrations connects the prospective users to the suppliers and create confidence for locally-made technologies.

The processing center has showcased the different technologies, their advantages and limitations to sustain an agro-processing enterprise. A good feedback mechanism must be in place to capture information generated from the center for reference to improve adoption or further develop technologies.

A quick look at the project achievements highlights the visibility of project in helping to promote the agro-processing enterprise to provide sustainable income to farmers, agro-processors and manufacturers. The project is able to demonstrate that collective efforts of different agencies could bring improve agro-processing technologies to target beneficiaries.

The SAA-AP project concentrates on improving techniques and equipment, but just as importantly, the information, knowledge and skills- and the capacity to organize these effectively – which small scale processors and manufacturers require.

The project not only provides immediate benefit to the people in the countries where they are conducted but also validate the approaches enabling them to be replicated throughout the region.

- **Strengthening Partnership, Capacity-building, Training**

One of the accomplishments of the project is building up the capability of the partners and strengthening the human resource-base in each country, recognizing the comparative advantage of the local partners in dealing directly with the end-users.

The empowerment of the individual women within the groups has built the communities' capacity to develop. It is the women's access to important information, their social contacts, family authority and their wealth of relevant knowledge which is the foundation stone for family and community development.

Another important achievement is the training of manufacturers and coordinating their activities so that the technologies are supplied with the right quality in the right place at the right time. The after-sales service component of the training makes the manufacturing industry more viable and attractive, eliminating one of the constraints to adoption of imported technologies, the availability of spare parts and services. In-country training courses conducted broadened the geographic spread of the technologies where users can now obtain equipment locally and be assured that services for needed repair and maintenance are available.

Agricultural machinery manufacturing in rural Africa still needs very strong support from both the government and the private sectors. The role of government entities is more explicit in providing follow-up training on fabrication and maintenance management of agricultural machinery, particularly the agro-processing machines. They also have important role on formulating policies affecting the availability and accessibility of improve technologies and associated services to the end users. The private sectors should provide the needed raw materials and services to promote local manufacturing industry. Importation procedures are complicated and costs are too high for the small-scale manufacturers to handle.

The role of the manufacturing sector is to provide farmers and agro-processors direct access to agro-processing equipment. They have an important role in linking the agricultural and industrial sectors for which supporting legislation is still weak, if not lacking.

There is a big potential for collaboration but a big communication gap exists between large and small-scale processors. Government agencies and development projects could fill this gap.

The participation of the private sectors must be encouraged and supported.

- **Adoption and Utilization of Improved Technologies**

Agro-processing equipment introduced in Ghana and Benin are simple, compact, easy to operate and maintain and addresses the diverse nature of African crop and food processing system. Considering the economic and technical background of the target-users, the machines are applicable for multi-crop application or with dual, or multiple functions. Adoption cases discussed indicated the most liked feature of the machines is their mobility. This allows the owner/operators to provide services to processors in remote places.

Current agro-processing enterprises emanating from the project and are improving the quality of life of the rural families through increased income, employment, improved food security, empowerment and nutrition include:

1. Production of *gari* in Ghana and Benin – The improved technologies resulted in increasing capacity and improved quality of *gari*.
2. Production of Sheanut butter in Ghana and Benin – With the improved technologies, Sheanut butter production spread throughout the year and is supplying the local and regional markets.
3. Production of groundnut butter and oil in Ethiopia - A more important objective of introducing the improved technologies for groundnut processing is to prevent microbial contamination. The machines are helping to process quickly for proper storage while waiting for favorable price in the market.
4. Processing of grain and cereals in Ethiopia- Using the multi-crop thresher opened up a business activity among teff and maize farmers in Ethiopia. Service-providers are active and making good profit. Service-users benefit by saving time and reducing field losses of their crops.

Small-scale agro-processing was addressed by the project in the first 3 to 5 years. This scale is particularly suited for women since it can be carried out in the home concurrent with the other household activities. As linkages to markets are created through improved processing at the household level, more mechanized machines and operations are introduced. This is now revolutionizing the development of agro-processing industry in the rural areas of Benin, Ghana and Ethiopia.

In addition to these established areas, SAA-AP has also been investigating new technologies in the following areas; processing perishable crops such as tomatoes, mangoes, pineapple, etc.

In general, the agro-processing technologies introduced help realize the farm household subsistence and cash income objectives directly through efficient use of labor and additional cash income. At the village level, they add to existing capacity. Investments into agro-processing projects are therefore justified since improving this sector of the production continuum has proven to contribute to sustainability, food security and poverty alleviation.

- **Spreading Out**

The impact of the agro-processing project in Ghana and Benin is seen in the number of equipment fabricated and sold by collaborating manufacturers and the increasing interest of new manufacturers to fabricate the equipment.

On request of government and non-governmental organizations, the project extends its activities to other countries in East and West Africa where there is already existing demand for improved agro-processing equipment.

Limited by funding, the approach being taken is to continue to strengthen the local human resource base (development and extension staff) and the manufacturers. The development and extension staff is sensitize on project objectives, strategies and activities, and allow them to develop a suitable project for implementation in their countries. Support for training on manufacturing, operation and maintenance management is done through the cooperation of local agro-metal workshops selected from recommendations of the collaborating development and extension programs.

Countries adopting the agro-processing technologies, where there are no trained manufacturers, imported from Ghana and Benin between 1995 and 1997. The numbers of countries importing is expected to reduce as the project responds to request for tapping local artisans in manufacturing the equipment demanded. However, the project emphasizes on the importance of quality control so that agro-processing equipment are delivered and utilized to their full merits.

- **Impact on livelihood of the beneficiaries**

The use of improved agro-processing technologies helps to produce value-added products similar to traditionally preferred qualities, and is nutritionally balanced. Farmers and processors could now produce in sufficient quantity for consumption and marketing. Coupled with training and linkages to markets, the agro-processing industry is providing sustainable livelihood to farmers and processors.

As a result of the extra income from agro-processing businesses, families have seen significant improvements in their lives. For instance, some

families now send their children to school and others have opted to improve their homes, bought land and livestock with the extra income. All these contribute to increased security in the family.

Social impact is felt on the growing and continuing participation of farmers and processors. It helps build up groups and strengthens the social structure for family and community development.

The agro-processing equipment is providing a significant income to manufacturers and technicians. This is evident in the increasing number of sales of equipment. Many more new manufacturers are fabricating and selling the machines, even those not formally trained by the project. Some workshops concentrate on providing repair and maintenance services.

- **Scaling up**

Influenced by the good examples and impact of the SAA-AP projects in Ghana and Benin, the Government of Guinea formed the Postharvest Technology Development Agency in 1996 to spearhead the development of the postharvest sector in Guinea. The agency is to adapt improve postharvest technologies for dissemination in Guinea.

The active involvement of partners from government and non-governmental organizations builds up their confidence to manage and sustain the program and the adoption of improved technologies.

The manufacturers' network and its recognition at the Ministry of Rural Development level is strong evidence that the project is scaling up. Extension workers know of the equipment and the manufacturers in the network.

- **More Challenges Ahead**

The agro-processing technologies introduced by SAA-AP project have generated interest among the crop growers and processors. Although feedback from users is satisfactory, the rate of diffusion of the technology is still slow. Several issues of design, social science, utilization science, and technology transfer require increased attention for research and development.

For agro-industry to develop in Africa, a number of interventions are still needed. Any intervention introduced must be profitable if farmers and agri-businesses are to invest on infrastructures.

1- Sourcing Appropriate Technologies

In order to cope with emerging markets and continuing technological development, a range of technologies, with the associated services, are still needed that will serve the small-scale operators. Technologies must be consistent with the level of sophistication that farmers can understand and afford. To the extent possible, these technologies need to be easy to communicate and replicate in order to facilitate farmer-to-farmer diffusion.

2- New Product Development

Traditional products are improved but new products must be developed to expand the market potential of a crop. New high quality products should be similar to existing preferences to ensure a high level of acceptability. Also improving the nutritional attributes of the crops must be considered along with providing expanded utilization alternatives for added value products.

3- Linkage to Market

For rural small-scale processors, marketing their produce is one of the most serious most serious constraints. The poor road network in the rural areas prevents access to better markets. They are limited to the local market and have limited bargaining power. The project could facilitate to create their linkage to other markets and market information.

4- Access to Credit

Agro-processing machines are expensive investments. With limited cash, agro-processing machine is not an immediate priority to small-scale farmers. Access to credit is an option to enable them to establish small-scale enterprises. SAA-AP must work with partner organizations that can provide credit and regular back-up support to the beneficiaries.

5- Continuing Training

Working with entrepreneurs, continuing training is needed to upgrade their skills. The project observed that continuing training could be more beneficial to support and upgrade the skills of those already trained, rather than extending training to new comers. Continuing training could bring out entrepreneurial initiative of the beneficiaries hence could facilitate adoption.

Annex 1-
PROJECT LOGFRAME

Project Title: Developing Agro-processing Enterprises in Ghana and Benin

Project duration: 10 years
Target Groups: Agro-processors and small to medium scale entrepreneurs

Date project started: 1994
Date prepared:
Date Revised: Nov 21, 2000

Narrative Summary	Objectively Verifiable Indicators (OVIs)	Means of Verification	Important Assumptions
Overall Goal Income of target groups increased.	Double income of owners, users and manufacturers after one year of utilization	Monitoring Reports	
Project Purpose Improved agro-processing technologies are adopted.	100 additional agro-processing enterprises set up and functioning in 2001 (50 in each country)	- List of entrepreneurs adopting - Monitoring reports	
Outputs 1. Project management system established	- Project Logframe - Project management team	Project reports	
2. Agro-processing technology identified, evaluated and adapted	By end of 2001: - 4 new technologies introduced: (Modified multi-crop thresher, rice mill, dry-type grinder, grain polisher) - Palm fruit digester developed - Palm kernel cracker developed - Groundnut sheller (motorized) adapted - Oil expeller tested	Test reports Fabrication drawings Operational features IITA reports Manufacturers' report	

Project Title: Developing Agro-processing Enterprises in Ghana and Benin

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Year project started: 1994
Date prepared:
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3. Manufacturers' network established	Manufacturers' Network formed in Ghana and in Benin by 2001	Certificate of Registration List of Members Memorandum of Understanding (MOU) with SAA/IITA signed	•
Narrative Summary	**Objectively Verifiable Indicators (OVIs)**	**Means of Verification**	**Important Assumptions**
Outputs 4. Agro-processing technology information disseminated to target groups	By the end of 2001: - Field demonstrations conducted: 40 (Ghana); 35 (Benin) - Trained operators/users: 50 (Ghana); 90 (Benin) - Manufacturers' training conducted: 3 each country - Operational Manuals published: 5 (Ghana); 3 (Benin) - 2 Video Clips produced (1 in each country) - Participated in 6 agricultural fairs (3 each country) - Radio broadcast: 4 (Ghana); Benin (?)	- Field demonstration reports - Monitoring reports - Training reports - Publications	

