**CROP POST HARVEST PROGRAMME**

**Improved cassava chip processing to access urban markets**

# R7580 (ZB0231)

# PROJECT FINAL REPORT

Start Date: 1st March 2000
End Date: 31st March 2003

Core Partners: Natural Resources Institute (UK),
Food Research Institute (Ghana)

Managing Partner: Natural Resources Institute
University of Greenwich
Central Avenue
Chatham
KENT ME4 4TB

# PROJECT EVALUATION REPORT

## Section A Executive Summary

A very brief summary of how the outputs of the project contributed to the purpose, the key activities and highlights of dissemination outputs. (Up to 500 words).

Many poor people depend on cassava as part of their livelihood strategies. Needs assessment studies in Ghana have indicated that cassava farmers need to enhance their incomes in order to assist their emergence from poverty. The marketing of cassava into new markets offers the potential to do this. The development of agro-enterprises also offers employment opportunities. This project investigates processing of high quality cassava products, based on traditional ones, to meet identified markets in urban areas. Specific attention has been given to issues of rural-urban linkages and quality assurance. At a regional consultation for the Global Cassava Development Strategy in June 1999 in Accra, the Ghanaian representatives ranked the commercialisation of traditional cassava products as the most important market opportunity that Ghana should address.

An initial workshop held with manufacturers and other stakeholders highlighted a number of key constraints facing manufacturers of improved cassava food products. These were: Problems with supply of raw materials (with respect to reliability, seasonality, cost, price volatility and appropriate varieties); High cost of production; Poor product quality and safety (i.e. hygiene); Weak linkages between R&D and manufacturers; Poor marketing, promotion and distribution of products; and Lack of industry forum for information sharing and lobbying. These constraints formed the main focus of the project's research activities.

The project has made a detailed analysis of market demand, and also identified some of the key constraints which have so far prevented the expansion of the market. Market indications are favourable, and work has therefore focused on addressing issues of consumer acceptability, cost reduction (through substitution of cassava starch with flour in instant *fufu* flour) and improved quality assurance. The project has developed a range of instant *fufu* products with very good sensory properties and high consumer acceptability. These products are prepared with cassava flour from several high yielding cassava varieties (rather than with cassava starch), and should therefore be significantly cheaper to produce. A full costing of the various options has yet to be finalised.

Different production systems have also been considered in order to increase manufacturers' efficiency and thus reduce costs. At present, manufacturers carry out all stages of the process themselves. The project has encouraged the involvement of processors who are able to produce high quality cassava flour (and other intermediary products) and supply it on a regular basis to the end manufacturers. This would streamline operations, reduce the number of processing steps and increase efficiency. Several entrepreneurs are interested in setting up such an intermediary processing facility, but lack of capital has so far prevented anyone from doing so. An intermediary processing plant would act as the link between rural producers and urban manufacturers.

Development of quality assurance systems with manufacturers has not moved as quickly as anticipated for two main reasons. Although manufacturers are eager to find cost effective improvements to their processes, they are aware that their food safety protocols are not well developed, and this has resulted in some reluctance to work with the project. It became apparent that there was little point in developing a HACCP plan when the factory could not meet the requirements of GMP, and the project therefore focused on explaining the principles and importance of pre-requisite programmes such as GMP, rather than going into details of HACCP. An additional issue is that of commercial confidentiality and the competition between manufacturers, which has resulted in some reluctance to share information freely with the project.

A new EC funded project (CASSAVA-SMEs) will bring together and further validate and expand to a broader range of products the results of this project and R7495. The two CPHP projects will co-fund CASSAVA-SMEs. This means that the CPHP projects will benefit from the outputs of the EC funded work. Further work is planned on optimising product quality, assisting manufacturers to develop integrated quality assurance systems, further reducing costs, promoting the products and developing a linkage between rural producers and urban manufacturers. A private sector company is participating in the EC project with the express intention of setting up such a linkage.

**Section B Project Background**

B.1 Administrative data

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| Period under report:1st March 2000 to 31st March 2003 | Project Leader/Institution: Stephanie Gallat (Andrew Westby) Natural Resources Institute |
| NRIL Contract Number: ZB0231 | Collaborating institution(s) Food Research Institute |
| DFID Contract Number: R7580 | Target Institution(s) Commercial food manufacturers, NGOs, IFAD, Ministry of Food and Agriculture |
| Project Title: Improved cassava chip processing to access urban markets | Start Date: 1st March 2000 End Date: 31st March 2003 |
| Research Programme: Crop Post Harvest Research Programme | Budget (i.e. Total Cost): £256,271 |
| Production System: Forest agricultural interface | |

**Section C Evaluating the identification and design stage (3 pages)**

Please describe the importance of the livelihood constraint(s) that the project sought to address and specify how and why this was identified.

