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COMPLETION REPORT OF THE POST PRODUCTION COMPONENT: ROOT AND TUBER IMPROVEMENT PROGRAMME

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ROOTS AND TUBER IMPROVEMENT PROGRAMME
MINISTRY OF FOOD AND AGRICULTURE
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POSTPRODUCTION AND MARKETING

Chapter 1

(i) Component design

The Post-Production and Marketing Component (PPMC) was implemented to improve access of resource-poor farmers, farmer groups and rural communities, including women, to improved post-production technologies. Although a Post-Harvest Component had been proposed during project formulation, this component was removed during project appraisal as it was envisaged that the Village Infrastructure Project (VIP) would provide the necessary assistance to processing and market infrastructure under its Post Harvest Infrastructure Component. Consequently, the operational linkages between RTIP and VIP were formalized in a Memorandum of Understanding between the two projects as a condition of loan effectiveness. The expected level of collaboration between RTIP and VIP did not materialize. This was partly due to weak coordination at district levels, but mainly as a result of a change in VIP's policy to channel funds through rural financial institutions instead of district assemblies as initially envisaged. This resulted in a delay of almost 2 years as all applications had to be re-submitted.

However, during the Project Launching and Planning Workshop on August 1 1998, it was acknowledged that post-production aspects should be part of RTIP as improved storage, processing and marketing were considered key to raising farmers' income. The Post-Production and Marketing Component (PPMC) was therefore added as a sixth project component in 1999 and incorporated in a revised logical framework, with activities being implemented by the CSIR-Food Research Institute (CSIR-FRI) and the Women in Agricultural Directorate (WIAD) of the Ministry of Food and Agriculture (MoFA), and supported by the Biochemistry Department of Kwame Nkrumah University of Science and Technology (KNUST). Activities of the Component were initially funded through the Community Mobilization and Support, and Adaptive Research Components, but from 2002, budgetary allocation was made for the component. In January 2004, a Post-Production and Marketing Specialist was appointed to work at the Programme Coordinating Office.

(ii) Specific interventions

Activities that were originally proposed under the Postproduction and Marketing Component were intended to address lapses that were assessed to exist in the postharvest handing of root and tuber crops in Ghana. These were determined after a review of locally generated research results, survey reports, etc, and formed a basis for planning the component activities. Activities were carried out to strengthen the postharvest handling and marketing of cassava, sweetpotatoes and yams with the overall aim of raising the income of resource poor farmers and processors. Activities were carried out specifically to;

1. identify and disseminate locally adapted processing technologies and equipment to target groups,
2. improve storage of root and tuber crops,
3. promote root and tuber recipes,
4. strengthen linkages between cassava stakeholders,
5. investigate specific root and tuber postproduction and marketing issues that could be addressed by scientific research.

(iii) Verifiable indicators

It was envisaged that;

1. Food scientists and technologists, biochemists, agriculturists and extension officers working with RTIP would become abreast with scientific literature/information and technologies which have been generated locally on the storage, processing, utilization and marketing of root and tuber crops.

2. Sweetpotatoes would be available during the off season due to improved storage of the tubers by farmers in the main sweetpotato growing districts.

3. Sweetpotato pastries and snack foods would be available on the market.

4. The market for cassava roots would be expanded due to demands for the production and utilization of high quality cassava flour by processors, farmers, bakers, caterers, etc.

5. Cassava bread, pastries and other cassava flour-based products would be available on the market.

6. Specifications would be available for good quality unfermented cassava flour.

7. There would be pilot plants in carefully selected communities where production of high quality cassava flour using Good Manufacturing Practices is demonstrated.

8. Information on the physico-chemical characteristics, functional properties and organoleptic quality of the released cassava varieties would be available at RTIP.

9. Modules for processing cassava into *gari, agbelima*, cassava chips, cassava flour, cassava starch and also for operating agro-processing equipment would be available to cassava processors, entrepreneurs, etc.

10. Health risks associated with gari roasting due to exposure to excessive heat and smoke would be reduced.

11. Performance of yam tubers during storage would be improved.

12. The following marketing information would be available at the Programme Coordinating Office;
    a. Marketing, processing and utilization of root and tuber crops in Ghana.
    b. The size of the potential market for cassava-based products in Ghana.
    c. Viability of producing cassava chips for incorporation into animal feed.

Chapter 2

Planned output targets

Year 1 (1999)

- Collate journal publications, technical reports, theses, and dissertation on root and tuber storage, processing, and marketing in Ghana.
- Conduct a nationwide study of the socio-economic analysis of marketing, processing and utilization of root and tuber crops in Ghana.

Year 2 (2000)

- Collate cassava and sweetpotato recipes from local and foreign sources.
- Conduct PRAs in three (3) major sweetpotato growing areas to evaluate sweetpotato production, storage, utilization and marketing in Southern Ghana.
- Evaluate three sweetpotato storage structures and analyse sweetpotato starch and flour during storage.
- Construct sweetpotato storage structures for six (6) beneficiary groups.
- Evaluate cassava and sweetpotato flour recipes.
- Organize a national training of trainers' workshop on production and utilization of unfermented cassava flour.
- Promote high quality cassava flour through awareness creation programmes organised by CMS and exhibitions at TRATECH and WESTFAIR.
- Construct 60 improved gari roasting stoves for beneficiaries in 5 regions.
- Organise study tour to neighbouring country to study cassava processing and utilization.
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Year 3 (2001)

- Conduct a study on the financial and economic analysis of cassava flour production.
- Train farmers, bakers and traditional cassava biscuit producers in the South Tongu District in the production and utilization of cassava flour.
- Conduct sensory evaluation of the four released cassava varieties and their processed products in all regions using traditional processors and consumers.