Project Title: Developing Agro-processing Enterprises in Ghana and Benin

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Year project started: 1994
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Narrative Summary	Objectively Verifiable Indicators (OVIs)			Means of Verification	Important Assumptions
5. Agro-processing equipment purchased and utilized	Number of technologies adopted at the end of 2001:			- Sales records - Monitoring reports	
	Technology :	Ghana	Benin		
	- Grater and press	25	20		
	- Sifter	20	5		
	- Chipper/Slicer, manual	5	-		
	motorized	5	5		
	- Wet-type grinder	5	15		
	- Multi-crop thresher	5	8		
	- Rice Mill	5	7		
	- Grain Polisher	-	5		
	- Digester	20	3		
	- Dry-type Grinder	2	2		
	- New products	3	2		
	TOTAL	75	67		

Project Title: Developing Agro-processing Enterprises in Ghana and Benin

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6. Product quality enhanced, utilization of crops expanded, quantity of products increased	By end of 2001: - Equipment used for production of 3 new products in Ghana and 2 new products in Benin - Double gari production - Reduced broken rice by 5-10% - Increased oil recovery from sheanut and groundnut by 20%	- Monitoring reports - Test reports	

Project Title: Developing Agro-processing Enterprises in Ghana and Benin

Project duration: 10 years
Target Groups: Agro-processors and small to medium scale entrepreneurs

Year project started: 1994
Date prepared:
Date Revised: Nov 21, 2000

I- Activity Logframe - Ghana

Activities	**Inputs:**			**Expected Output**	**Important Assumptions**
	Staff	Duration	Cost/Equip		
Output 1 – Project management system established					
1.1 Planning, monitoring and evaluation	Project Management Team	3 times per year		Project Reports Minutes of meetings	
1.2 Sensitizing the project goals and the roles of partners/collaborators	Project Management Team	Continuing		More stakeholders participating	
Output 2 – Agro-processing technologies identified, evaluated and adapted					
2.1 Conduct survey and analysis of agro-processing technologies 1. For Cassava 2. For Palm Oil 3. For Groundnut & Sheanut 4. For Maize	D. Ankrah L. Halos-Kim	Continuing		Survey Reports	
2.2 Select and adapt appropriate technologies to the need of the users	V. Akoto D. Ankrah P. Quansah L. Halos-Kim Manufacturers	Continuing		Project Reports More appropriate technologies available	
2.3 Modifying agro-processing technologies to the needs of the users	L. Halos-Kim P. Quansah	Continuing		Improve technologies	

Project Title: Developing Agro-processing Enterprises in Ghana and Benin

Project duration: 10 years
Target Groups: Agro-processors and small to medium scale entrepreneurs

Year project started: 1994
Date prepared:
Date Revised: Nov 21, 2000

Activities	**Inputs:**			**Expected Output**	**Important Assumptions**
	Staff	Duration	Cost/Equip		
Output 3 – Manufacturers' Network established					
3.1 Identify manufacturers	P. Quansah	Continuing		List of manufacturers with addresses	
3.2 Establish and sensitize SAA-IITA Agro-processing Manufacturers' Network	P. Quansah	2 days in April 2001		Form network of manufacturers	
3.3 Plan activities of manufacturers' network	P. Quansah	To be covered in Activity 3.2		Workplan	
3.4 Monitor quality of manufactured products	P. Quansah L. Halos-Kim V. Akoto	Continuing		Monitoring Report	
3.5 Establish a functional supply store	P. Quansah Manufacturers	October 2001		More regular supply of spare parts	
3.6 Develop operation and maintenance manuals	P. Quansah Manufacturers	Continuing		Manuals for each equipment (grater, press, chipper)	
3.7 Participate in promotional activities	P. Quansah Manufacturers	Continuing		Field demonstration reports	

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Date prepared:
Date Revised: Nov 21, 2000

Activities	**Inputs:**			**Expected Output**	**Important Assumptions**
	Staff	Duration	Cost/Equip		
3.8 Update sales records regularly	P. Qaunsah V. Akoto D. Ankrah	Quarterly		Sales Record	
Output 4 – Agro-processing technology information disseminated to target groups.					
4.1 Identify target groups for selected technologies: 1. Cassava equip package 2. Palm oil digester 3. Wet-type grinder	D. Ankrah V. Akoto	1st Quarter 2001		List of target groups to visit	
4.2 Conduct field demonstrations for selected technologies:	D. Ankrah V. Akoto	From 2 quarter 2001		Field demonstration reports	
4.3 Develop training and extension materials - Cassava processing equipment package (Grater, Press, Sifter) - Digester	D. Ankrah V. Akoto P. Quansah L. Halos-Kim	From May 2001		Operational & maintenance manuals for grater, press digester	
4.4 Participate in agriculture and food fairs/exhibitions at district, regional and national levels	D. Ankrah	Per invitation		Report Visitors logbook	

Project Title: Developing Agro-processing Enterprises in Ghana and Benin

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Year project started: 1994
Date prepared:
Date Revised: Nov 21, 2000

Activities	**Inputs:**			**Expected Output**	**Important Assumptions**
	Staff	Duration	Cost/Equip		
4.5 Promotion through national media	D. Ankrah	Continuing		- 1 cassava processing video cassette - Reports	
4.6 Promote the idea of agro-processing technologies to NGOs, district assemblies, government organizations, etc.	D. Ankrah V. Akoto P. Quansah	Continuing		Trip reports	
4.7 Train manufacturers on manufacturing & maintenance of improved agro-processing technologies: - Thresher - Wet- type grinder & Rice mill - (Dry-type grinder)	D. Ankrah P. Quansah L. Halos-Kim	March 15-30 June December		Training reports	
Output 5 – Agro-processing purchased and utilized					
5.1 Link buyers/users to manufacturers, credit facilities/ financial institutions, etc.	D. Ankrah P. Quansah V. Akoto	Continuing		Report Visitors logbook List of buyers, banks, credit institutions with addresses & contact person	

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Year project started: 1994
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Activities	**Inputs:**			**Expected Output**	**Important Assumptions**
	Staff	Duration	Cost/Equip		
5.2 Conduct follow-up visits to manufacturers, users and processors	D. Ankrah P. Quansah V. Akoto	Continuing		- Monitoring Report - Field trip reports	
5.3 Collaborate with NGOs, district assemblies and government organizations, etc. in the establishment of Agro-processing cottage industries	D. Ankrah P. Quansah V. Akoto	Continuing from 2nd Quarter		Report	
Output 6 – Product quality enhanced, diversified products produced and products quantity increased.					
6.1 Demonstrate new technologies and crop products	D. Ankrah	3rd Quarter		Report	
6.2 Train processors in new crop products	D. Ankrah	3rd Quarter		Report	

Project Title: Developing Agro-processing Enterprises in Ghana and Benin

Project duration: 10 years
Target Groups: Agro-processors and small to medium scale entrepreneurs

Year project started: 1994
Date prepared:
Date Revised: Nov 21, 2000

II- Activity Logframe - Benin

Activities	**Inputs:**			**Expected Output**	**Important Assumptions**
	Staff	Duration	Cost/Equip		
Output 1 – Project management system established					
1.1 Planning, monitoring and evaluation	Project Management Team	3 times per year		Project Reports Minutes from meeting	
1.2 Sensitizing the project goals and the roles of partners/collaborators	Project Management Team	Continuing		More stakeholders participating	
Outpt 2 – Agro-processing technologies identified, evaluated and adapted					
2.1 Conduct survey and analysis of agro-processing technologies 1. For Cassava 2. For Sheanut 3. For Maize 4. For Rice 5. For Oil Palm 6. For Groundnut 7. Tomato, Pineapple	A. Aoga *DiFOV* L. Halos-Kim	3 months (to coincide with monitoring activities)		Survey Reports	

Project Title: Developing Agro-processing Enterprises in Ghana and Benin

Project duration: 10 years
Target Groups: Agro-processors and small to medium scale entrepreneurs

Year project started: 1994
Date prepared:
Date Revised: Nov 21, 2000

Activities	**Inputs:**			**Expected Output**	**Important Assumptions**
	Staff	Duration	Cost/Equip		
2.2 Select and adapt appropriate technologies to the needs of the users	A. Aoga *Partners* L. Halos-Kim Manufacturers	Continuing	IITA fund	Project Reports More appropriate technologies available	
Output 3 – Manufacturers' Network established.					
3.1 Convene manufacturers to form Network	A. Aoga T. Wakili L Halos-Kim	Continuing		- List of active manufacturers with addresses - Memorandum of Understanding (MOU) with SAA/IITA signed	
3.2 Register Manufacturers' Network with the Ministry of Internal Affairs	D. Sabirou A. Aoga T. Wakili	Before April 2001		Registration Certificate issued	
3.3 Plan activities of Manufacturers' Network	D. Sabirou A. Aoga T. Wakili	1 week (Dec 2000)		Work plan	

Project Title: Developing Agro-processing Enterprises in Ghana and Benin

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Target Groups: Agro-processors and small to medium scale entrepreneurs

Year project started: 1994
Date prepared:
Date Revised: Nov 21, 2000

Activities	**Inputs:**			**Expected Output**	**Important Assumptions**
	Staff	Duration	Cost/Equip		
3.4 Monitor quality of manufactured products	D. Sabirou A. Aoga Halos-Kim	Continuing		Monitoring Report	
3.5 Develop operation and maintenance manuals	D. Sabirou Halos-Kim	Continuing		1 operational & maintenance manual for each equipment: grater, press, thresher, rice mill, wet-type grinder	
3.6 Update sales records regularly	A. Aoga	Quaterly		Sales Record	
3.7 Participate in promotional activities	D. Sabirou Manufacturers A. Aoga T. Wakili	Continuing		Report from activities	

Project Title: Developing Agro-processing Enterprises in Ghana and Benin

Project duration: 10 years
Target Groups: Agro-processors and small to medium scale entrepreneurs

Year project started: 1994
Date prepared:
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3.8 Establish a functional supply store for manufacturers	D. Sabirou A. Aoga	November 2001		More regular supply of spare parts	
Activities	**Inputs:**			**Expected Output**	**Important Assumptions**
	Staff	Duration	Cost/Equip		
3.9 Establish distribution channel for spare parts	D. Sabirou	December 2001		Functional channel	
Output 4 – Agro-processing technology information disseminated potential stakeholders.					
4.1 Conduct field demonstrations	A. Aoga D. Sabirou T. Wakili	Continuing		Field demonstration report	
4.2 Conduct training for users, processors and manufacturers - Thresher and polisher - Rice Mill - Dry Grinder	A. Aoga L. Halos-Kim D. Sabirou T. Wakili	 1-15 Feb 1-15 June 1-21 Nov		 Report Demo unit of machines	
4.3 - Subscribe to mass media (TV, radio, newspapers) to advertise technologies - Develop posters - Produce video	A. Aoga T. Wakili Manufacturers Halos-Kim	Continuing		News clipping Video clips Posters	

Project Title: Developing Agro-processing Enterprises in Ghana and Benin

Project duration: 10 years
Target Groups: Agro-processors and small to medium scale entrepreneurs

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4.4 Visit different partners (NGOs, users, financial institutions district assemblies, government organizations, etc.) to promote the idea of agro-processing technologies	A. Aoga T. Wakili D. Sabirou	Continuing		Report	
Activities	**Inputs:**			**Expected Output**	**Important Assumptions**
	Staff	Duration	Cost/Equip		
Output 5 – Agro-processing purchased and utilized					
5.1 Disseminate information on agro-processing technologies and their features to target groups	L. Halos-Kim A. Aoga T. Wakili D. Sabirou	Continuing		Report	
5.2 Link buyers/users to manufacturers, credit facilities/ financial institutions, etc.	A. Aoga T. Wakili D. Sabirou	Continuing		Report Visitor logbook List of buyers, banks, credit institutions with addresses and contact person	