Many poor people depend on cassava as part of their livelihood strategies. Needs assessment studies in Ghana have indicated that cassava farmers need to enhance their incomes in order to assist their emergence from poverty. The marketing of cassava into new markets offers the potential to do this. The development of agro-enterprises also offers employment opportunities. This project investigates processing of high quality cassava products, based on traditional ones, to meet identified markets in urban areas. Specific attention has been given to issues of rural-urban linkages and quality assurance. At a regional consultation for the Global Cassava Development Strategy in June 1999 in Accra, the Ghanaian representatives ranked the commercialisation of traditional cassava products as the most important market opportunity that Ghana should address. This was ahead of the development of other market opportunities.

A small scale pilot market research study indicated that there is a willingness amongst some urban consumers to pay for a higher quality product. The Food Research Institute (FRI) pilot-plant has been producing high quality *kokonte* (fermented cassava flour) and instant *fufu* (pre-gelatinised cassava based flour) on a small-scale commercial basis. The FRI products are priced significantly higher than the traditional ones, but despite this, has found a ready market in the Accra urban area. The products are patronised by a variety of different consumer groups, including traders, students, office workers, overseas travellers and exporters. In fact, the production volume of the pilot-plant cannot satisfy market demand, although marketing has so far been limited to only one outlet. Small-scale commercial food processing companies also produce high quality packaged cassava products, but have so far focused mainly on the export market due to the relatively high cost of their products, the limited purchasing capacity of the domestic market, and the challenge of selling a new concept which replaces a traditional food.

This highlights an opportunity for rural processors to access the higher quality, higher priced urban markets. This project has built upon the village level cassava chipping technology developed under a previous cassava processing project (R6506) and examines the market linkages between rural producers and urban consumers. Although the FRI pilot-plant manufactures products which are in high demand by urban consumers, previous research has shown that processing of cassava chips is not a financially attractive enterprise within the Accra urban area. This is due to the existence of a ready market for fresh cassava roots, which command a price premium over dried chips. There is therefore no real incentive for cassava farmers in the Accra area to engage in chip processing. Chip processing is only attractive in the more remote parts of Ghana, where the limited market for fresh roots, combined with irregular transport, makes marketing of perishable fresh roots highly risky.

Under these circumstances, farmers value a ready market for dried chips, even though they achieve a lower price.

This project has taken forward the issues raised in the previous project (R6506). It focuses on the urban market because there is a growing demand amongst urban consumers for products which are convenient, high quality and safe. In addition, there is evidence that these consumers are willing to pay a premium for such products.

If relevant, how and to what extent did the project team understand and work with different groups of farmers?

The project was divided into two main components. Component One dealt with the supply of raw materials i.e. cassava, and its processing into intermediary products such as cassava flour, cassava starch and cassava grits. It was felt that the supply of raw materials was key to the project, as interaction with manufacturers revealed that that their main problem was the lack of a reliable supply of raw or semi-processed materials at a competitive price. Component One of the project was therefore supposed to deal with organisation of farmers who could supply cassava, and the establishment of a centralised processing factory in the producing areas which would convert fresh cassava into stable, intermediary forms which could be used by manufacturers in the preparation of the finished cassava products. For this component of the work, the project needed to identify an entrepreneur with an interest in setting up an intermediary processing factory. We were successful in identifying such an individual, but due to inability to raise sufficient capital within the project timeframe, the factory has not commenced operation. Therefore, the project was unable to initiate any significant work within component One, and has therefore not been able to interact with farmers who had been targeted to supply cassava to the factory. Please see Section F for how Component One will be addressed by future work under the co-funded EC Cassava-SMEs Project.

Component Two of the project dealt with processing of improved cassava products for the urban market, and therefore interacted with manufacturers as well as potential consumers of these products. The interactions with these two groups are described below.

Did the project work with a specific target institution. Which one? And how did they plan for the future adoption of project outputs at the design stage? Please describe the strategy the project team agreed upon with the target institution(s).

The target institutions for Component Two of this project were the manufacturers of high quality, packaged cassava foods, and the potential consumers of these products. Component Two of the project aimed to develop improved cassava products on a laboratory scale, and then pilot test them with the manufacturers. Cooperation of manufacturers was sought through workshops, individual visits and regular sharing of information on an informal basis. Once the manufacturers had participated in pilot testing and developing improved and cheaper sourcing systems and processing methods, it was hoped that these would be taken up by the manufacturers on a long term basis. Workshops would disseminate information to new clients (manufacturers), and the project would then work alongside and guide manufacturers in improved technologies and sourcing systems.

The project also interacted with potential consumers through market and sensory surveys. These surveys were carried out to gauge consumer perception of packaged cassava convenience foods, and ascertain which factors were critical for their acceptance in the domestic market.

How was the collaborating institution involved in the design of this project and why did they collaborate?