- Organize cassava flour training workshops in all the regional capitals and RTIP districts.
- Continue promotion of high quality cassava flour through awareness creation programmes, AGRIFEX and Asanteman Agrofair.
- Organise cassava and sweetpotato utilization workshops in the Upper East and Upper West Regions to document traditional recipes.
- Complete construction of improved gari roasting stoves for beneficiaries.
- Carry out studies on the production of snack foods from cassava flour.
- Develop quality specifications for cassava flour.
- Carry out studies on the minimal processing of yam.

Year 4 (2002)

- Establish four (4) RTIP cassava flour pilot plants for beneficiary groups in four regions.
- Complete organization of cassava flour training workshops in all 67 RTIP districts.
- Develop six (6) training modules for processing cassava into traditional and non-traditional products.
- Organize two (2) training workshops to train 55 MoFA staff in cassava processing

Year 5 (2003)

- Evaluate the performance and use of the improved gari roasting stoves constructed for beneficiaries.
- Complete the establishment of the four (4) RTIP cassava flour pilot plants for beneficiary groups.
- Train RTIP pilot plant beneficiary groups in cassava flour and gari production.
- Train RTIP pilot plant beneficiary groups in plant hygiene and basic Good Manufacturing Practices.
- Evaluate environmental impact of processing at RTIP pilot plants.
- Organise training workshop for agbelima and gari producers in the Ga District on quality of products.
- Organise workshop to promote use of sweetpotato as a source of vitamin A

Year 6 (2004)

- Conduct a tracer study to evaluate the effectiveness and impact of cassava flour training programmes.
- Train 25 AEAs in the construction of improved gari roasting stoves.
- Construct improved stoves in trained AEAs' operating districts.
- Evaluate the re-designed gari stoves built for beneficiaries.
- Conduct need assessment of cassava processing groups.
- Develop and implement HACCP at RTIP cassava flour pilot plants.

- Conduct a study to update the size of the potential market for cassava-based products in Ghana.
- Conduct a study to assess the viability of producing cassava chips for incorporation into animal feed.

Achievements

Year 1 (1999)

Scientific information/literature and technologies generated locally and elsewhere which could be disseminated to improve the storage, processing, utilization and marketing of cassava, sweetpotatoes, yams, and cocoyam in Ghana were collated from the local research institutions and universities and reviewed. The information collated showed that the processing of cassava had received considerable research attention and had led to the upgrading of the traditional processes for gari, agbelima and kokonte production. This had led to the establishment of pilot/semi-commercial scale gari, agbelima flour and improved kokonte plants by groups, public institutions, NGOs, and entrepreneurs. Agbelima in particular had been the subject of in-depth scientific investigation including doctoral and MSc theses which had led to the elucidation of the biochemical and microbiological changes which occur during fermentation. Gari roasting still posed a health risk to processors even though improved stoves which incorporated chimneys had been developed locally and could substantially reduce smoke inhalation by processors. The review also showed that the production and utilization of unfermented cassava flour for both food and industrial uses could substantially expand the market for cassava roots in Ghana. Yams and cocoyams were processed industrially into fufu flours, but minimally processed yam i.e. frozen blanched yam slices could be developed for the export market. There was very little information on the local postharvest handling of sweetpotatoes. Several specific postproduction issues were also identified which could be addressed by research. These included:

- Improvement of the storage of root and tuber crops including pretreatmant before storage.
- Storage of processed root and tuber products.
- Development of new recipes from cassava and sweetpotato flours.
- Characteristics and differences in the functional properties of starches and flour from different cassava and sweetpotato varieties.
- Screening of sweetpotato varieties for starch characteristics and production of gari.
- Physicochemical properties and cyanogenic potential of cassava varieties.
- Effect of harvesting time on some agronomic properties and quality of starch from different cassava varieties.
- Suitability of different cassava varieties for different products.
- Standardisation of the quality and procedure for the production of unfermented cassava flour.
- Development of appropriate stoves for roasting gari to reduce smoke inhalation by processors.

- Production of mushrooms using peels of root and tuber crops as substrate.
- Use of unfermented cassava flour for the production of indigenous fermented foods.
- The presence of phenolic compounds and browning in yam varieties.
- Preservation of partially cooked yam slices.

A preliminary study of the socio-economic analysis of marketing, processing and utilization of root and tuber crops was carried out[1]. The survey showed that of the root crops only cassava was processed traditionally and this formed an important economic activity in several communities. The cassava processing units surveyed were mostly small scale and in the informal sector of the economy, individual and /or privately owned, and operated by semi-skilled or skilled hire labour. However some of the units were funded by NGOs and run by local institutions. The processing technologies in use were indigenous and carried out to transform the highly perishable rootcrop into self stable or more convenient and easily marketable products: gari, agbelima, and kokonte.

The collation of literature and survey of cassava processing marketing and utilization were the only post-production activities carried out in Year 1. This was because the Postproduction Component had not been instituted yet, and these post-production activities were carried out as part of the Adaptive Research programme. Copies of the technical reports collected were made available at the Programme Coordinating Office in Kumasi.

Year 2 (2000)

Participatory rural appraisals were conducted in the Abora Asebu Kwamankese and Twifo Hemaa Lower Denkyira Districts (Central Region)[2], the Afram Plains (Eastern Region)[3] and the Techiman District (Brong Ahafo Region)[4] to gather information and indigenous knowledge on the cultivation, storage and processing of sweetpotatoes in these dominant areas.

The studies identified sweetpotato cultivation as an important economic activity in these districts. However, farmers could not maximize their profits, because they were not able to store their produce to command higher prices during the off-season when the produce was not available on the market. It was estimated that sweetpotato farmers could increase their revenue by 40% if they could store some of their produce and sell during the off season.

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[1]Dittor et al., 2000. Socio-economic analysis of marketing, processing and utilization of root and tuber crops. RTIP report.