Project Title: Developing Agro-processing Enterprises in Ghana and Benin

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5.3 Produce specification sheets for agro-processing technologies	L. Halos-Kim A. Aoga T. Wakili D. Sabirou	April to June 2001		Fact sheets	
Activities	**Inputs:**			**Expected Output**	**Important Assumptions**
	Staff	Duration	Cost/Equip		
5.4 Conduct training for buyers/users on operation and management of equipment	A. Aoga T. Wakili D. Sabirou L. Halos-Kim	Continuing		Training reports	
Output 6 – Product quality enhanced, diversified products produced and product quantity increased					
6.1 Demonstrate use of agro-processing equipment for the production of new products	A. Aoga T. Wakili D. Sabirou	2rd Quarter		Report	
6.2 Train processors in processing new products	A. Aoga T. Wakili D. Sabirou L. Halos-Kim	3rd Quarter		Report	

Annex 2 -

Monitoring Visits and Interviews (November 2004)

Adoption and Utilization of Improved Agro-processing Technologies in Benin

by:

LEONIDES HALOS-KIM
Consultant, SAA-AP Project

Credits and appreciation for assistance during monitoring visits and interviews to:

Mr. Aoga Antoine
SAA-AP Project Coordinator- Benin

December 2005

Annex 2 –

Adoption and Utilization of Improved Agro-processing Technologies in Benin

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Adoption and Utilization of Improved Agro-processing Technologies in Benin

A. Metal Fabricators and Manufacturers

1. COBEMAG in Parakou

COBEMAG (Coopérative Béninoise de Materiel Agricole) located in Parakou, initially formed to assist member farmers with machines for their cotton farming, is a collaborating manufacturer of the SAA-AP program since 1996, and a member of Réseau F.M.T.A., manufacturers' network in Benin. It is the key manufacturer and supplier of agro-processing equipment in Northern Benin but has 21 service centers throughout the country.

1- Mr. W. Erasme, General Manager of COBEMAG – The Manufacturer of good quality equipment

The General Manager, Mr. Whannou Erasme relates the benefits gained by the company as partner of the SAA-AP program. Since joining the program, COBEMAG is able to diversify its products. Specifically, the program provides information on design of reliable post-harvest equipment appropriate for the local processors and provides associated training on manufacturing and servicing of the same machines. They are also linked to potential customers. This increased the sales and income of COBEMAG. The sales of agro-processing equipment, which used to be 10% of the total income of the company, now contribute at least 30%.

Further, Mr. Erasme indicated that the program's monitoring activity had help them realize the importance of after-sales service to maintain good customer relation and help processors maintain and optimize the use of their machines. Through this activity, COBEMAG, as is the other members of the network, gained a reputation as 'manufacturer of good quality equipment'. 'Policy-makers and major government and non-government rural development programs come to us for advice and supply of required equipment', he added. Their participation in the project also enabled them to participate in local, regional and international trade fairs opening up to more market and earned them

various recognitions and awards for quality fabrication.

The program had also sensitized COBEMAG management to make modifications on machine designs to adapt to local conditions. COBEMAG now puts more emphasis on product development to improve their business. For example, when the wet-type grinder was introduced to produce butter from Sheanut, they noticed that the processors need to crush the nuts into smaller pieces for more effective grinding. They then adapted a nut crusher with the wet-type grinder which increased the adoption of the system, now known as the 'Sheanut Complex'. As they continue to relate with the customer, they are now developing a kneader to be included in the Sheanut processing complex.

Mr. Erasme also noted the importance of training to improve the skills of their technicians and to make good training for operators on machine operation and maintenance. The recognition of the government given to the Manufacturer's Network (Réseau F.M.T.A.) formed among the collaborating manufacturers in Benin, shows the government commitment and confidence on the supply of good quality locally-made machines. The Ministry of Industry has also helped technicians of the network members to undergo refresher training to upgrade their skill in Tunisia in 2004. Recently, the network has been asked to participate in planning the Mechanization Program of the country which is to be funded by Food and Agriculture Organization (FAO).

'The biggest challenge we have now is funding the activities of the network. Agricultural machinery business is difficult because farmers and processors can't afford to buy them. Agro-processing and introduction of improved equipment are new in Africa and therefore we need to work harder in terms of reaching the customers', Mr. Erasme finishes with a positive outlook.

2. The 'Welder from Kere' in Glazoué

A grater similar to IITA-design was spotted in front of this roadside mechanical workshop on the Cotonou-Parakou Road in Glazoué District.

2- The IITA-designed grater fabricated by the 'Welder from Kere' displayed in front of his workshop

The workshop provides welding services for repair of various types of tools and fabricates doors and windows for about 12 years already. In 2001, the owner sent his son to C.F.T.S. in Ouidah, a member of

F.M.T.A. (Manufacturers' Network in Benin) for training. From there, the son saw the selling potential of the grater and double screw press. When he went back to their workshop, he started fabricating the grater and double screw press. The first unit of grater was used to demonstrate to processors and provide grating services in the village. This has created demand. In 2003, they sold 2 sets of grater and press while continuing to provide grating services.

3. Atelier et Service de Formation (SOCOMÉ) in Savé District

Located farther up the Cotonou-Parakou Road, in Savé District, the Atelier et Service de Formation (SOCOMÉ), lines up its agro-processing machines for sale. Not in the line of prototypes on display, but is on the billboard, are the drawings of the IITA-designed grater and double press.

3 - On sale by the roadside are agro-processing machines fabricated by SOCOMÉ. Easy access markets facilitate product promotion and sales

The owner, Mr. Homer Onidje, a welder turned entrepreneur, is a former staff of COBEMAG in Parakou, a member of F.M.T.A. and then of Songhaï, an international NGO for rural development. He decided to set-up his own workshop adopting agro-processing equipment for his main products.

He was encouraged by the number of sales of the agro-processing machines he saw in COBEMAG. As soon as he started, he received orders for the IITA- designed grater from processors who are using the same. He sold 5 units of the grater.

Assessing the processors needs, he immediately adapted the double screw press to be more portable and affordable. The modified press sold quickly. He keeps his business running by fabricating anything the customers ask.

He sees that more equipment are needed by the processors. His experiences in COBEMAG help him to adapt designs thru association with the customer and testing. 'The business is good but the processors do not have the cash to pay for machines. Only if there are programs, like NGO, that could support them ', he sighs.

4. CEFACOM in Azove Town

CEFACOM (Centre de Formation de Fabrication et d'Ajustage en Construction Metallique) joined F.M.T.A. in 2003. Its workshop is located along the national road in Lokossa, Aplahoué District, Azove Town, Mono Department.

CEFACOM adapts and fabricates different agro-processing machines including cassava grater, rice mill, palm oil digester, press, groundnut decorticator, etc.

4- CEFACOM workshop equipped to supply good quality processing machines and associated services

The well-equipped workshop is established with the assistance of the Belgium government. They provide training to local artisans.

5. Ets - AFM (Atelier de Soudure-Fabrication Métallique) in Hagoumé

A metal workshop located along the national road in Hagoumé, Dogbo displays small-scale agro-processing machines such as graters which look like a down-sized model of the IITA-designed grater. The owner, Mr. Vlavo Job, is a welder trained in Azové and in Parakou.

Mr. Job started his business in 2002 fabricating doors, windows and metal grills. He noticed that people need agro-processing machines as he keeps receiving jobs to repair their graters. This encouraged him to go into fabrication of graters, and cassava slicers, which are displayed in front of his workshop for sale. He copies the graters which were brought to his shop for repair; some of them were fabricated by CEFACOM.

5- Mr. Vlavo Job, Ets-AFM Director fabricates, sells and repairs agro-processing machines

In 2003, he fabricated and sold 18 single screw presses for an NGO-assisted project. He noted that the machines are good but people could not buy unless through project funds.

B. Cassava Processors and Processing Sites

6. Cassava Processors in Savé

A cassava processing shed along the Cotonou-Parakou Road is being used by a group of 20 women who process cassava into *gari* and *tapioca*. At one time, the group received assistance from a rural development NGO providing them with grater and press. They, however, did not cope with the machine operation and maintenance. After few months, the grater and the press, broken, were abandoned.

The women continue to use the processing shed. An entrepreneur from the village comes to provide grating service to the women for a fee.

He comes to the site from 4:00 o'clock in the afternoon. When done, he leaves the grater in the site but bringing home the engine.

6- Cassava processors in Savé depend on grating service-provider to pursue their business

The women prefer this kind of arrangement. It frees them from the problems of machine operation and maintenance keeping them focused in their processing. The women appreciate the machines reduced the drudgery in cassava processing allowing them to increase their processing capacity and income, and still gain more time to spend with their families.

7. Cassava Processing Site in Toui Village

A new cassava processing site is being established in Toui Village along the Cotonou-Parakou Road. A grater and two double-screw presses are positioned in front of a frying shed. The machines are provided by an entrepreneur in Cotonou and managed by his brother and a friend from the village.

Interestingly, the grater was bought 7 years ago (1997) from CIJOFAM, a group of technicians trained by C.F.T.S. (a member of F.M.T.A.) in Ouidah. The grater is based on the conventional local design but has adopted the grating assembly of the IITA-designed grater.

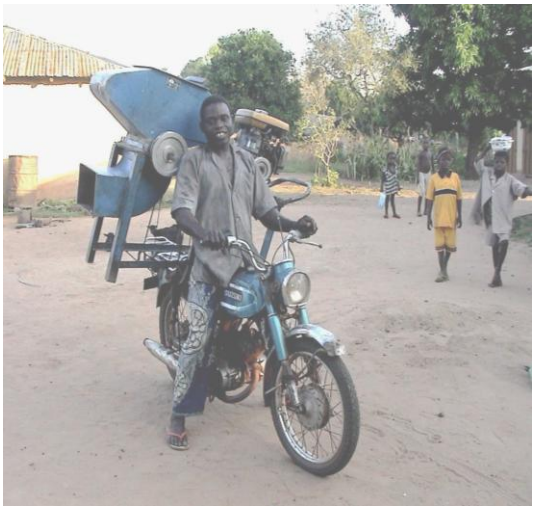
The operation in the site started in September 2004 currently providing regular employment to 6 women who fries the *gari* daily. Additional workers are hired on casual basis to harvest and bring cassava to the site. In addition to *gari,* the center will also produce *tapioca* and flour from cassava.

The manager, Mr. Djossou Arouna is a diesel mechanic by training and foresees a bright prospect of the business. In the last 2 months of operation, they are now developing their market within the village and in the town market. Other processors in the village also come to the site to grate and press their cassava which provides additional income from the facility.

7- Cassava processing site in Toui Village being developed to be equipped with a grater and double screw presses to produce *gari, tapioca* and flour

8. Grating Service Provider in Borone Village

Mr. Boni Hubert, an auto-mechanic in Borone Village, Tchaourou Town, invested in a portable cassava grater which he saw during a demonstration by the SAA AP backed by the CREP program in 1995. He does not process '*gari'* himself but saw it as an opportunity to help the people in his village and at the same time earn his income.