The main collaborating institute in the project was Food Research Institute (FRI). FRI has the mandate for national post-harvest research and development activities, and in particular, has extensive experience in working with local food industries and manufacturers. FRI also has a pilot plant where it has pioneered the development of many of the convenience cassava foods which the project intended to work with. However, due to restricted funding, FRI were not able to develop these products to fully meet their commercial potential. This project provided such an opportunity, and FRI therefore saw the project as an opportunity to continue with some of their own prioritised work. The objectives of the project were discussed, and a plan of activities jointly drawn up to meet the project's outputs and contribute to its objectives. FRI's role was broad ranging, and their work contributed to Outputs 2, 3 and 4. Please see Section E for details of the project outputs.

The other main collaborating institute – Ministry of Food and Agriculture - was in the end not involved in the project to any significant extent. This is because Component One of the project was not undertaken, for the reasons described above.

## Section D Evaluating the implementation process (5 pages)

How was participation achieved among the different stakeholders (the lead institution, the collaborating institution(s), the target institution(s), the CPHP and, where relevant, farming communities) in the research process?

Participation of the collaborating institution was achieved as described in Section C above. Participation of manufacturers was sought in two ways – through workshops, and through individual visits and discussions. It took considerable time to build the confidence and trust of the manufacturers. Much of the information imparted by the manufacturers was regarded by them as confidential, and the project team respected this confidentiality. It was therefore only possible to tease out information strand by strand as the manufacturers became more comfortable with the project team and its work.

The experiences of this project highlight an important dichotomy in public-private sector partnerships. Where is the line drawn between confidential information which has commercial implications, and information which should be available in the public domain to promote research findings and enhance knowledge for the public good? The experiences from this project suggest that an intimate knowledge of, and trust between the partners is essential. Furthermore, discretion must be exercised at all times, and each issue treated according to its own particular set of circumstances.

The project also secured the cooperation of potential consumers of improved cassava foods. This was done through a market survey, sensory evaluations and a Home-Use-Test, where consumers agreed to try out the test product in their homes, and provide a report of their perceptions of it.

What were the major changes that took place during the implementation period. For each one, explain why they came about and how well do you think the project team managed them?

A key change was the realisation that Component One of the project dealing with farmers and the establishment of an intermediary processing factory would not be possible to undertake due to the reasons described in Section C. The project instead had to refocus its activities on Component Two, which involved development of improved and cheaper processing technologies, and working with the manufacturers. The project achieved some significant results in this area, although we were unable to follow the supply chain route we had originally intended. However, we still have an opportunity to tackle Component One under the new Cassava-SMEs project co-funded by the EC. The EC project has a budget allocated for the establishment of an intermediary processing factory, in which the entrepreneur identified under this CPHP project will play a central role. In 2003/2004 operation of the intermediate pilot plant facility was achieved under the CASSAVA-SMES project.

A second major change was the refocusing of the project's activities from *kokonte* to instant *fufu*. When the project was first designed, our objective had been to focus on products made exclusively from cassava, with the aim of commercialising traditional cassava foods and finding new market opportunities for cassava farmers. However, we soon realised that in the quality convenience cassava product market, instant *fufu* occupies a much more prominent position than *kokonte,* although it consists of only 50% cassava and 50% of other crops including plantain, cocoyam and yam. Nonetheless, our attention has so far focused on the cassava component of the product, because we have identified areas where significant improvements can be made in terms of reducing the cost of the product. Our research has however highlighted that sensory and physical properties of instant fufu are significantly influenced by the different constituent flours viz. plantain, cocoyam and yam. Research on the properties of these flours is planned under the Cassava-SMEs Inco-dev project.

A third change in the project was our assumption that we would be able to work hand in hand with the manufacturers from the start of the project. In fact, it has taken considerable time to build the confidence and trust of the manufacturers, and it is only now at the end of the project that we feel are more confident of their future collaboration and participation in project activities, particularly pilot studies. Fortunately, the EC Cassava-SMEs project will enable us to continue our collaboration with them. Our experience with the participation of manufacturers highlights an important conclusion – projects of a 3 to 4 year duration

are rarely sufficiently long to make sustainable changes in people's thinking and institutional development.

What were the strengths and weaknesses of your monitoring system? How did you use and how useful was the information provided by your monitoring system?
The project did not plan or budget for an internal monitoring system, and as such, no formal monitoring activities took place.

## Section E Evaluating your activities (5 pages)

This section should include a summary analysis of all the research activities (studies, surveys etc.) conducted to achieve the outputs of the project set against their respective OVIs in your project LogFrame.

Information on any facilities, expertise and special resources used to implement the project should also be included.