[2]Amoa-Awua, W.K., Tortoe, C., Fordjour, K., Tandor, M. 2000. Appraisal of the production, marketing and utilization of sweetpotatoes in the Asebu Kwamankese and Twifo Hemaa Lower Denkyira Districts of the Central Region. CSIR-FRI/RTIP Report

[3]Tortoe, C., Vowotor, K., Anlobe, J. 2000. Appraisal of the production marketing and utilization of sweetpotatoes in the Afram Plains. CSIR-FRI/RTIP Report

[4]Vowotor, K., Tortoe, C., Quaye, W., Larweh, P. 2000. Appraisal of the production, marketing and utilization of sweetpotatoes in the Techiman District of the Brong Ahafo Region. CSIR-FRI/RTIP report.

Pit, clamp, and other storage structures which are used to store sweetpotatoes in East Africa, as well as a local method, were evaluated at the Food Research Institute and the University of Cape Coast, but these structures/methods proved ineffective.

In most cases the tubers started sprouting within a month even when they were cured before storage[1,2]. The moisture content of the samples increased during storage whilst the swelling power and solubility of the sweetpotato starches and flour decreased[3]. Thus sweetpotato storage structures which had proved successful in other parts of the world were found to be of limited usefulness in Ghana. This was attributed to the prevailing environmental conditions including high humidity and high ambient temperatures which facilitated sprouting and rotting of the tubers.

A national training of trainers programme in the production and utilization of cassava flour was organized in February 2000 to train a core group of trainers for cascade training in the regions and the districts. Training covered both the production of high quality cassava flour (unfermented cassava flour) and preparation of bread, pastries and other snack foods from the flour. Twenty five (25) participants who were trained as the core group of trainers were drawn from the Ministry of Food and Agriculture, KNUST, the Polytechnics, Bakers' Associations, Caterers, and NGOs. The resource persons were from the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria and the Food Research Institute.

Recipe trials and organoleptic assessment of 8 cassava and 26 sweetpotato recipes collated from IITA, FAO and the Home Science Dept of the University of Ghana was conducted at the CSIR-FRI to assess the suitability and acceptability of the recipes, and adapt or standardize them where necessary. Major adaptations were done to the cassava flour recipes to make them comparable to wheat flour products. Queen cakes, chinchin, coconut biscuits, meat pie, and composite bread were ranked highly and acceptable by the taste panel. Sweetpotato products which were ranked highly were sweetpotato chips, spicy cake, pancake, chocolate pie, butter cake, doughnuts, pastry pie and cookies[4]. These recipes were selected by the CSIR-FRI team for promotion at awareness creation programmes, exhibitions, fairs and training workshops.

At KNUST work was carried out to characterize starches from different sweetpotato varieties as well as their suitability for producing gari. Differences were observed in the functional properties of the different sweetpotato starches as well as their pasting

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[1]Vowotor, K, Tortoe, C., Obodai, M, Oduro-Yeboah, C., Amoa-Awua, W.K. 2000. Studies on three storage structures for sweetpotato in Ghana. CSIR-FRI/RTIP Report

[2]Obodai, M., Tortoe, C. 2000. Preliminary studies on the microbial deterioration of sweetpotatoes (*Ipomea batatas*) under different storage structures. CSIR-FRI/RTIP Report.

[3]Oduro Yeboah, C., Amoa-Awua, W.K. 2000. Effect of sweetpotato storage in three different structures on the functional properties of sweetpotato flour and starches. CSIR-FRI/RTIP report.

[4]Larweh, P.M. 2000. Organoleptic assessment of cassava flour and sweetpotato recipes. CSIR-FRI/RTIP report .

characteristics. Sweetpotatoes could also be processed into gari and yoghurt and these products together with cassava and sweetpotato snack foods were exhibited at different for a and fairs including RTIP Awareness creation programmes, and also in other countries, at the 6th Biennial Congress of the Association for Dietetics in South Africa, the 18th Biennial Congress of the Nutrition Society of South Africa, 2000 and the 12th Symposium of ISTRC in Tsukuba, Japan [1,2,3,4,5].

Cassava flour based recipes were extensively demonstrated and exhibited at the awareness creation programmes organized by the Community Mobilization and Support Component in all regions to sensitize the public to RTIP activities. The products were also exhibited at TRATECH 2000 held in May 2000 at KNUST and also at WESTFAIR 2000 held from 26 November to 3rd December 2000. At both fairs, cassava based snacks were sold to the general public and proved very popular.

A study tour was organized for selected entrepreneurs, traditional processors, bakers, farmers and food scientists, etc, to visit cassava processing installations in Nigeria in order to learn at first hand the state of art of cassava processing in Nigeria. This was a useful exercise since it inspired some of the participants to expand their activities in cassava processing including the entrepreneur/farmer who eventually established the Amasa Agro-Processing Co Ltd.

The Amasa Agro-Processing Co Ltd was established as a subsidiary of the Motherwell Farms located at Ayikai Doblo, near Accra. The Motherwell Farm was an accredited secondary multiplier of the improved varieties of cassava and sweetpotatoes under RTIP and the chairman of the company was invited to join the team which undertook a study tour of Nigeria. On his return, the chairman decided to venture into cassava processing based on what he had seen in Nigeria. He established the agro-processing company with technical support from the Food Research Institute. The company is currently at the forefront of medium scale cassava processing in Ghana and has support from the National Board for Small Scale Industries. The company produces high quality cassava flour, gari, agbelima flour, and kokonte for both the local and foreign markets. It has executed orders to several African countries, U.K and the USA. In 2003 the company

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[1]Oduro, I., Ellis, W.O., Aryeetey, S.K., Ahenkora, K.,Otoo, J.A. 2000. Pasting characteristics of starches from new varieties of sweet potatoes. *Tropical Science*, 40:25-28.

[2]Yempew, S., Ellis, W. O., Oduro, I., Dziedzoave, N.T. 2001. Characterization of sweetpotato starch – The effect of cultivation time. *Journal of Ghana Science Association*. 3:41-44.