8- Mr. Boni Hubert (*Baba Oléo)* with his grater on the move to service cassava processors in the village

Mr. Boni carries his grater around the village at the back of his motorbike. He books his customers one day before the operation. He can service for up to 35 customers in a day with a gross earning of CFA 1,500 to 4,500. As a practicing mechanic, he maintains and keeps his grater in good condition all the time. His grater is probably the oldest of the IITA-designed grater in the locality which is still very functional.

The processors in the village are happy with the arrangement. Grating service is easily accessible which allows them to program their *gari* and *tapioca* production effectively. To date, there are 4 additional graters servicing the processors, but are operated on sites where processors go to grate their cassava. Their grating business is also doing well.

Providing grating service had improved Mr. Boni's social status and has earned him sufficient income. He re-invested part of his income in a 2-ha cashew farm and uses part of it to support family needs such as children' schooling and plastering his mud house with cement. His popularity in the village has given him an important role in village development being elected the President of the village youth association.

Mr. Boni's operation has provided a good feedback on the design and utility of the grater resulting in a simpler grater and on how to make grating a profitable farm enterprise.

IITA has called Mr. Boni 'the Grater President'. In the village he is known as *Baba Oleo* (Chief of Grater) or *Baba Kupo* (Chief of Engine).

9. Cassava Processing in Eni

In 1998, a group of six women processors in Eni Village formed to avail of a loan to acquire a package of cassava processing equipment provided through a rural development project by IRCOD, a French NGO. The group called

themselves *Isso-Issinadou* which means may God bless you.

9- The double screw press in Eni eliminated the use of stone piles to dewater grated cassava

IRCOD program required the group to contribute a certain amount of cash (CFA70,000) plus water and gravel towards the construction of a store and a machine shed. The land was provided by the group.

The construction was completed in 10 months after which the grater and double screw press were delivered. A fenced pressing and fermenting concrete platform was provided which drains effluent water to a covered pit. This helps keep the surrounding tidy.

Members used to process using manual rasper to grate cassava and pile stones on bagged grated cassava to de-water. The new facility had helped them to improve their production. They now have to buy cassava to process for as far as 4 km away. The group doesn't hire operators; the members operate the grater and press. From time to time they provide grating and pressing services to other processors in the neighborhood. The group felt their number is manageable and doesn't intend to extend membership to other processors.

10. Cassava Processing in Banikani Village

The *Sênoumatê* Women Group in Banikani also formed to avail of IRCOD assistance. They were provided with grater and double screw press. A conflict in management however prevented them to use the facility. The press was abandoned and the grater could not be located.

11. Cassava Processing in Avakpa

The *Dagbe Bamide* Women Group in Avakpa received a generous donation of rural infrastructures including agro-processing machines from the African Development Fund (ADF) in 1999. A social worker from the Ministry of Women Affairs in Allada identified the group and recognized their hard work and self-help development initiative recommending them for the ADF benefit. As *Dagbe Bamide* means-

10-The cassava processing center in Avakpa Village managed and operated by the *Dagbe Bamide* Women Group. It is equipped with graters, double screw presses and frying stoves

after your suffering, good thing will come one day, the women are happy that this project has come to their village.

The group was provided with processing shed, 1 grater with petrol engine, 4 double screw presses, frying stoves and water well. The machines were selected and procured in consultation with the women processors. APROMAH, a member of Réseau- F.M.T.A., also a beneficiary of ADF fabricated and supplied the machines.

The group members were trained by APROMAH technician on the operation and maintenance of the machines. They seldom require an outside operator, until the 2nd grater with diesel-engine was added to their facilities due to their increasing capacity. The women felt that the grater with petrol engine was easy enough to operate.

They use the facilities for their own processing but also extend grating and pressing services to the processors within the village and the neighboring villages. Improved processing provided a decent income for the women to buy food for their families and send their children to school. With increasing processing and *gari* production capacity, they now look at organizing their market.

12. Cassava Processing in Agoudenou Village

Working with the Ministry of Rural Development (DiFOV), the SAA-AP project selected Agodenou Village in Carder Atlantique to establish a site for a Model Processing Center. One of criteria for site selection was the diversity of crops grown in the area. This will provide an opportunity to demonstrate and test different technologies and technology packages.

The site was provided with grater, double screw press, fermenting stand, wet-type grinder, multi-crop thresher and palm fruit digester. They were provided on loan on the assumption that the center will be a self-sustaining facility for training and demonstration and therefore should be able to pay for its operations.

The processing shed equipped with a number of frying stoves was built for the group by the Carder Atlantique program. Carder program also provided the group a conventional local grater and single screw press.

11–'Processing pays' say the *Gbezealou* Women of Agodenou who produce and market *gari* and other food products from cassava using simple and efficient machines

The *Gbezealou* Women Group now with 16 members (3 are men) manages the facility. Among the

various technologies demonstrated, only the *gari* processing package was well adopted. The facilities helped the community process their food and provide them a major source of income. The women normally use the facilities to process their own cassava and provide grating and pressing services to other processors in the village. They hired a man operator for the grater who also helped them to keep track of their processing activities.

The women claim *gari* processing pays. Over the years, the women realized that the market for their good quality *gari* is expanding. Improving and maintaining the quality has been the focus of their management operation since last year. They observed that the stainless grating sheet they are using produces a whiter pulp than the local sheet; therefore they continue to use it. The hired fryers are also paid according to the quality of *gari* they produce. This gives them an incentive to concentrate on their work.

The President of the women group, Mdme. Abassi Houton, proudly says 'we are famous for good quality *gari* in the area. Many customers from the neighboring villages and Cotonou come to the center to buy our *gari.* We charge higher price for our first class *gari.* The customers are satisfied.'

Gari processing using improved machines is proving to be a good enterprise in the village. The former grater operator of the *Gbezealou* group saw the increasing demand for grating services so he invested in a grater privately while continuing to assist the *Gbezealou* women. He now provides grating services to the other processors and is able to improve his family's living standard from his income.

13. Cassava Processor in Hinvi Village

The respondent, Mr. Hessou George, was a civil servant turned farmer-entrepreneur in 2002 on retirement. He farms cassava, maize, oil palm in Hinvi Village, Atlantique Department. While farming, he realized that farming is not good without processing. 'With processing you can sell your products easily,' he added.

He then established his gari processing site within the farmstead. He built a shed and installed 6 frying

12- Cassava processing in Mr. Hessou's farm improves the value of his crops and provides employment to men and women in the village

stoves, and bought a grater and a press from CAMEMEC, a member of F.M.T.A.). He now hires workers to fry *gari* for him. In order to optimize the use of the grater to increase his income, he moves it around the village to service other processors who could not bring their cassava to the center.

Mr. Hessou keeps a good record of his farm and processing activities. Based on this, he can say that agriculture is a profitable business. Encouraged by his *gari* processing business, he plans to buy machines to process his maize and palm oil produce, as well.

14. Gari Processing in Davohoué Village

Our respondent is the Chief of the Village, Mr. Foton Basadji. He advises and supervises the women in the village in their farming and processing activities.

Mr. Basadji helped to form the *Bobonsou* (which means it is good to be together) Women Group initially to improve their farming. Later, the women realized that farming cassava does not pay unless it is processed.

In 1998, the group bought grater, press and sifter to enable them to improve their processing methods. The facilities allow them to process the produce from their farms and still buy more cassava from the local market.

The processing business proved to be profitable; other processing groups were formed following the success of the initial group. In 2002, they acquired a 2nd grater through a loan from CARDER.

Two mechanic/technicians were trained to operate and maintain the graters and other facilities.

The Village Chief supervises the groups. He said, 'group management requires a good supervisor who will guide the farmers and processors in their farming and processing activities and help them to understand the profitability of their activities'. He commits to continue to supervise his people for as long as needed to help them improve their lives.

13-The double screw press is one of the processing facilities in use by the *Bobonsou* women in Davohoué helping them increase their processing capacity

15. Cassava Processors in Sirarou

Cassava processing in Sirarou has been expanding, so is the number of processors. The *Taki-Sari* Women Group formed in 1992 with 6 members now has 52 members, including 1 man. The name of the

group, *Taki-Sari*, means nobody cheats which embodies their philosophy in life, that is, if they have something they always share equally. Conditions for membership to the group are tough. They emphasize on members' character and ability to work in a group.

The group started processing cassava using manual rasper until 1996 when the improved processing machines were introduced to them by the SAA-AP project. The project provided a grater and sifter to the group on loan. The women used the facilities and saw the business was good. It encouraged them to work harder and in one year they were able to repay their loan. In the same year, the membership increased to 26. The management of the group is coordinated by a leader who schedules their operations in consultation with the members. In 2000, IRCOD, a French NGO, noticed the groups' hard work and provided them credit to buy a 2nd grater and press set. The Ministry of Rural Development also donated a single screw press to the group in recognition of their hard work.

In 2004, IRCOD provided loan to the group to acquire and install a bread-making equipment package.

IRCOD assists the group in constructing the housing, and in training the women on bread-making.

The large amount of processing in the center however resulted in problems of draining effluent water from cassava. The water well near the center was contaminated which caused conflict among the villagers. The conflict was settled and processing continues as the villagers found a new water source.

14-The *Taki-Sari* Women Group in Sirarou continues to grow in membership as their processing and marketing operations expand. The women acquired simple processing equipment to process Cassava into *gari, tapioca,* flour and recently bread-making

16. Cassava Processor in Aligoudou

The *Massitohou* Women Group with 16 members was formed in 1995 to help each other in developing their community. They are a beneficiary of a government program called PAMER which taught them to improve *gari* processing and introduce them to processing fritters from cassava starch. They were also given machines a cassava grater on credit. The grater is the conventional local design.

Some women members don't know how to process gari then and are not

aware of processing machines. As the women adopted *gari* processing using the improved techniques, they requested the CARDER program to provide them an additional grater, for which they were given the IITA-designed grater. In addition they also received a double screw press and a fermenting stand which they found very useful.

The group has a chance to compare the graters based on features that enhances capacity, safety and maneuverability. They recommended that the IITA-designed grater be improved in terms of increasing capacity and providing safety feeding features. In terms of quality, the women liked the fine and smooth mash from the IITA-designed grater. The press and fermenting rack are found very handy and useful.

The group uses the facility to process their own cassava and also to provide grating and pressing services to other processors in the village.

15-Cassava processing in Aligoudou using 2 types of graters, a fermenting rack, double screw press and frying stoves. The processors are building up their processing capacity and discovering the potentials of Cassava as a cash crop through processing

C. Rice Millers and Mills

17. Rice Miller in Beroubouey Village

The owner/operator, Mr. Amadu Getti, observed that the four conventional rice mills in their village are being patronized by the people. With the help of his father, he decided to invest on a rice mill, but one which mills rice in only one passing. He was directed to COBEMAG, a member of F.M.T.A., where he procured one unit in December 2003.

The rice mill is a modified IITA-design where the Engleberg mill roller was adapted. A 12-Hp diesel engine is used as power drive instead of the 7 Hp petrol engine used in the IITA-designed rice mill.

The rice mill was installed with a separate housing in Mr. Amadu's family compound. The COBEMAG staff trained Mr. Amadu on machine operation and maintenance. The owner/operator, being a technician by training repairs and maintains the machine regularly keeping it in good working condition at all times.