*Key constraints of manufacturers identified (this is an additional output which does not appear in the project memorandum)*
A workshop held with manufacturers and other stakeholders to initiate the project highlighted a number of key constraints facing manufacturers of improved cassava food products. These were: Problems with supply of raw materials (with respect to reliability, seasonality, cost, price volatility and appropriate varieties); High cost of production; Poor product quality and safety (i.e. hygiene); Weak linkages between R&D and manufacturers; Poor marketing, promotion and distribution of products; and Lack of industry forum for information sharing and lobbying. These constraints formed the main focus of the project's research activities.

*Potential urban demand for high quality dried cassava products assessed*
A market assessment study was carried out by Research International (RI) in four urban areas of Ghana to determine the public's acceptance of hygienically processed and packaged convenient forms of traditional cassava products. These included fufu, gari, kokonte and agbelima. Specifically, the study sought to: determine the public's awareness of hygienically processed and packaged products; establish levels of acceptance; ascertain attitudes towards the products; suggest interventions that can lead to positive attitudinal change, and to determine optimum price levels for these products. The study found that amongst the target group (young professionals in Living Standards Measure groups 5-8 who could generally be considered as the growing middle class), there was a high willingness to buy into the concept of purchasing hygienically prepared and packaged cassava products. A large majority (90%) said they were likely to purchase. The perceived quality associated with processed and packaged cassava products led to respondents feeling that these products are better than traditionally prepared ones. From the observations made in this study, it was concluded that there is potential for the production of high quality cassava products for urban markets in Ghana. Price, hygienic manufacture, and good packaging were determined to be key criteria for adoption of the products, and these perceptions must be taken into account in promoting these products.

The study described above did not attempt to estimate market size, and further investigations were therefore conducted to assess the potential size of the market, combining information from the first study with that from the Ghana Living Standards Survey. It was estimated that the true annual potential demand for instant fufu flour probably lies in the range of 1,000 to 17,000 metric tonnes. Even the lower limit would represent a substantial new opportunity for Ghanaian food manufacturers, albeit one that would not be easy to exploit. The estimated demand translates to a 2,000 to 34,000 metric tonne derived requirement for fresh roots (c.a. 0.8% to 13.2% of total trade) as well as substantial demand for plantain. It is likely that farmers would enjoy substantial added benefits if these markets could be exploited.

*Modified cassava processing technology developed to produce products that meet consumer requirements and*
A key ingredient of instant *fufu* flour is cassava starch, which serves as a binder and ensures that key sensory properties of the product are maintained. However, cost of producing cassava starch is high

due to low extraction yields and complex processing method. This makes instant *fufu* expensive, and is a key factor limiting its market size. The project has studied the sensory properties of instant *fufu* formulated with cassava flour from four high yielding Ghanaian varieties as a cheaper, and technically simpler alternative to cassava starch.

A preliminary sensory evaluation (PSE) indicated that texture of *fufu* improves significantly with increasing levels of cassava flour. In the range tested, 50% cassava flour had the highest score. Some improvement in texture was also observed with an increase in the level of cassava starch from 30% to 40%. However, there was no significant difference between samples prepared with 40% and 50% cassava starch.

Overall, *fufu* products formulated with cassava starch achieved higher scores than those prepared with cassava flour, particularly at the 30% inclusion level. However, these differences were progressively reduced at the 40% and 50 % levels of inclusion. Greater variation was observed in the sensory scores of cassava flour products than those based on starch. This is to be expected because the paste hydration and flow characteristics of powders are usually adversely affected by the presence of coarse cellular materials (Kethireddipalli *et al*, 2002), and cassava flour is more likely to contain such types of materials than cassava starch (Niba, *et al*, 2002).

The suitability of the four cassava varieties for their use in instant *fufu* was also compared. F*ufu* products prepared with cassava flour from *Abasa fitaa* and *Gblemo duade* had significantly higher scores (at $P<0.05$) than those prepared with flour from *Afisiafi* and *Tek Bankye*. A more detailed sensory evaluation compared experimental products with four commercial ones. *Fufus* prepared with flours from *Abasa fitaa* and *Gblemo duade* were comparable, and in some cases superior to, commercial *fufus* prepared with cassava starch.

An In-House Sensory Evaluation (IHSE), compared *fufu*s formulated with flour from the two best cassava varieties identified by the PSE (*Abasa fitaa* and *Gblemo duade)*, with a starch based *fufu* (control), and four commercial *fufu* products (formulated with cassava starch) sold on the Accra market. Products formulated with flour from *Abasa fitaa* achieved consistently high scores, and compared favourably not only with the starch based control, but also with the various commercial products. For plantain *fufu*, the *Abasa fitaa* product outperformed all four commercial products. Fufu formulated with flour from *Gblemo duade* also performed well in the plantain and yam categories, but obtained a surprisingly low score for the cocoyam product. The reason for this is unclear, but overall, it has been observed that sensory scores of products formulated with *Gblemo duade* flour exhibit a greater degree of variation than those prepared with *Abasa fitaa*.