[3]Ellis, W. O., Oduro, I., Barimah, J., Otoo, J. A. 2002. Quality of starch from six (6) Japanese sweetpotato varieties under study in Ghana. *African Journal of Root and Tuber Crops*.

[4]Oduro, I., Ellis, W. O., Acquah, S., Kyerematen, F. 2003. Solar and Tray drying methods and the physicochemical properties of sweetpotato starch. *Ghana Journal of Agricultural Science* (Submitted)

[5]Oduro, I., Ellis, W. O., Otoo, J. A., Akuffo, A. O., Moses, E. 2000. Production of gari from sweetpotato tubers. In: Nakatani, M., Komaki, K. (Eds), Potential of Root Crops for Food and Industrial resources. Proc. of 12th Symposium of ISTRC, Tsukuba, Japan. pp..292-294.

was awarded a Certificate of Merit, which is a special national award during the 19th National Farmers' Day celebration.

Thirty five (35) improved *gari* roasting stoves were constructed for processing groups in eight communities in the Greater Accra, Eastern, and Brong Ahafo Regions to serve as demonstration and test models for dissemination of the technology. This was to reduce the health risks associated with gari roasting due to exposure to excessive heat and smoke inhalation.

Studies commenced at KNUST to develop quality specification for cassava flour. A survey was carried out of all stakeholders in the flour industry at Berekum, Techiman, Accra, Akosombo, Cape Coast and Kumasi in order to identify all the possible sensory quality attributes associated with flour used for baking. The survey showed that most of the flour users judged the flour by the quality of the products obtained after baking, the lightness (flow), colour and texture of the flour. The major problem encountered was clotting of the flour during storage and 63% of the respondents were prepared to use other types of flour apart from wheat flour.

Studies were carried out on the minimal processing of yam into frozen slices by KNUST and CSIR-FRI. Two varieties of yam, *pona* and *punjo* were cut into slices of various sizes and chips, pretreated by parboiling or steaming, cooled, packaged in low-density polyethylene pouches and frozen. With the exception of the chips, parboiling was the most acceptable technique based on consumer acceptability response. The product could be frozen for at least six months without any significant changes in the quality of the frozen product.[1]

Studies were also carried out at KNUST to evaluate the nutritional and physico-chemical properties of different cassava varieties and as well as the formulation, quality evaluation and shelf life of snack foods produced from flours of these cassava varieties[2]. Work carried out showed that the quality of composite flour is affected by the level of substitution and that cassava flour used in composite flour should have low moisture content, high ash content and relatively high water binding capacity and swelling power.

An important planned activity which was not carried out in Year 2 was the construction of six sweetpotato structures in three communities. This was because no suitable sweetpotato structure/method was found for dissemination to the communities. Also only 35 out of the planned 60 improved gari roasting stoves were constructed for beneficiary groups. This was because the groups were required to erect sheds first before the stoves could be constructed under them. Apart from the groups which already had suitable

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[1]Oduro, I., Ellis, W. O., Asamoah-Okyere, K. D., Adu-Amankwah, P., Alemawor, F., Amagloh, F. K. Minimal processing of Yam to increase consumer acceptance. Proc. 13th Symposium of the Int. Society of Tropical Root Crops (ISTRC), Arusha, Tanzania, in press.

[2]Aryee, F. N. A., Oduro, I., Ellis, W. O., Afuakwa, J. J. 2003. The physicochemical properties and cyanogenic potential of flour from 31 cassava genotypes and their potential uses. Food Control, in press.

sheds, most of the groups were not able to erect sheds as required. This activity was therefore continued the following year. Research on the development of quality specifications for cassava flour and development of cassava based snack foods were also continued the following year.

Year 3 (2001)

A feasibility study to establish the financial and economic viability of cassava flour production in comparison with wheat flour as an input to flour based foods and industrial products was carried out[1]. For a maximum cassava flour output of 174 metric tonnes per anum giving revenue of 427 million cedis, the raw material requirement and cost were estimated at 880 metric tonnes and 242 million cedis. The total capital investment cost was 52 million cedis and a Net Present Value and Financial Internal Rate of Return 45.99 million cedis and 75% respectively, giving an indication of a project that was highly feasible. On comparative basis, cassava flour was found to be competitive with wheat flour in the light of favourable short and long term project indicators, with cassava flour projected to sell at 2,452 cedis whilst wheat flour sold at 3,500 cedis per kg.

A training workshop was organized for traditional cassava biscuit producers and bakers at Sogakope in the South Tongu District in the production and utilization of cassava flour. Two groups at Dorploma and Atseive near Sogakope were organized and trained to produce cassava flour for sale to bakers at Sogakope. The groups continued to produce flour on small scale throughout the year and two bakers at Sogakope routinely produced composite cassava bread, which were fairly well patronized[2].

Training workshops were organized in all the regional capitals to train bakers, caterers, processors, entrepreneurs and NGOs to promote production and utilization of high quality cassava flour for making bread, pastries and other cassava flour-based products. The training programmes were carried out in conjunction with the Community Mobilization and Support Component.

Promotion of cassava flour was supported with research and further recipe development by WIAD, KNUST and CSIR-FRI. One hundred and eighteen (118) cassava and sweetpotato recipes were collated and forty two (42) of the recipes evaluated by a taste panel. Where necessary, the recipes were modified to suite local tastes. Further evaluations were conducted involving caterers and bakers, and 80% of a total of 73 bakers and caterers interviewed were satisfied with the formulations.

Cassava flour and sweetpotato snacks were exhibited at the Asanteman Agrofair in

[1]Owusu Boakye, E. 2002. Financial and economic analysis of cassava flour production in Ghana – A study of the Amanase Cassava Processing Group project. RTIP report.

[2]Agbodeka, E.E. 2001. Promotion of cassava recipes among farmers and bakers in the Sogakope (South Tongu District) of the Volta Region. BSc Agricultural; Extension Programme dissertation. School of Agriculture, University of Cape Coast.