Mr. Amadu started to operate the mill on February 2004 on custom-hire basis competing with the other 4 conventional rice mills in the village. On the average, he is receiving up to 30 customers per day. He operates 2-3 days in a week during the lean season and everyday from February to April in 2004.

16-Mr. Amadu Getti and his rice mill providing his family with good income. He plans to buy another rice mill to cope with the growing demand for this service in the village

This translates to an average milling capacity of 1.0 to 1.5 tons milled rice per day or an average income of CFA10,000 (or approx $20 per day) for Mr. Amadu.

Mr. Amadu's business started well and he sees continuing business potential as processors in the village now prefer his rice mill because it is faster and produces less breakage.

For SAA-AP project, the experience of Mr. Amadu has confirmed the technical viability of the rice mill. Based on this, COBEMAG, in collaboration with the local manufacturers in Guinea fabricated and successfully demonstrated 3 units of the rice mill in Guinea. This has remedied the problem reported on the IITA-design which was introduced there earlier.

18. Rice Millers in Boké Village

The rice millers of Boké walked 2 km to the next village to wait for their turn to mill their rice. When lucky

they could return to their village with their milled rice within 4 to 6 hours. Else, they have to go back the next day, or use their mortar and pestle. This was the scenario not long ago before they acquired their own rice mill.

The women of Boké cultivate and process groundnut, maize, millet, sorghum and upland rice on small scale. A group of women with 28 members initially formed to improve their groundnut farming and processing.

However, some women later realized that their rice processing activity, although small in scale, is giving them more income and has good potential to develop into a business. The opinion of the women was divided causing the women to re-group. The *Nanaye* Women Group evolved and was interested in rice milling. Through the help of a Missionary Nun of a Catholic Church from France, the *Nanaye* women group acquired a rice mill in January 2004. Interestingly, the group's name *Nanaye* means – if I know!

The mill is a modified IITA rice mill powered with 12- Hp diesel engine. The group built an open shed near the village market where the mill was installed and could be accessible to processors. In April 2004, the women started using the rice mill. Since then 10 to 15 customers and processors come to mill on Fridays, day before the market day.

17-The *Nanaye* Women Group and their rice mill in Boké Village. They believe rice milling is a potential business

Two volunteer young men were trained to operate and serve the group after their farm activities, so that operation is very dependent on their availability. The operators also keep a record of users and fees paid. The women see that the mill will soon be fully operational and plan to hire a more permanent operator so they can mill their rice anytime.

19. Rice Millers in Mani Village

Two kilometers from Boké, is the Mani Village where the same rice mill was donated by the Nun in January 2004. A women group operated the machines for three months but they stopped when the operator left. The group is now making arrangements to find a new operator.

D. Sheanut Processors and Processing Complexes

20. Sheanut Processing in Tourou Village

The *Borignindou* Women Group was formed with 10 members in 1992. They named their group *Borignindou* as an expression of their satisfaction or happiness working on the principle that group work brings better results.

They acquired the Sheanut Complex, the package consisting of a Sheanut cracker and the wet-type grinder) from COBEMAG in 1999 with a loan from IRCOD, the French NGO. The group uses the machine shed and processing center facility put up by the Ministry of Agriculture in the district.

Sheanut processing by the group had since developed to a more commercial scale. During peak harvest season, the women buy as much Sheanut as they can which they store which keep their business going during the lean months when the price of the Shea Butter is also higher.

The women are happy with the quality and quantity of butter produced from the machines. It is very fine and easily yields oil reducing the kneading time and increasing oil recovery. Other processors, who are non-members, also come to use the facility because of the good quality of ground butter. The service fees collected add to the income of the group.

18-The Sheanut complex consisting of Sheanut cracker and the wet-type grinder is providing a reliable income to the *Borignindou* women group and other processors in Tourou Village

The group hires an operator, especially for the diesel engine. He comes to the center according to his farming schedule.

The role of COBEMAG is very crucial in the success of the operation in the processing compound. The women are not worried about machine breakdown. The accessibility of COBEMAG makes them confident that any needed repair and

19-Sheanut processing compound in Tourou has a processing capacity of about 1 ton per day keeps the women busy and appreciating good business management

maintenance is easily attended by their technicians. They are willing to pay the costs of these services.

Women expressed their satisfaction with the machines and are happy of the direct benefits that come to their families. The increasing income from processing Shea Butter enable them to feed their families, send their children to school and provide better medical care for the family. They also get additional capital to buy raw materials during the peak harvest season. They could now process and store their products to wait for a good market.

21. Sheanut Processing in Koroborororu

The *Sodom'se* Women Group owns and operates a Sheanut Complex. They initially formed as a cotton production group consisting of men and women formed in 1988 with initial membership of 32. The women later decided to form their own group because they don't get their share from their husbands. The group called themselves, *Sodom'se* meaning- You have to wake up! Their guiding principle is working together to improve their lives.

The women however realize that they need a man to help them in their operations and especially to advise them in their group management. Mr. Yirima Gorubi Wurugani, a brother of a group member, who is always interested in their activities was requested to be their adviser. He also represents the group in village meetings and community activities.

The group is processing Sheanut for a long time on a very small scale using traditional method. The enumerator of the French NGO, IRCOD, visited the village and she informed IRCOD's program to help women processors improve. The group availed of the loan to purchase the Sheanut complex on the conditions that they will contribute towards the construction of the machine house and that they will payback in three years. The women worked hard and were able to payback in 14 months. Because of their good repayment record, IRCOD recently donated a bread-baking facility to the group.

20-Members of *Sodom'se* Women Group pose with Mr. Aoga (SAA-AP Coordinator, Benin) in front of their processing building

Using the Sheanut complex is not a problem to the women. They hired an operator and the members themselves are able to operate the machine. They take pride to share

their benefits to the other processors who are non-members by allowing them access to the machines. They see the business very promising with increasing demand for machine services. They plan to buy a second unit which they can put up in the nearby village so that they can help the processors save time in carrying their crops to Koroborororou for processing.

The immediate concerns of the group are to improve their kneading operation and to find a market for their Shea Butter. IRCOD is helping to advertise their product, and those of the other project beneficiaries, by displaying and selling their products in Boutique la Qualité in Parakou.

22. Sheanut Processing in Baká

The Sheanut Complex in Baká was donated to the community by the Catholic Relief Church (CRC), an American-based NGO dealing with Health and Social Welfare in the communities. A management committee consisting of 7 members (5 are men), was elected by the community members. The machines were acquired in June 2004. Three technicians were trained to operate the machines and record the use and income from the machines.

Talking to some men in the community, they informed that the facility was built primarily for the women processors. 'In general, the women does not know how to earn income, they only work very hard', they added. The husbands provide their wives with cash to buy raw materials to process, so they can sell better.

A group of processors called the *Antisua* Women Group with 32 members are the primary beneficiaries of the machines. *Antisua* rightly describes the determination of the women in the village emphasizing self-help and hardwork. *Antisua* means- if you want to carry a load on your head try to do it first, others will help you.

A lady processor and member of the group expressed her pleasure in using the facility. The women first saw the machine in Koroborourou Village, about 3 km away, which they informed the social-worker from CRC. The community helped to put up the housing for the machines as their contribution.

21-The Sheanut complex in Baká operates more than 8 hours on a normal business day

The machines now keep the women busy and realize that what they used to do manually is now an income-generating activity. They process Sheanut into butter two times in a

week and still spend more time for their families, especially the children. Their income increased which add to family income and allows them to provide for family needs.

In addition to the Sheanut complex, the group plans to purchase cassava processing machines and also learn methods of processing *dawa-dawa* (a fermented condiment from locust beans). They can use the Sheanut complex to grind the beans to ferment.

23. Boutique la Qualité in Parakou

IRCOD, the French NGO supporting projects for the improvement of women agro- processors which started in 1993. They have a shop in Parakou where samples of products from their project beneficiaries are displayed on sale and offered to potential markets.

The IRCOD enumerator, Mdme. Maimounath Zacharie Kora said that IRCOD assistance is focused to 5 groups only. The program provides loan to women groups to enable them purchase their needed equipment. IRCOD developed a working relation with COBEMAG as a result of a field demonstration conducted by SAA-AP project. Groups applying for funds are introduced to COBEMAG for equipment selection. The group pays the first CFA100,000; IRCOD pays the rest which will be paid back by the group in an agreed duration, usually 3 years. Mdme. Zacharie said they get good loan re-payment from the groups. The key to their success is a continuing monitoring and support. She visits the groups regularly, at least once a month, talks to them and gives advice on issues related to their operations.

'IRCOD will continue to monitor the projects for as long as needed to encourage the women to take care of their businesses. The problems in monitoring are many. For example most of the women are illiterate and needs regular follow-up. We have to be very patient', she added.

22-Mdme. M. Zacharie Kora at the IRCOD boutique where samples of products from their women beneficiaries are displayed to find their markets

E. Maize Farmers and Threshers

24. Maize Threshing in Sori Village

The mobile multi-crop thresher had been very popular in the village of Sori where maize farmers used to shell their maize by putting them in bags and beating with stick.

A young entrepreneur, a technician by training operates a mechanical workshop fabricating simple gadgets; saw a demonstration by the SAA-AP project of the multi-crop thresher in 2000. He bought one unit of the thresher from COBEMAG. Because of the mobility of the thresher, he thought he could help the farmers by providing threshing services. He started to move around the farms and villages with his thresher. The people patronized the threshing service which provided good income and popularity to the owner-operator. The maize farmers come to him to schedule their operations. He maintains his thresher and engine regularly keeping it in good condition all the time.

Based on this experience, another 5 units of the thresher were bought by other entrepreneurs about 250 km North of Parakou and are being used to provide service to farmers and processors.

25. Maize Threshing in Atomey Village

Atomey Village in Mono Department is reachable only through a very rough road, almost un-passable on rainy days. In 1997, the CREP of Atomey with about 300 farmer-members acquired a thresher with a manually-operated grain cleaner/ sorter for use by the group and the other maize farmers in the community.

The thresher was very useful to the farmers such that two other CREP groups in the nearby villages bought the thresher with cleaner. One individual entrepreneur also bought one thresher which adds up to the threshing capacity in the village, yet they need more.

23-The thresher in Atomey is being utilized at full capacity by more than 300 maize farmers. The spring actuated grain cleaner/ sorter (forefront) lasted only for two seasons

Our respondent, the Manager of the CREP of Atomey, Mr. Aklan Justin, informed that their group trained and employed 2 operators who are paid from the proceeds of threshing

services provided. They also appointed a management committee to manage the facility.

The introduction of the threshers with cleaner in the neighboring villages created a competition which reduced their threshing fee from CFA1,000 to CFA800 per bag of 120-kg threshed maize. Group management of the thresher presented the following constraints:

Conflict in scheduling of work,

Decision-making is slow, and

Repair and maintenance is not done on time.

The general problem with the CREP program in the country hinders the farmers to make better decisions on their farming activities. The farmers found the profitability of agro-processing. They encourage men and women to do more agro-processing instead of cotton farming. Based on experience, CREP plans to give loan to individuals instead of the groups to buy agro-processing equipment.

The work of the SAA-AP program provided processing options to farmers which enable them to process their crops to be stored while waiting to be sold.