It is also of interest to note the differences between overall scores for cocoyam, plantain and yam *fufus*. All four commercial plantain products had significantly lower scores than the experimental ones. The reason for this is unclear, but is perhaps an indication of processing problems with plantain, as manufacturers single out plantain as being a particularly difficult raw material to process.

A Home-Use-Test showed high levels of consumer satisfaction with the experimental *fufu* product. Cocoyam *fufu* formulated with *Abasa fitaa* flour achieved a high level of consumer satisfaction, with 63% of consumers rating it as “highly acceptable”. These results correlate with data obtained from the IHSE, and support the notion that *Abasa fitaa* flour can be used in the formulation of *fufu* products with high consumer acceptability. The issue of colour needs to be addressed, as only 11% of respondents rated product colour as “highly acceptable”, and 45% rated it as only “slightly acceptable”. Further, 80% of respondents affirmed their desire to buy such a product on a regular basis for use at home. However, the issue of an acceptable price was not raised, and it is likely that the percentage of consumers who can afford to purchase such products at current prices is in fact significantly smaller. However, the HUT has confirmed the consumer acceptability of instant *fufu* products based on a cassava flour rather than a cassava starch formulation, and market demand will be mainly influenced by price.

These results demonstrate that cassava flour can be a highly acceptable substitute for starch based instant *fufu*, and can significantly reduce the overall cost of production of the product. However, great care is required in the preparation of the flour, as only a high quality, non fermented flour will perform well in these products. Manufacturers have reported their own experiences of using cassava flour which was not carefully prepared, and produced disappointing results.

Although a general trend emerged as levels of cassava flour and starch were increased, there were a number of inconsistencies in the data. One factor responsible for these inconsistencies is the tendency of the *fufu* surface to harden after some minutes. This hardening is due to retrogradation caused by realignment of the glucose polymers, primarily the amylose portion. Therefore, the time at which the sensory analysis is conducted is critical. However, when a small percentage of potato starch (10 %) was added as a partial replacement for cassava starch or flour, there was a significant reduction in the tendency of the *fufu* surface to harden, and the smooth texture of *fufu* was retained for a significantly longer time period after its preparation. Two hours after preparation, there was a reduction in panel score of only 4% and 5% for cassava starch and cassava flour based *fufus* respectively. By contrast, there was a reduction of 16% and 12% in control samples to which potato starch had not been added. These differences in texture become even more pronounced after 4 hours. It is not immediately clear why this should happen, but it is documented that starches from different botanical sources retrograde at different rates and to various degrees (Thomas & Atwell, 1997).

Despite the acceptability of certain varieties of cassava flour as a replacement for cassava starch, there are question marks over the flour's storage stability. Accelerated shelf-life studies on fufu flour samples were therefore undertaken to assess changes in moisture content, microbiological count and colour. The studies were conducted over 5 months. Vacuum packaging had a significant effect in delaying moisture uptake. The lower moisture content also delayed the increase in microbial load for aerobic and yeast and mould counts. In the presence of anti-oxidants and anti-caking agents, the growth of microorganisms was also inhibited. The increase in aerobic microorganisms was greater with cassava flour based products than cassava starch based ones. This might be a result of the richer nutrient content of the flour as compared with the starch. Based on this premise, a similar trend for moulds and yeasts would have been expected. The fact that this was not the case could be attributed to the reduced competition offered by the lower number of bacteria to the yeasts and moulds.

There was virtually no change in the CIE system of colour parameters. This indicated that browning was not taking place despite the increase in moisture content, as well as the fact that mould growth had not reached sufficiently high levels. This indicates that the 5 month shelf-life study was not long enough for spoilage to begin.

Improvements to the quality of kokonte (dried fermented cassava flour) were also studies. Three drying modes were used: a) drying initially at 70 °C in a mechanical dryer followed by solar drying (av. 38 °C) for 2 days; b) drying initially in a solar dryer for 2 days and finishing off in a mechanical dryer; c) drying only in the solar dryer for 3 days. Three chip sizes (5 mm, 7 mm and 9 mm thickness) were subjected to each of the drying regimes. The three drying regimes resulted in variations in moisture profiles and microbial loads of the final products. In addition, a direct correlation between chip thickness and microbial load was observed, with 9 mm thick chips having a significantly higher microbial load. Drying only in the solar dryer for 3 days resulted in unacceptably high microbial loads, especially for the 9 mm cassava chip size, with aerobic plate count averaging $3.5 \times 10^8$ and moulds and yeasts counts as high as $3.5\ 10^{12}$. Drying in all cases was fastest for the 5 mm chips. A preliminary sensory evaluation carried out on the aroma, colour and acceptability of the flour made from the chips indicated that the drying sequence starting with the solar dryer followed by the use of a mechanical dryer at 70 °C to finish the drying process gave best results. This could be attributed to the initial slow drying in the solar dryer allowing partial fermentation to occur in the chips. This fermentation process is responsible for the development of aroma in kokonte. This is also known to affect the textural properties of the reconstituted and cooked kokonte flour. Drying initially in the mechanical dryer followed by the solar dryer tended to remove moisture too quickly for the necessary fermentation to take place. An attempt is being made to adopt the mechanical cassava chipper to produce cassava chips for kokonte flour.