Kumasi held on 8-10 November 2001 and AGRIFEX 2001 held at the Accra International Trade Fair Centre from 3-9 December 2001. The exhibits attracted a lot of people to the stands.

WIAD conducted a nationwide participatory sensory evaluation of the introduced/improved cassava varieties promoted by RTIP involving traditional cassava processors in 18 districts. The traditional cassava processors processed *afisiafi*, *tekbankye*, *gblemoduade* and *abasafitaa* into *gari*, *agbelima, ampesi*, *banku, yakayaka*, and starch biscuits, and evaluated the products for quality and acceptability. The most preferred variety was *tekbankye* which was assessed to produce the best *fufu* and *gari*.

A 3-day workshop was organized in Bolgatanga for the Upper East and Upper West Regions where knowledgeable persons were invited to prepare and evaluate the local traditional sweetpotato and cassava recipes. The selected dishes included *beng-moni, jeberee, kponkpong kusi, mwululu nyangbaa,* sweetpotato drink, sweetpotato light soup and sweetpotato *sawala.* These recipes were exhibited at Agrifex 2001.

Twenty five (25) more improved *gari* roasting stoves were constructed for processing groups in the Northern and Volta Regions. At four Tanyigbe towns in the Volta Region, a 2-day participatory rural appraisal was carried to involve the communities in the design of the stoves before they were constructed for the beneficiary groups.

The quality of starch and flour produced from three of the released cassava varieties, *afisiafi*, *tekbankye*, *abasafitaa* and the local variety, *bosom nsia* were analysed for pH, moisture content, swelling power and volume, solubility and gelatinisation temperature, fat, protein and ash contents. *afisiafi* had the highest edible portion, starch yield, swelling power, swelling volume and solubility as compared to *abasafitaa* and *tekbankye* whilst *bosom nsia* had the highest fat content and lowest moisture[1].

Studies carried out on the development of cassava based snack foods at KNUST were completed[2,3]. The proximate and physico-chemical properties of cassava-wheat composite flour was evaluated and compared to that of hard and soft wheat flour found on the local market. The cassava flour and cassava-wheat composite flours compared favorable to wheat flour in terms of shelf life. There were no significant changes in the physical parameters with storage time. However weevils were found in the pure wheat flour and some of the cassava composite flours by the third month while the cassava four had no weevils even at the 4 months. The cassava flour had higher water binding capacity and swelling power relative to the wheat flour and composite flours indicating varying properties of the cassava flour to the other two flours.

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[1]Kudjoe, S.J., Amoa-Awua, W.K. 2001. Qualitative and quantitative analysis of starch and flour produced from released and a local variety of cassava. CSIR-FRI/RTIP report.

[2]Oduro, I., Ellis, W.O., Arloo V. and Amagloh, F.K. Tin size impact on loaf volume and crust thickness of cassava composite bread. Poster presented at the 13th Symposium of the International Society for Tropical Root Crops, Arusha, Tanzania, 9-15th November, 2003, in Press.

Studies at KNUST to develop quality specification for cassava flour were completed. The specifications stipulated were moisture content, 11%; ash, 2.0%; pH, 5.5 – 6.5; water binding capacity; 1.5 – 2.0 times that of wheat flour; and colour, white to light cream[1].

Studies to extend the shelf life of yams during barn storage by partial dehydration of three yam varieties *pona, laribako,* and *lobare* commenced at KNUST[2]. Yam tubers were pretreated by dehydrating in a solar chamber dryer for 2 months and then stored for 5 months in traditional yam storage barns. Storage and analysis elapsed into the following year.

A survey of the major manufacturers of root and tuber processing equipment in Ghana was carried out. The survey identified 37 companies engaged in the manufacture of cassava processing equipment[3].

All activities planned for Year 3 were completed by the end of the year. This included two research projects which had run for two years

Year 4 (2002)

The establishment of four RTIP cassava flour pilot plants to serve as demonstration centres for the efficient processing of cassava into high quality cassava flour employing Good Manufacturing Practices commenced. The selected beneficiary gropups were expected to put up processing halls/structures for RTIP to supply and install the necessary equipment for trhe production of high quality cassava flour. The sites were selected in four different regions based on location in intensive cassava growing area, ongoing traditional processing of cassava, proximity to transport routres and accessibility to market and a performing processing group. The selected towns were Adidwan in the Ashanti Region, Amanase in the Eastern Region, Sokode in the Volta Region and Gomoa Eshiem in the Central Region. The beneficiary group at Adidwan and Amanase completed their structures and were supplied with a cassava grater, a screw press, a mill and an 8HP engine. However the Amanase group was supplied with only a mill and an engine, because they had assistance from VIP to acquire the other equipment. Solar or platform dryers were also constructed for the groups.

Six training modules for processing cassava into *gari, agbelima*, cassava chips, cassava flour and cassava starch, and also for operating agro-processing equipment were drafted. They were tested as IEC material for training and found to be useful to trainees.

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[1]Ellis, W. O., Oduro, I. 2002. Annual reports on Two Projects: Quality specification for cassava flour and Production of snack foods from cassava flour. KNUST/RTIP report.

[2]Ellis, W. O., Oduro, I., Akomeah- Adjei, Amagloh, F. K. On-farm pretreatment of yam tubers to extend shelf life. Proc. 13th Symposium of the Int. Society of Tropical Root Crops (ISTRC), Arusha, Tanzania. (In press)

[3]Amoa-Awua, W.K. Mohammed, A.A. 2002. Manufacturers of root and tuber processing equipment. RTIP report.

A sweetpotato and cassava recipe book was written and used to promote both cassava and sweetpotato recipes. Training of bakers in utilization of cassava flour in the 67 districts was completed and a total of two thousand and six hundred (2,600) beneficiaries were trained by RTIP.

Cassava flour based snacks were exhibited at the Asanteman Agrofair in Kumasi held on 11-20 October 2002 and at the National Farmers Day at Cape Coast on 6th December 2002. The products which were in sale were patronized by the public.