26. Multi-crop Thresher in Lokokoukoume

A multi-crop thresher was purchased by a farmer-entrepreneur, Mr. Hounou, for de-husking and shelling his maize crops. Lokokoukoume Village is about 60 km east of Cotonou where Mr. Hounou's 100-ha oil palm plantation can be found. He also grows cassava and maize in the farm.

A palm oil processing plant is installed in the farmstead where dozens of workers are employed. Two maize storage rooms and cribs are built close-by.

The maize thresher proved to be very useful in their maize farm. What they used to thresh for 5 months could now be threshed in 2 months, though still constrained by cleaning. The operator, a son of the owner, is an engine mechanic and trained in C.F.T.S., a member of F.M.T.A. He is backed by his brother who was also trained in operating the machines.

The Farm Manager said they plan to buy a second unit of the thresher. With the thresher, they can now program their operations to wait for a favorable market price.

24-The multi-crop thresher in Mr. Hounou's farm has helped cope with de-husking and shelling maize during peak harvest season and when the 'price is right'

L. Halos-Kim / Dec '04

Annex 3 –

Monitoring Visits and Interviews: (27 October to 07 November 2004)

Adoption and Utilization of Improved Agro-processing Technologies in Ghana

by:

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Consultant, SAA-AP Project

Credits and appreciation to the following for assistance during monitoring visits and interviews

Mr. Patrick Quansah
in Volta and Eastern Regions

Mr. Francis Divine Asare
Mr. Kwame Tugbah
in Ashiante Region

Ms. Dorothy Ankrah
in Eastern Region

December 2005

Annex 3 –

Adoption and Utilization of Improved Agro-processing Technologies in Ghana

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Adoption and Utilization of Improved Agro-processing Technologies in Ghana

A. Metal Fabricators and Manufacturers

1- GRATIS Foundation in Tema

GRATIS (Ghana Regional Appropriate Technology Industrial Service) located in Tema was established in August 1987 by the Government of Ghana with a mandate to promote small-scale industrialization in Ghana. It was incorporated as a Company Limited by Guarantee, as GRATIS Foundation, in December 1999.

GRATIS Foundation operates through a network of nine Regional Centers and three District Rural Technology Service Centers (RTSC). GRATIS Foundation manufactures equipment for agriculture and agro-processing, environment and sanitation.

GRATIS Foundation is an active partner of the SAA-AP program. During the last 5 years, it had participated in the project's promotional activities such as field demonstrations and trainings. GRATIS Foundation activities create regional linkages to promote adoption of locally-made agro-processing machines. The availability of machines in the local market would facilitate the processing of farm produce and help reduce postharvest losses, improve food security and create employment especially for women and the youth.

Among others, GRATIS Foundation has fabricated and installed 350 sets of the *Gari* processing equipment package which consists of grater, double screw press, fermenting rack,

1- GRATIS Foundation displays its products in national and international trade fairs to increase awareness of clients on availability of locally-made good quality agricultural machines and to encourage their adoption

and sifter, and 25 sets each of the Sheanut butter and groundnut oil processing machines for the Ministry of Women and Children's Affairs of Ghana.

GRATIS Foundation provides technology-based training to its clients to equip them with the necessary technical, vocational and entrepreneurial skills for self-employment.

GRATIS Foundation hosts the Ghana Manufacturers' Network with members from its regional centers and its clients.

- ***Interview with Mr. Kwabena Dankyi Darfoor, Executive Director, GRATIS Foundation***

Mr. Kwabena Darfoor heads GRATIS Foundation. He advocates the strengthening of the local manufacturing industry to support the growth of mechanization to enhance agricultural development in the region.

Mr. Darfoor hopes that Ghana will be a center of agro-processing in the region. His policies, and that of GRATIS Foundation, emphasize technologies for farm-gate processing to create rural enterprises and rural employment. GRATIS Foundation is strengthening its after-sales services which are being done by competent staff of the Gender and Marketing Unit in cooperation with the Design and Testing Unit.

2- Mr. Darfoor makes sure that every machine produced by GRATIS Foundation passes quality check before releasing to customers

Mr. Darfoor represents the interest of small- to- medium scale enterprises in the country and at regional forums he has been pushing for policies that will promote the growth of agro-business industries in Ghana. Recently he recommended the establishment of 'trading houses' in the rural areas where the processors are invited to show their products and get in touch with customers. He sees that the agricultural policy of the Government of Ghana is moving towards industrializing agriculture.

Mr. Darfoor observes that the region needs more development work on packaging of agricultural produce, and on competitive marketing.

- ***Interview with RTSC Managers, GRATIS FOUNDATION***

Mr. Francis Divine Asare of Mampong RTSC, Ashanti Region, is one manager who gives personal attention to his customers. He makes sure that he visits them personally and monitors the performance of the machines they are selling. "The repair and maintenance services of

Mampong RTSC, and that of GRATIS Foundation, helped to develop the confidence of our customers which increased our number of sales of agro-processing machines in the last 3 years", he said. "The SAA-AP program linked us to our customers and trained our technicians to be competent in providing these services."

Mampong RTSC is now a major supplier of agro-processing machines in the Ashanti Region. They have trained other local manufacturers who support them to supply the increasing demand for improved agro- processing equipment and provide the associated repair and maintenance services.

3- Mr. Francis Divine Asare heads Mampong RTSC in Ashanti Region providing personal supervision and customer care to their clients

Mr. Asare is thankful of the benefits from the SAA-AP project. He said that the training component has been very useful especially for technicians. The training helps them to understand the importance of supplying the appropriate machines to customers and emphasize on quality control. He recommends that the project continue to strengthen this area of collaboration.

Ho RTSC Regional Director, Mr. George Baddoe said that the agro-processing machines introduced by the SAA-AP project had been popularly appreciated in the Volta Region because they are neither bulky nor expensive. They are continually finding ways to assist processors to acquire their own machines. For example, the company offers an easy payment scheme with low down payment and provides one year free repair and maintenance. They are strengthening their promotion and marketing activities through participation in regional and national exhibitions and conducts occasional in-field demonstrations. Mr. Baddoe hopes that the processors will improve their operations through access to these simple but versatile technologies.

2- ENTESEL in Tema

In the light industrial area of Tema is a well-equipped Machine/Welding Fabrication shop, the ENTESEL Establishment (Engineering and Technical Services Establishment). It is one of the 'clients' of GRATIS Foundation and has been an active member of Ghana Manufacturers' Network. ENTESEL works with GRATIS Foundation and most Ghana-based NGOs in rural industrialization and poverty alleviation.

Mr. Sam Quaye, Managing Proprietor and Chief Executive Officer of ENTESEL, invested in this business in 1982 to provide mechanical engineering services to established industries through plant installation, commissioning, maintenance and modification. In 1986, his establishment started the production of replacement parts to service their maintenance activities as a matter of necessity.

In 1993, ENTESEL, through GRATIS Foundation, sent technicians to be trained by the SAA-AP project. This boosted his business allowing him to expand his product lines and his clients. From 1996, ENTESEL is one of the major producers of agro-processing machines supporting the project. He now says more than 30 percent of the company's income is derived from sales of agro-processing machines introduced by the project. The project enables them to reach the customers improving their marketing activities, and understanding customers' real needs and resources.

Mr. Quaye is particular on the quality of machines they produce. He says "Excellence is a journey. It is not a destination". Therefore they strive for excellence in their manufacturing process. A rigorous quality control is done on all pieces of products they produce.

He also makes follow-up on machines sold to make sure that customers are making use of their investments properly. With the help of the SAA-AP project, this was feasible until 2004. Mr. Quaye is concerned on how to sustain this initiative since it involves additional financial and human resources. He hopes that the Manufacturers' Network could be well-coordinated and strengthened and that collaboration with national agencies continues to support them to carry out this important task.

4- Mr. Sam Quaye, Managing Proprietor of ENTESEL, makes sure that quality control is fully enforced and strives for excellence in their manufacturing process

B. Cassava Processors and Processing Sites

3- Community Processing Center in Abodom Bomso Village

Abodom Bomso Village in Kade District, Eastern Region was selected by the project to set-up a model processing center because of the opportunity to demonstrate multi-crop processing. It is located in the humid savanna zone where a variety of crops are grown and is accessible to main roads and major markets.

The center was equipped with the *gari* processing equipment package (grater, press, fermenting rack, sifters and improved stoves), the multi-crop thresher, wet-type grinder (to process maize, beans and soybeans), and a palm oil digester. An open shed and an adjoining store room were constructed by the villagers.

A women group was formed to manage the center. The center served as a showcase for improved processing and value-added products. The women adopted the *gari* processing package and developed their *gari* business which used to be a backyard process for family consumption. Marketing the processed cassava (*gari*) gave them additional income which enables them to support their children in school and other family needs. They now supply a big proportion of the *gari* requirement in Kade District and partly in Greater Accra. Consumers come to the village to buy their *gari* consumers claimed to be of good quality. With increasing processing capacity, the women now require a bigger capacity machines.

Other processors in the nearby villages started to use the facilities. One processor purchased a set of the same equipment and provides services in her village.

The other processing equipment did not match well with the users' current needs and requirements and hence was not fully utilized. Farmers and processors are yet to be sensitized on the economic importance of value-adding for the other crops because of lack of market or lack of access to it.

5- The agro-processing center in Abodom Bomso has demonstrated that *gari* processing is a profitable business. The machines helped the processors appreciate the importance of value-adding to farm produce

4- Food Processing Plant in Bodua Village

The St. Michael Catholic Church' Processing Plant in Bodua Village, Eastern Region is established in 1997 through a Catholic Mission Church primarily to supply good quality food to the community.

The processing plant is equipped with 2 sets each of grating machine with bagging stand, double screw press, sifters, concrete washing and fermenting tanks and improved stoves/fryers. The stoves were constructed outside the main building for safety. The processing plant is also provided with a store room where the finished products are kept.

The plant employs 12 regular staff: 2 men operating the machines and 10

6- The St. Michael Catholic Church Processing Plant demonstrates good management and focused on the production of good quality and hygienic food products

women doing other unit operations such as peeling and frying. They produce *gari* and tapioca on regular basis. In the first 2 years, the Plant supplied *gari* not only to individuals but also to the national prison and the schools in the community. *Gari* is sold based on weight instead of volume. People come to the Plant to buy their *gari* which they claimed to be of good quality because it is fine, has less lumps, well roasted therefore can keep longer, and also swells better than other *gari* produced in the village.

In addition to *gari*, the plant also processes cassava dough. Recently, it has acquired a palm oil digester and started processing oil.

The instability of the market in the last 2 years discouraged the management to continue the regular supply of *gari* to their customers, nor expand and compete in the market. It however continues to operate to serve the church members and the community.

5- *Gari* Processing Equipment Package for Women's Ministry

The Ministry of Women and Children's Affairs of Ghana contracted the GRATIS Foundation in 2002 to manufacture 200 sets of *gari* processing machines for 13,000 women farmers' groups in the country. Each group was given loans by the Ministry to expand their enterprises. The processing package includes the cassava grater, fermentation rack, double screw press and sifter, the model developed at IITA.