*Model processing system developed such that a product of desired quality can be sustainably produced at a price acceptable to the market*

Due to the constraints described in Section C above, the project was unable to undertake an analysis of the entire supply chain for the production of commercial cassava products. As explained, we were constrained by the lack of an intermediary processing facility, which was intended to create a linkage between rural producers and urban manufacturers. The existence of such an intermediary facility is crucial in establishing a regular supply of raw and semi-processed materials to the manufacturers. It will

also reduce costs through economies of scale, lower transport costs, and developing specialisation and increased efficiency through each player in the supply chain (farmer, intermediary processor and end manufacturer) being encouraged to focus on his or her core activities.

*Development and testing of a quality assurance system for cassava processing*
If cassava flour is to be routinely used in the formulation of instant fufu flour, a quality assurance system is needed. In terms of general food safety and quality standards, a baseline safety and quality systems audit was conducted at the premises of one of the participating manufacturers. For reasons of confidentiality, we refer to him as Company X. Most categories scored 25 - 30% conformity to international standards. It should be noted that Company X is one of the better and more progressive companies in this sector. Two other companies, Y and Z, were also visited. They had a very limited understanding of the principles of Good Manufacturing Practice. It was therefore felt that a formal baseline audit would be premature in their current situation. Instead, the project team held detailed discussions with the management of the two companies, to explain the principles and importance of GMP, and provide practical advice on its implementation. A baseline audit later in 2003 is planned as part of the CASSAVA-SMEs project when some GMP practices have been put into place.

*Outputs of research promoted to target organisations*
The project has worked with a number of manufacturers, and communicated research findings to them on an individual basis. It has also asked manufacturers to conduct factory trials using the high quality cassava flour used in the project's experimental work (and supplied by the project to the manufacturers on a trial basis). The feedback on this has been very favourable. Wider dissemination will take place through the CASSAVA-SMEs project.

## Section F Evaluating Project effectiveness

This section of the report uses the rating criteria for the purpose and your outputs previously used in your annual reports.

- **The Purpose (2 pages)**

Based on the values of your purpose level OVIs, to what extent was the purpose achieved? In other words, to what degree:

- Have target institutions adopted or are likely to take up the research outputs and how have they done this or plan to do this? And/or

Our target institutions i.e. cassava product manufacturers, are very interested in the improved technology which the project has developed. However, we have as yet been unable to secure a reliable supply of high quality cassava flour from an integrated cassava supply chain. Without this, the manufacturers will not benefit significantly from this technology. The Cassava-SMEs project must therefore focus on the development of an integrated cassava supply chain which can assist manufacturers to obtain a reliable and consistent supply of intermediate cassava products for use in their operations. In terms of food safety, the project has raised awareness amongst manufacturers of Good Manufacturing Practice, but the majority of manufacturers are not yet ready for the implementation of a full HACCP system.

- Have the results of the research been validated as potentially effective at farmer level and how was this done?

No, they haven't. As described above, the project has been unable to work with rural producers due to the lack of an intermediary processing facility, linking producers to urban manufacturers.

**Project Purpose**
This project makes a contribution to the purpose "Strategies developed and promoted which improve food security of poor households through increased availability and improved quality of root crop and horticultural foods and better access to markets".

**Contribution of outputs to purpose**

The project has made a detailed analysis of market demand, and also identified some of the key constraints which have so far prevented the expansion of the market. Market indications are favourable, and work therefore focused on addressing issues of consumer acceptability, cost reduction (through substitution of cassava starch with flour in instant fufu flour) and improved quality assurance. The project has developed a range of instant fufu products with very good sensory properties and high consumer acceptability. These products are prepared with cassava flour from several high yielding cassava varieties (rather than with cassava starch), and should therefore be significantly cheaper to produce. A full costing of the various options has yet to be finalised.

Different production systems have also been considered in order to increase manufacturers' efficiency and thus reduce costs. At present, manufacturers carry out all stages of the process themselves. The project has encouraged the involvement of manufacturers who are able to produce high quality cassava flour (and other intermediary products) and supply it on a regular basis to the end manufacturers. This would streamline operations, reduce the number of processing steps and increase efficiency. Several entrepreneurs are interested in setting up such an intermediary processing facility, but lack of capital has so far prevented anyone from doing so. An intermediary processing plant would act as the link between rural producers and urban manufacturers.