A 3-day workshop was organized at four (4) antenatal and two (2) day-care centres in the Greater Accra Region and also at Akatsi in the Volta Region to promote sweetpotato as a source of vitamin A in order to curb micro-nutrient deficiency disorders in infants.

Studies to extend the shelf life of yams during storage by partial dehydration was completed at KNUST[1,2]. The taste of the pretreated tuber were enhanced at higher levels of dehydration with decreased mealiness. All varieties could store for up to 7 months but *pona* had relatively higher rots with *lobare* having the least. However *lobare* had the highest sprouting (75%) but only 18.5 and 20% for *laribako* and *pona* respectively.

Research was carried out by CSIR-FRI to further diversify the uses of high quality cassava flour for use in indigenous staple foods. The flour was used successfully to produce agbelima using lactic acid bacteria as starter culture[3]. The peels generated during cassava processing could also be incorporated into substrate for cultivating mushrooms though this gave very low yields as compared to cocoyam peels which gave much higher and satisfactory yields[4].

It had been planned that establishment of the four cassava flour pilot plants would be completed during Year 4. However only two of the plants were operational by the close of the year. This was because only two of the beneficiary groups were able to complete the construction of their structures for equipment to be installed by RTIP. Construction of structures by the other two groups delayed because of their own financial constraints.

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[1]Alemawor, F., Ellis, W. O., Oduro, I. 2003. Phenolic compounds and browning intensity in selected yam (Dioscorea sp.) varieties. *African Journal of Root and Tuber Crops* (Submitted)

[2]Ellis, W. O., Oduro, I., Akomeah-Adjei, F. 2003. On-farm pretreatment of yam tubers to extend shelf life. KNUST/RTIP report.

[3]Amoa-Awua, W.K., Owusu, M, Feglo, P. 2005. Utilization of unfermented cassava flour for the production of of an indigenous African fermented food, agbelima. *World Journal of Microbiolology and Biotechnolog,* 21, 1201-1207.

[4]Amoa-Awua, W.K., Obodai, M., Cleland-Okine, J., Dzomeku, M. 2003. The efficiency of cassava and cocoyam peels as substrate for the production of oyster (*Pleurotus ostreatus)* and oil palm mushrooms (*Volvariella volvacea*). Proceedings of the Seminar of the Root and Tuber Improvement Programme, Ghana. December 2002, Kumasi. In press.

Year 5 (2003)

The Adidwan and Amanase beneficiary groups completed their structures for their pilot plants. Equipment were installed in the halls and the groups trained in the production of high quality cassava flour and gari. Both plants became operational. The beneficiary groups at Sokode (Volta Region) and Gomoa Eshiem (Central Region) started construction of structures for their pilot plants.

An assessment of the performance of the improved gari stoves built for processors was carried out in four regions[1]. The survey showed that even though most of the processors were of the view that the stoves were good and desirable, they had been abandoned in several areas because they did not meet their peculiar requirements. The study recommended that the stoves be redesigned with the involvement of the traditional processors[1]. The improved gari roasting stove was therefore redesigned based on the general needs expressed by processors. Ten (10) redesigned stoves were constructed for a beneficiary group at Krabokesse in the Suhum-Kraboa-Coaltar District.

The sweetpotato and cassava recipe book was printed and used to promote both cassava and sweetpotato recipes.

The two operational pilot plants at Adidwan and Amanase were trained in plant sanitation and Good Manufacturing Practices. The environmental impact of the plant at Amanase was assessed by an officer from the Environmental Protection Agency and remedial measures were taken to improve sanitation at the plant. This included relocation of the screw press and construction of a drain to collect effluent from the press.

Handy measures for retailing gari were introduced to forty (40) processing groups who adopted the use of 1kg, 2kg, 25kg and 50kg packages as a more objective way of retailing *gari* instead selling by volume.

Cassava flour and sweetpotato snacks were exhibited at the GNAT conference hall during the Meet the Press programme of the Hon. Minister of Food and Agriculture on 11 February 2003, held at the World Food Day Farmers Forum held on 27 May 2003 at Kasoa and also at AGRIFEX 2003 at the International Trade Fair Centre in Accra from 11-17 November. The exhibitions were successful and the Hon. Minister in particular was very impressed with the pastries.

A two (2)-day training workshop was organized for *agbelima* and *gari* processors in the Ga District to educate the processors on good hygienic practices at the processing sites, and measures to ensure that high quality and safe products are produced for the market.

Two (2) training programmes on cassava processing were organized for 55 MoFA staff in the Brong Ahafo and Ashanti regions.

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[1]Appiah, P., Nortey, E., Kagya-Ageman, C. 2003. The assessment of the performance of improved gari roasting stoves built for processors in seven districts in four regions. RTIP report.

All activities planned for the Year 5 were carried out during the year.

Year 6 (2004)

The two remaining pilot plants were supplied with equipment and the plant at Sokode became operational.

A Hazard Analysis Critical Control Point (HACCP) system which incorporates Good Manufacturing Practices and is suitable for the production of microbiologically safe high quality cassava flour was developed and drafted in a manual[1].

Twenty-five (25) Agricultural Extension Agents (AEAs) were trained in the construction of the improved stoves in Akwapim South, Sekyere West and Yilo Krobo Districts for the transfer of the technology to their districts. As a result, twenty-two (22) stoves were constructed by the AEAs together with local artisans for five (5) processing groups in Sekyere West, Birim South and Ho Districts.

An evaluation of the performance of the redesigned improved stoves was conducted and showed that 72% of a sample of 90 small-scale processing groups in Suhum-Kraboa-Coaltar, Ewutu-Efutu-Senya and Ho Districts were satisfied with the performance of the stoves and were of the opinion that it had reduced the health hazards associated with traditional gari roasting such as excessive inhalation of smoke, irritation of the eyes and headaches. Most of them also responded that using the improved stoves could cut fuel costs by two-thirds.