To facilitate delivery, GRATIS Foundation assigned fabrication to its regional branches. The Ministry advised the distribution of the package as follows: 30 sets each in Eastern and Western Regions, 35 sets each in Brong-Ahafo and Volta Regions, 25 each in Greater Accra and Central Regions and 20 sets in Ashanti Region. The machines were completed in early 2003 but were delivered only later that year. The Technical Team of the GRATIS

Foundation provided demonstration and training to operators and users of the machines upon delivery.

Two recipient groups in Ho District, Volta Region were visited: the group in Saviefe Village and the group in Exi-Dzagato Village.

Before these machines were delivered in Saviefe Village, the group has access to 4 other local graters powered by a lister engine. The women process their *gari* in their compounds after grating in the village graters. The women hope that the arrival of the facility will reduce their time queuing in the village' graters, gaining them time to increase their processing capacity.

Although the facilities are new to the users, they already appreciated the features of the machines. Among the facilities, it was found that the double screw press was liked most by the users because it is small and portable. It has reduced their de-watering process by 90% and eliminated the drudgery of stooping when using rocks and logs resulting in back and waist pains.

The grater is still scarcely used; however users noted the fine and smooth texture of grated pulp which they prefer. The sifter and the fermenting rack are still idle. The women are yet to appreciate the benefits from the package before full adoption. Meantime, the community is organizing their marketing group and improving the process in the production of dough (which is further processed to '*banku*'), another important food product from cassava in Ghana.

7- The double screw press used by the women in Saviefe Village has increased the de-watering capacity by 90%

The women group in Exi-Dzagato Village, as with the other women group beneficiaries in other villages, is also starting to appreciate the processing package.

6- Josma Agro-processing Ltd. in Wuraso Village

The Josma Agro-processing Ltd. in Wuraso Village, Mampong District, Ashanti Region is in full operation processing cassava into *gari*, starch and flour. It was established in February 2004 with a work force of 25 staff. The entrepreneur, Mrs. Janette Jima Kesse, invested in the processing machines upon retiring from her position in a local bank. She witnessed one of the field demonstrations by the SAA-AP project after which she visited Mampong RTSC.

She initially acquired the package of cassava processing equipment based on IITA design. Within 6 months of operation, she saw the increasing processing capacity and the potential of the business demanding for higher-capacity machines. Through RTSC Mampong, she purchased the local conventional grater with an 8-Hp petrol engine. At the same time, RTSC Mampong doubled the length of the double screw press expecting to increase its capacity.

Besides *gari* production, the center also processes grits, starch and flour from cassava. The company is developing its market quickly. It is currently supplying over 2 tons of *gari* every week to the Agriculture Producers Council in Accra. The Mother-well Farm in Kumasi, in addition to the local market, is also their regular customers. Plans are underway to put up more machines and contract specialized market outlets such as hospitals and schools.

8- Josma Agro-Processing Ltd. is emerging as a successful agro-enterprise using simple equipment. It is supplying *gari* and cassava flour to major markets in Ashanti and Greater Accra regions

The users have a chance to compare the machines. They noted the IITA grater produces finer mash than the local grater. However, the feeding system discourages the operators from full adoption for fear of accidental injury to fingers and hand.

The original design of the double screw press was now appreciated better because they can press faster than the expanded design. They load in several batches and press the cassava mash to the desired moisture level for frying. The bigger press is now used for preliminary removal of moisture from grated pulp then the bags are transferred to the original double screw press for final de-watering.

The center is an example of a successful small agro-enterprise management inviting many visitors from all around Ghana including staff of MOFA's IFAD project (RTIP), NGOs, Rural Youth Organizations and farmers. NGOs from Benin Republic also visited the center to learn from their experience.

7- Cassava Processing in Yawso Krobo Village

Ten women in Yawso Krobo Village, Mampong District, Ashanti Region came together and called themselves *'Ekwafo Angfa Amma Yebuada'* to avail of a bank loan to purchase cassava processing machines to increase their *gari* processing

capacity. The name of the group which means "if you don't work you will starve" reflects the desire of the women to improve their lives.

The *gari* processing equipment package they acquired includes a grater, double screw press, fermenting stand and sifter. The machines were installed in an open shed provided by the leader of the group. Five traditional frying stoves were also constructed in the same shed.

The women process their *gari* individually in their own backyards mainly for consumption before they acquired their facilities. The market is distant, not developed and barely known to them.

9- The women group in Yawso Krobo meets the requirements of the *gari* market by improving the traditional process with the use of simple equipment

Although the women had used the equipment for 14 months already, they still require more training in order to understand the operational potential of the machines to optimize their benefits from the system. With their current capacity, however, the women realize that good *gari* attracts buyers. They don't need to bring their *gari* to the market because customers come to buy from them directly. Some farmers also contract their services to process their cassava to *gari* or other forms of food products such as flour or dough. With the new machines, they are now able to connect to the market. They say that the business is picking up which enables them to support their children' schooling and to buy their family food.

8- *Gari* Processor-Exporter in Mampong Town

Mrs. Abena Nkuduo started processing *gari* since she was young assisting her parents to process for family food. When she got married, she helps her husband by processing and selling *gari* to provide for family needs. Initially she depended on grating services provided by some operators in town until she saw the grater and other agro-processing machines demonstrated by the SAA-AP project staff in 2003. She thought that the machines are small, portable and affordable enough to own.

With the help of her son, she bought the machines from RTSC Mampong which she intended to use for her own *gari* production, and to provide grating service to the other processors in the area. She also bought the double screw press which she installed in a concrete elevated-fenced platform, and set-up 4

10- *Gari* processing activities in Mrs. Nkuduo's compound is prospering. The business is expanding its market to Mali and provides employment to processors in the village

traditional frying stoves. She put-up her *gari* processing facility at the back of her house located near Mampong market.

In less than a year, Mrs. Nkuduo is producing *gari* more than enough to sell in the local market. She expanded her market by supplying a school in Kumasi. She also started to send some of her *gari* to markets in Mali and plans to explore more the potential of this market.

On the other hand, providing grating service to other processors had given her some management problems. Many of the customers don't know how to operate the machines. She ends up spending more for repair and maintenance than the fee she collects. The grater is now only used in the compound for her own *gari* business.

Mrs. Nkuduo did not have any problem with machine breakdowns because RTSC is always around to provide repair and maintenance services. She says that it is a good relief to know that you can depend on them for assistance at any time.

The business is now the family's major income source to buy their family provisions and pay the school fees. It is also providing employment to women processors in the village.

9- Grating Service in Mampong Town Market

Mrs. Rose Osei, sells various provisions and operating grinding machines for service in a small stall 'the Naomi Enterprises' by the roadside in the public market of Mampong. She and her husband, Mr. Samuel Saffo Mensah, decided to add a grating machine in their utilities for rent.

11-Grating service in the market and along the roadside provides a conveinet option to women and processors

The husband first saw the portable grater (IITA-design) demonstrated by SAA-AP and RTSC Mampong staff. He then purchased the grater from RTSC Mampong and started to operate it together with the other

processing machines. Grating service in the market is not very common and therefore quickly attracted the attention of many women and processors. Since then, at least 20 regular customers come to grate cassava daily.

The grating service was so popular that many more customers come each grating from 1 to 5 bags peeled cassava (up to 500 kg per customer) daily. She noted that she needed another grater because of the increasing demand for the service. *Gari* processors are very happy with the fine mash produced by the grater which is preferred for *gari* production. For processing cassava dough, the grater facilitates the process. The grated cassava mash is passed through the hammer mill which saves about 50% of the time required using the hammer mill alone. Furthermore, the texture of the product is superior.

Mrs. Osei claims that about 50% of her daily income is contributed by the grating services.

10- The Adade' Family Cassava Processing Business

Gari processing is now a main business of the Adade family in Mampong. Before, Mrs. Lydia Adade used to go to the next village to grate a small quantity (approx 50-60 kg) of cassava then bring back to her house for further processing to *gari*. Now the processors come to her place to grate and work for a fee.

Five years ago, the only available grater is a modified portable grater serving the whole village. The grater service became very popular, the women has to wait for a long time for their turn. Also since the fees are not fixed, negotiations became the language of the trade which results in exaggerated fees. With time, the grater started to develop faults making more difficult to schedule their operations.

Consulting her husband and other women processors, using her own money and a soft loan from the SINAPI Abbah Scheme sponsored by the Seventh Day Adventist Church, she bought her own grater and the double screw press in 2002. She set-up the facilities in her compound to process her own *gari*, and extended grating and pressing services to other processors in the village. In one year she re-paid her loan and recovered her investments within 2 years of operation.

12- The Adade family with Mr. Asare (RTSC Mampong) and their casava grater providing income and services to the community

With her time saved from bringing her cassava to the next village and queuing to use the small grater, she now has more than double her processing capacity. She used to bring her *gari* to sell in Mampong market but now people come to her place to buy it. Her *gari* sells well because 'it tastes fine, not pasty, well dried and light', she claims.

Mrs. Adade's yard has since been busy particularly from 4PM daily and the whole day on Saturdays when women bring their cassava not only for peeling, grating and pressing. There are at least twelve regular customers who come to grate and press regularly in Mrs. Adade's place. Their relation with the people in the village as well as their social status had improved. Mrs. Adade is being helped by her husband and children.

11- *Gari* Processor, Grater Service Customer

Mrs. Boatima Aduwa is a *gari* processor and a friend to the Adade family. She has been a part of Mrs. Adade's decision to invest on the grater and since been a regular customer to the grating services provided by the Adade family.

She lives in the next village but prefers to grate in Mrs. Adade's compound because the machine produces very fine mash which is good for *gari*. She also enjoys the social atmosphere in the compound while processing.

13- Mrs. Aduwa thanks the grating service providers because she could not afford to buy her own machine and yet she can increase her processing capacity

Mrs. Aduwa likes the arrangement because she could not afford to buy her own machine. She said that she will continue to patronize service-providers because it keeps her business steady and worry-free from operational management of the machines.

12- Grater Innovator and Service Provider

Mr. Paul Amoah is an innovator and technician. He is a customer to RTSC Mampong where he received some technical training in 1998.

Before he had his training in RTSC, he had developed and operated a portable cassava grating machine powered with a 1-Hp diesel engine which he got from a backpack sprayer. He claimed that his machine can grate 100 kg cassava roots per hour. Since then he provided grating services to the processors in his village and neighboring villages. He either goes around the village with

his machine mounted at the back of his bicycle, or customers come to their house to grate.

14-Mr. and Mrs. Paul Amoah depended on their portable grater for family subsistence for many years until newer portable graters become available

Mr. Amoah provided this much needed help to processors for about 5 years until the machine developed a major breakdown. Lack of operational funds did not allow him to repair his machine. As *gari* processing capacity increased, Mr. Amoah could hardly cope with the demand for his grating services. His customers had to find other ways to grate their cassava.

Mr. Amoah's contribution to the *gari* processing business is noble and innovative. He said that providing access to machines to small-scale *gari* processors is one way to help them grow their businesses. At the same time it gives him income. Mr. Amoah continues to devise simple machines to help the small-scale processors.

13- *Gari* Processing Plant in Kwesinyako Village

With technical advice by the SAA-AP project staff, Mr. Sackuy, a public servant, purchased the cassava processing equipment package consisting of the grating machine, fermenting stand, and double screw press to start his own *gari* processing business. The machines are now being installed in Kwesinyako Village, Akuafim South District, Eastern Region.