Development of quality assurance systems with manufacturers has not moved as quickly as anticipated for two main reasons. Although manufacturers are eager to find cost effective improvements to their processes, they are aware that their food safety protocols are not well developed, and this has resulted in some reluctance to work with the project. We realised for example that there was little point in developing a HACCP plan when the factory could not meet the requirements of GMP, and we therefore focused our attention on explaining the principles and importance of GMP rather than going into details of HACCP. An additional issue is that of commercial confidentiality and the competition between manufacturers. Again, this has resulted in some reluctance to share information freely with the project. However, we are confident that we will overcome this as they become more confident in dealing with us, and their safety and quality standards improve. This issue will be developed in the CASSAVA-SMEs project of which this project is a part. This project and the CASSAVA-SMEs project were designed to be integrated parts of a whole, and it is the intention of the project to report back to the CPHP on the progress made in the EC funded project until the end of the RNRKS research strategy.

- **The Outputs (5-10 pages)**

What were the research outputs achieved by the project as defined by the value of their respective OVIs?

Were all the anticipated outputs achieved and if not what were the reasons?

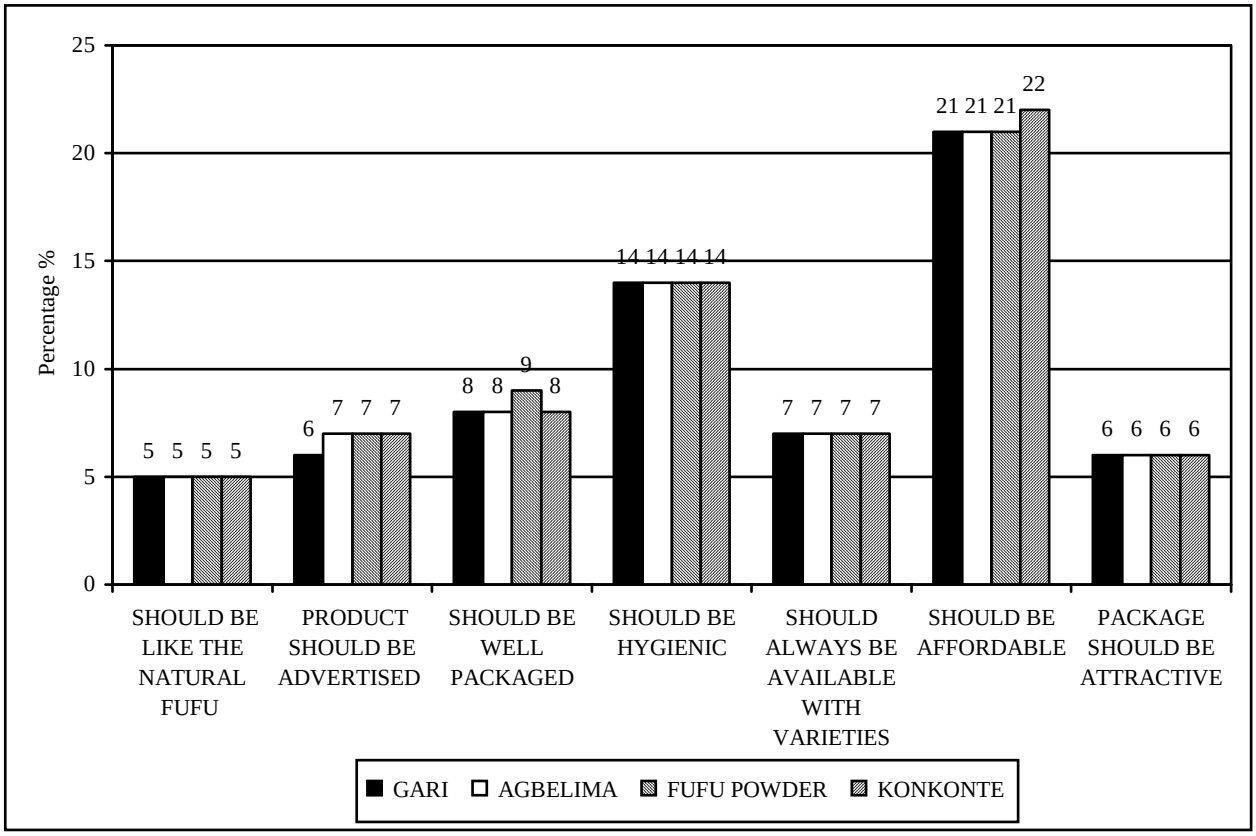
Your assessment of outputs should:

- be presented as tables or graphs rather than lengthy writing, be provided in as quantitative a form as far as is possible; and
- include a qualitative assessment as to their quality and relevance as perceived by their intended users (if this last aspect is not covered in your assessment of the purpose).