A tracer study was carried out to assess the extent to which knowledge and skill acquired by trainees from the cassava flour training programmes had been put into practical use[2]. The study showed that the training programme had a greater impact on cassava flour utilisation than on flour production since more of the trainees engaged in utilisation then production of the flour. Lack of cassava flour, equipment and capital prevented most trainees from continuing to use the knowledge acquired. 80% of the trained processors who engaged in cassava flour production, produced sufficient quantities for their own requirements with little left to sell commercially.

A check-list was developed to facilitate the identification of processing, marketing and end-user groups; building of a database on processing and marketing groups being supported by RTIP; and needs assessment of the processing and marketing groups. Three hundred and eighty nine (389) processing groups and 24 marketing groups, made up of 1,945 females and 402 males were identified and sensitized on issues relating to food

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[1]Amoa-Awua, W.K., Sablah, M. 2004. Manual for implementing Good manufacturing practices GMP and Hazard analysis critical control point (HACCP) in the production of high quality cassava flour. FRI/RTIP report.

[2]Asante, E.O. et al. 2004. Tracer study on the extent of utilization of post-production management training by beneficiaries under RTIP. RTIP report.

safety, hygiene, and quality during cassava processing. They were also informed about the importance of forming cooperative groups registered with the Department of Cooperatives and having bank accounts, etc. The requirements for most of the groups were for financial support/access to capital and training.

A study was carried out to assess the emergent sector for high quality cassava flour production/producers, utilisation of cassava flour by caterers and substitution of wheat flour with cassava flour[1]. The study showed that the potential demand for cassava flour amongst caterers was high, outstripping supply. Constraints identified were unavailability of cassava flour, poor image of cassava and cassava based products, inconsistency in flour quality and lack of credit facility and equipment for expansion. There was only one medium scale producer producing more than 60 bags of flour per week, whilst the majority of producers produced about 8,000 kg per week with caterers requiring about 10,920 kg per week at the household level. Sixty-five percent (65%) of consumers pooled said that they would prefer to use of wheat substituted flour for pastries.

A study was carried out to investigate the adoption requirement for alternative approaches to cassava processing, costs and benefits as well as user perceptions of the existing cassava processing approaches[2]. The study showed that apart from the improved gari stoves, the critical issue in adopting improved technologies at the small scale level was affordability of improved graters and presses. Production of *gari, kokonte, agbelima* and cassava flour on the large scale level was found to be profitable. For *gari* cost, benefit and selling price per unit was ¢2,810, ¢551, and ¢3,361 respectively; for *agbelima* and *kokonte* ¢2,876, ¢564 and 3,440; and for high quality cassava flour ¢2,601, ¢510, and ¢3,111 in the same order. Processing approaches used were deemed suitable to the village/community based setting by the majority of the processors.

A study was carried out to update estimates of the size of the potential market for cassava-based products in Ghana in order to identify marketable cassava products and markets which could be targeted by RTIP during second phase of the programme[3]. The theoretical market potential estimated for fresh cassava was over 297,000 tons per annum composed of 22,536 tons for cassava flour, 221 tons for cassava starch, 190 tons for modified cassava flour/starch, 9580 tons for cassava-derived industrial alcohol, 692 tons of cassava-derived glucose syrup, and 1,782 tons for cassava chips/pellets.

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[1]Ellis, W.O. 2005. Study on wheat substitution in snacks and biscuits in Ghana. KNUST/RTIP report.

[2]Quaye, W., Plahar, W.A. 2004. Cost benefit analysis of alternative approaches to cassava processing. FRI/RTIP report

[3]Dzeidzoave,N.T. 2004. Potential market for cassava based products in Ghana. FRI/RTIP report.

[4]Kwadzo, G.T-M., Egyir, I.S., Amoa-Awua, W.K. 2004. Cassava supply lines. RTIP report.

A feasibility study carried out to assess the viability of producing cassava chips for incorporation into animal feed showed that 20 cassava chips producing groups could be organized in each cassava producing district to produce 1,066 metric tons per annum. The net present value of centralized and decentralized models could yield 1,075,890,043 and 2,457,730,506 cedis respectively at 20% discount rate for a life of 10years[4].

Activities planned for Year 6 were completed during the first quarter of 2005 due to an extension of the programme and request for additional studies following the mid term review of RTIP.

Constraints and limitations to achievement of outputs

Several constraints were encountered during the implementation of RTIP postproduction activities and these had an effect on the achievement of project outputs. The PCO did not have an officer who was solely devoted to overseeing implementation of postproduction activities until the beginning of 2004. Before then, the Community Mobilization and Support officer was responsible for facilitating some of the activities of the component. The absence of a full time postproduction officer at the PCO hampered coordination of project activities since it was left to the research scientists from CSIR, university lecturers from KNUST and MoFA staff to implement these activities. Apart from WIAD staff, most of the MoFA staff were not conversant with food processing activities since their area of specialization was in food production. Even of the WIAD officers, few had formal training in food science and technology and were mainly agronomists who had been working in the area of food processing. Also the WIAD staff were only stationed at the regional offices and at the district level the project team had to rely on the AEAs who had limited experience in food processing. This was seen as the greatest drawback in carrying out post production activities at the district levels, i.e. absence of postharvest technicians/officers at the district level who could competently oversee implementation of food processing activities. There was also a limit to the amount of time that the postharvest research scientists and lecturers could spend on RTIP activities, since they had their core functions to perform in their own institutions who were their employers.