Mr. Sackuy constructed a processing shed with frying stoves, a workplace and a store room. He hopes to provide a decent environment for processors and at the same time do a good business from the first quarter of 2005. The plant was well-laid out with provision for drainage of effluent water.

15-Cassava processing shed in Kwesinyako Village showing installation of press and frying stoves

C. Palm Oil Processors and Processing Sites

14- Oil Palm Plantation and Palm Oil Processing in Apremso Village

Mr. Emmanuel Obeng Pare, a retired civil servant proving to be a successful farmer/ entrepreneur. After retiring from his office, he bought an oil palm plantation where in 1999 he also set-up medium-scale palm oil processing plant in Apremso Village, Aburi Town, Akuapim South District, Eastern Region.

The processing plant was established in consultation with the MOFA-SAA AP project staff. The plant is equipped with palm fruit digesters and double screw presses of the IITA-design. In addition, improved oil- separation pits, stoves and boilers were also put in place.

The plantation and processing plant is known to villagers as the "Nana Koffi Pare Farms" which provides regular employment to 7 workers: 5 women for palm oil processing, 2 men for harvesting and transport of fruits and other plantation works. Casual labors are employed during peak harvest season.

The oil processing plant produces 200 gallons of palm oil every 3 weeks.

Market is not a problem. Mr. Pare delivers his oil to major markets in Aburi and Greater Accra. Mr. Pare will expand his operations in order to supply the growing demand for his good palm oil.

During the lean season, he allows other processors from the nearby villages to use the digester and presses for a fee. This adds up to his income.

16-Palm Oil Processing Plant ideally situated within the 'Nana Koffi Pare Palm Oil Plantation is equipped with digesters, presses and improved fruit boilers and stoves. The plant is expanding and market is growing due to the good quality of oil it produces

15- Palm Oil Processing in Old Abirim Village

Mr. Peter Yeboah has been very excited relating his experience in the use of the palm fruit digester which he bought through the SAA-AP project. He witnessed the demonstration of the machine by the SAA-AP team in 1998. He bought one unit immediately and used it to provide service to palm fruit processors in his village.

Old Abirim Village in Brim North District, Eastern Region is a small village where backyard palm oil processing used to be the main source of income of the residents. During processing time, everybody pounds their palm oil using the mortar and pestle making a distinctive noise all over the place. Single screw presses could be found in almost all households.

When Mr. Yeboah started to go around the village with his palm oil digester, the village became quieter. Many people patronized the machine, abandoned their mortar and pestle and even increased their palm oil production. The capacity of the machine was good for their household operation.

Soon, with one unit of the digester, Mr. Yeboa could not cope with the growing demand for his services; therefore he bought a second unit after one and a half years of operation.

residential block. Bigger investors bought high powered- digesters and presses and installed in the processing block. This affected the Mr. Yeboa's operation as people now turned to use the bigger machines.

In order to compete in the market, Mr. Yeboa bought the bigger digester plus 7 screw presses using his earnings from the small digesters. At the same time he hired two operators and sent the IITA-designed digesters to the adjacent village of Akoukuwaso. The processors in the village patronized the machines well however the income was not properly accounted for by the operator. He then parked the machines but treasured them because it had given him sufficient capital to continue on with his business. With his income he sends his children to school and bought additional 15 acres to his palm oil plantation.

Mr. Yeboa intends to continue using the small digester to service those

17- Mr. Yeboah finds treasure in using the portable palm oil digester. With it, he increassed his income and helped to improve the palm oil processing enterpise which used to be small backyard business in Old Abirim Village

The rapidly increasing backyard oil processing however created a conflict in the village. The village became messy and the chief ordered that the palm oil processing be done in a central location in the outskirts of the

who are far from the processing plant. He believes that there is always this potential to expand his business as many more processors are in the remote villages with poor road and transport system.

To sustain the requirements for the commercial level processing, he recommends that the digester be modified to increase the capacity while keeping its simple make.

L.Halos-Kim / Dec '04

Annex 4 -

Monitoring Visits and Interviews
(December 2004)

Adoption and Utilization of Improved Agro-processing Technologies in Ethiopia

by:

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Credits and appreciation to the following for assistance during monitoring visits:

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December 2005

Annex 4 -

Adoption and Utilization of Improved Agro-processing Technologies in Ethiopia

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Adoption and Utilization of Improved Agro-processing Technologies in Ethiopia

A. Metal Fabricators and Manufacturers

1- Selam Technical and Vocational Center (STVC) in Addis Ababa

Selam is a Christian-oriented organization established with the objective of raising orphaned children by providing shelter, food and education and equipping them with vocational skills to make them self-supporting citizens (Selam Brochure, 2004). Thus the Selam Children's Village was founded in Addis Ababa, Ethiopia in 1985.

Selam Technical and Vocational Center (STVC) is an extension of the Children's Village. Since its establishment, it has grown to a well-equipped and organized training center. It trains orphans from Selam Children's Village, other orphanages, as well as private applicants.

General mechanics, Auto Mechanics, Drafting, Electricity, Woodwork and Machining are the streams that trainees join according to their interest. 'What makes STVC the only one of its kind in the country is that the trainees are directly involved in production throughout their training', says STVC Managing Director. Mr. David Röschli (known to many as 'Papi').

1- Mr. Röschli briefing the SAA-AP project team from Ghana, Benin and Uganda on STVC, its programs, facilities and support to the SAA-AP project in Ethiopia.

2- The metal workshop in STVC complex providing technical support in training, fabrication, testing, and demonstration of agro-processing machines in Ethiopia.

STVC is also home to the SAA-AP project in Ethiopia. STVC has provided a metal workshop and an office, and granted a special privilege to access and use of its other facilities and services to the project team.

Working with an established institution to help improve the welfare of the small-scale farmers

and processors facilitated the extension work in Ethiopia.

Since December 2001 to February 2004, STVC technicians were trained through the project on the fabrication, operation and maintenance of the multi-crop thresher, rice mill/polisher, groundnut sheller, wet-type grinder, cassava grater and chipper. Trained technicians form the technical team providing technical backstopping to the project in Ethiopia. They have an important role in adapting and modifying the agro-processing machines for introduction to the Ethiopian farmers as required by their environment.

B. Adopters of Agro-processing Equipment

2- Multi-crop Thresher in Shashemene

The multi-crop thresher without cleaner and powered by a 7 Hp petrol engine was introduced in Ethiopia to help solve the drudgery of threshing teff, the staple food crop of Ethiopia. Between 2002 and 2004, seven threshers had been purchased and being used in Shashemene to provide threshing service in the villages.

Traditional threshing is still prevalent and is done by a gang of 6 to 8 oxen or donkeys driven around the pile of crop by 2 to 3 men. It takes 8 hours to thresh 2 bags of approximately 120 kgs of grains using this method. Farmers harvest their crops at the same time making difficult to thresh immediately after harvest. Crops are left in piled in the fields up to one month which could result in deterioration and crop losses.

Grain collection is inefficient. A significant amount of grains are left on the ground and contaminated with soil and sometimes with animal manure.

In addition to teff, Ethiopia produces other grain crops such as maize, millet and sorghum which are also threshed with this method. Handling and transport of crop also present a big problem in grain harvesting.

3- Traditional threshing by animals, of teff and other grains, results in time and crop losses.

Few units of combine harvester are operating in the area but are used only for wheat, are not easily accessible and waste straw and fodders. The practice of crop-livestock farming system necessitates that straws and fodders be made available for livestock feeding.

The introduction of the multi-crop thresher with a field capacity of 500 to 600 kg per hour had significantly reduced the time and other difficulty

using the traditional method. In order that the thresher could be moved around conveniently to reach the farms, the SAA-AP project in collaboration with STVC developed and introduced the donkey cart for the thresher.

Mr. Ayele is the first farmer who invested on the thresher after he saw a field demonstration by the SAA-AP project staff. He now owns 3 units of the threshers in Shashemene which he operates with 5 hired workers. Providing threshing service has become his family's main source of income. Mr. Ayele is popularly called 'Mr. Thresher' in the area which he takes pride with a big responsibility, i.e. service to his people.

his house in town and moved into the village, bought the thresher with the cleaner and started to provide threshing services in the villages with his 2 hired operators. He sees that the thresher will help the farmers a lot and at the same time give him a good income.

The number of farmer-entrepreneur is steadily increasing which is not a bother to existing operators. There is more than enough crop to be threshed. The system is working well and immediately adopted by the farmers for teff threshing. The thresher does not only save time and crop losses but also produces straws and fodders in slightly crushed and of shorter lengths which are found appropriate

4- Mobility of the thresher using a donkey cart has been a popular feature of the machine. The thresher is reaching the farmers in their farms eliminating bulk transport of crops and hence handling losses. Farmers glean over the threshed grains and bring home the clean ones. Straws are collected for feed or plowed back in the soil.

Encouraged by his success, his brother also bought the thresher. He now owns 2 units of threshers and employed 5 operators.

A third owner, Mr. Takele, also learned of this booming thresher enterprise in Shashemene. He sold

for animal feeding in terms of handling and digestibility, or even as soil conditioner/ fertilizer when plowed back to the field.

The farmers are now evaluating the thresher for maize, wheat, barley, sorghum and millet. Feedback is

encouraging and recommendations for improvement are now being addressed by the SAA-AP project team while continuing demonstration and technology awareness campaign is being done in other parts of Ethiopia.

3- Groundnut Processing in Babile

Babile in Eastern Harar is among the major producers of groundnuts in Ethiopia. Groundnut is considered as a cash crop. It is sold raw, eaten boiled or roasted, or processed into butter and oil. Butter and oil are commercial products which could be developed to a cottage industry.

Groundnut butter and oil production requires special grinder to make smooth flowing paste for efficient oil extraction. The traditional method involves shelling, winnowing, roasting, de-skinning, and grinding the nuts. The processes are all manually done including grinding with a mortar and pestle. Kneading the butter is yet another step to finally obtain the oil. With the traditional method, groundnut oil production is a cumbersome process and is still done at the household level.

To help improve the system, the manually-operated groundnut sheller and the wet-type grinder were tested and introduced to groundnut farmers/ processors in the Harar Region.

The groundnut sheller was proven to increase shelling capacity and time efficiency. The resulting broken nuts however was not acceptable to processors and consumers who used the shelled nuts for other purposes or for processing later. According to the users, the bruises in the nuts result in discoloration both in nuts and in oil which make it unattractive in the market and could not keep long in storage.

The wet-type grinder had contributed to improved efficiency and is adopted by the processors. The butter obtained was smooth and renders for easy oil extraction using a simple press. It also allows diversification of products.

5- The wet-type grinder is helping to build groundnut processing a profitable cottage industry in Babile.

The JICA project supported the Babile Groundnut Processing Cooperative to set-up a processing center and is helping to develop their market for peanut butter. The processing center is equipped with the wet-type grinder, and the packaging materials for butter. A small store in front of the processing room is maintained by the cooperative which showcase and sell their products.

The cooperative had recorded good sales of products and is encouraging other groundnut processors and cooperatives to adopt the improved system. The SAA-AP project continues to look into ways of further improving the system.

6- The Babile Groundnut Processing Cooperative is developing a marketing strategy to demonstrate and sell their products within the region. Their products are now reaching major markets in Addis Ababa.

L.Halos-Kim / Dec '04