Targeted beneficiary groups in most cases did not have the basic resources to meet their obligations in acquisition of technologies intended to be transferred them and this often caused delays in implementation of project activities. For example in the establishment of the RTIP cassava flour pilot plants, each of the beneficiary groups which had been carefully selected was required to put up a structure to house the plant to be supplied by RTIP. It was envisaged that this would take a maximum of six months, yet none of the groups was able to put up their facility within a year. This was because the groups lacked financial resources and access to capital to put up the structure. In nearly all cases, RTIP had to assist the groups with construction materials.
Sometimes the beneficiary groups also lacked sufficient cohesion to enable smooth implementation of component activities. Most of these problems were eventually addressed but this took time and affected timely achievement of project outputs. For example during one support mission, a beneficiary group started arguing violently amongst themselves in the presence of the mission team and it was decided that RTIP

would not deal with the group until they had resolved their differences. These misunderstanding sometimes occurred due to the expectation of the group members who believed that they had been encourage to form groups in order to receive from the government agencies. As such they were not ready to contribute their own resources towards the successful transfer of technology to their group. They felt that RTIP had to provide everything that was needed by them, including even payment for labour that they provided for installation of equipment for their pilot plants.

Chapter 3. Achievement of component outcomes

An important outcome of RTIP postproduction intervention was the realization of the potential of cassava as both food and industrial/cash crop by farmers and processors. Prior to the promotion of cassava flour recipes, most people were not aware that cassava could be used to make bread, cakes and other pastries. In fact cassava had to a large extent been perceived nationally as only a food crop until the establishment of the Ayensu Starch Company which highlighted the potential of cassava as a cash crop. Also through the awareness creation programmes, fairs, training programmes, etc, most people became aware that cassava flour could be used in the plywood and paperboard industry as glue extender and even as adhesive, and that it could also be processed into glucose/maltose syrup for use in confectioneries. Thus through RTIP intervention, the image of cassava roots has been enhanced significantly in the country and for Agrifex 2000, RTIP adopted the slogan, 'Cassava, an old crop with new potential'.

The promotion of utilization of high quality flour was successful. This was to the extend that demand for the flour far outstripped supply. Though the training workshops covered both the production and utilization of the flour, most of the trainees were interested in the use rather than production of the flour. This necessitated RTIP to commission FRI as a stop measure to produce cassava flour for RTIP which was sold to bakers and caterers. With respect to cassava flour production, the case of the Amasa Agro-Processing Co is worth noting. A farmer who was an RTIP secondary multiplier and who had been sensitized through the awareness creation programme, was selected to join the team which was sponsored by RTIP for a study tour of Nigeria. The entrepreneur was encouraged and given technical assistance to establish the cassava processing company and is currently at the forefront of medium scale cassava processing in the country. The company produces high quality cassava flour, gari, kokonte and fermented cassava dough flour among other products for the local and sub regional markets. Other private companies are currently engaged in medium scale processing of cassava including Sekyere Cassava and Vegetable Processors Association, Farmidux which produces glucose syrup from cassava and Flours and Starches.

The introduction and promotion of improved gari roasting stoves, though suffered some drawbacks during implementation, has taught a lot of the traditional cassava processor that problems encountered during gari roasting can be overcome by modifying the traditional stoves. For example, at Tanyigbe where two stoves were constructed for a processing group, the stoves stood in the middle of the town and were only used occasionally by the group. However the individual processors started modifying their

traditional gari stoves in their homes by incorporating the basic principle of the improved stove in their design, i.e. elimination of smoke through the construction of a dwarf wall between the processor and the fire inlet.

The unsuitability of the sweetpotato storage structures evaluated under our local conditions still poses a challenge to RTIP. A successful development would have had an impact on sweetpotato production in the country by ensuring higher returns for sweetpotato farmers during the off season. In the northern regions, there is a local storage method which involves parboiling the tubers before storage. This procedure could not be investigated during project implementation and should be studied for adoption during the second phase of RTIP. Due to the limitations of the storage structures evaluated, the Postproduction component laid emphasis on the processing of sweetpotato into a shelf stable flour. This was successful and fifty sweetpotato flour recipes were collated and evaluated, and eight of the recipes selected for promotion through the awareness creation programmes, training workshops and food fairs.

Work on yams was limited to minimal processing into an exportable product and storage of the tubers. Suitable technologies were developed during both studies but could not be promoted during the first phase of RTIP. This will be addressed during the second phase of RTIP.

Chapter 4. Lessons learnt and recommendations

In dealing with resource poor beneficiary groups, the seeming inability of the members to make meaningful financial contributions as requirement for implementation of specific project activities cannot be overlooked and causes delays in project implementation. At the other extreme, the doling out of complete packages without any contributions from the beneficiaries undermines the commitment of the members to the inherited facility. The group members tend to take the facility for granted and see it as a responsibility of the government which has been met by the project through a government agency. The successful approach should be a balance between the two.

In the transfer of technology to resource poor beneficiaries, the attitude/capacity of the members to absorb the technology being transferred cannot be taken for granted. This could be seen from the success of the Amasa Agro-Processing Co. Ltd. as compared to the RTIP pilot plants. Whereas the experienced entrepreneur adopted a business approach to the management of the company and employed a university trained biochemist to be in charge of operations, the resource poor farmers struggled to come to terms with the technology being introduced to them. The possibility of beneficiary groups employing competent managers and technicians to run their facilities should be encouraged by RTIP in the future.

In the development of technology, the peculiar needs of the intended target group should be of paramount consideration and cannot be assumed. Improved gari roasting stoves which have been used by staff at the Food Research Institute for several years and have even been adopted by some factories in Cameroon and Benin, were abandoned by some

of the traditional processors. The design was such that processors could comfortably sit on chairs resting their backs whilst roasting gari, but most of the traditional processors still preferred to sit on low stools without back support and use both hands to stir two roasting pans at the same time. But even this preference varied from area to area. Processors in Brong Ahafo who used hired labour to roast gari demanded that the hired hand operated two stoves at the same to increase the output. Yet in one of such towns, Mesidan, the project team members saw that large rectangular roasting pans with much bigger capacities had once been introduced to the community, yet these had been abandoned by the processors. It appeared that the traditional processors preferred to use methods that they had been used to and were not always ready to experiment or change their procedures.