*Potential urban market for high quality dried cassava products assessed*

Please refer to Section E for information on the market survey conducted. It was concluded that there is a potential for the production of high quality cassava products for urban markets in Ghana. Price, hygienic manufacture and packaging of products were determined to be key criteria for adoption of the products. The key factors identified by the survey which require consideration when developing the market for improved cassava foods are illustrated in Figure 1 below.

Figure 1. Factors to be considered in developing the market for improved cassava foods




**Estimates of potential market size**

The market survey did not attempt to estimate market size, and further investigations were therefore conducted to assess the potential size of the market, combining information from the first study by Research International (RI) with that from the fourth Ghana Living Standards Survey (GLSS4). Please refer to Section E for details.

After applying the relevant weights and multiplier to the GLSS4 data, the following estimates (rounded to the nearest thousand) of households falling into the Living Standards Measure (LSM) 5 to 10 category were made:

Table 1. Estimated number of LSM 5 to 10 households

| | No. of households | Average household size |
|---|---|---|
| Accra | 91,000 | 3.49 |
| Tema | 108,000 | 4.22 |
| Kumasi | 113,000 | 3.66 |
| Sekondi/Takoradi | 12,000 | 3.95 |
| Ghana | 424,000 | 4.09 |

Source: Authors' estimations using GLSS4 dataset

After trying the instant fufu during the RI product placement trial, an overwhelming proportion of participating consumers claimed that they would either probably or definitely buy the product if it was sold at a reasonable price. Table 2 gives the responses for the four centres surveyed during the RI fieldwork.

| Table 2. How likely would consumers buy instant fufu? | | | | | | |
|---|---|---|---|---|---|---|
| Centre | Would definitely not buy | Would probably not buy | Not sure | Would probably buy | Would definitely buy | Sum |
| | % | % | % | % | % | % |
| Accra | 0 | 2 | 0 | 21 | 77 | 100 |
| Tema | 0 | 0 | 8 | 38 | 54 | 100 |
| Kumasi | 2 | 8 | 4 | 26 | 60 | 100 |
| Sekondi/Takoradi | 0 | 0 | 4 | 26 | 70 | 100 |
| Source: Authors' estimations using RI dataset | | | | | | |

Table 3 gives an indication of the frequency with which consumers from the different centres would buy instant fufu.

| Table 3. How often would consumers buy instant fufu? | | | | | | |
|---|---|---|---|---|---|---|
| | Two times a week | Once a week | Once a fortnight | Once a month | Never | Sum |
| | % | % | % | % | % | % |
| Accra | 17 | 64 | 13 | 6 | 0 | 100 |
| Tema | 19 | 31 | 8 | 42 | 0 | 100 |
| Kumasi | 54 | 30 | 6 | 8 | 2 | 100 |
| Sekondi/Takoradi | 28 | 54 | 11 | 7 | 0 | 100 |
| Source: Authors' estimations using RI dataset | | | | | | |

Interestingly, although the smallest proportion of interviewees claiming that they would probably or definitely buy instant fufu came from Kumasi, the reported frequency with which these same people would buy fufu was substantially greater than claimed in the other urban centres. This perhaps indicates that people from Kumasi, who are generally Ashantis, are large but discerning consumers of fufu.

Table 4 gives the results of converting the claimed frequencies into a weighted average number of packets purchased per week[1].

| Table 4. Claimed purchase intentions: Weighted average number of instant fufu packets purchased per week by urban centre. | |
|---|---|
| | Weighted average number of packets purchased per week |
| Accra | 1.1 |
| Tema | 0.8 |
| Kumasi | 1.4 |
| Sekondi/Takoradi | 1.2 |
| Source: Authors' estimations using RI dataset | |

Assuming that the weight of a packet of instant fufu is 1kg (the pack weight used in the RI placement trial) and, for the time being, that the actual proportion of all LSM 5 to 10 consumers in the four urban centres that *would in reality* buy instant fufu is accurately reflected in the RI categories "would probably" and "would definitely" buy instant fufu, then the following estimates of potential annual demand apply (Table 5 – all figures rounded to the nearest 100 tonnes):

[1] Weights merely reflected the frequencies reported in Table 3 and were used to estimate the number of packets consumed per week.

| Table 5. Estimated potential annual demand by urban centre | |
|---|---|
| | Tonnes per annum |
| Accra | 4,900 |
| Tema | 4,300 |
| Kumasi | 7,200 |
| Sekondi/Takoradi | 700 |
| Total | 17,100 |
| Source: Authors' estimations using GLSS4 and RI datasets | |

In their report, RI warn about the likelihood that the trial participants overclaimed their purchase intentions. In this light, the 17,100 tonne estimate probably serves as an upper limit to potential demand. Table 6 gives a range of figures for estimated potential annual demand, incorporating various degrees of overclaim. For instance, 75% overclaim means that only 25% of those who claimed that they would either "probably" or "definitely" buy instant fufu actually do so, and that they only buy a quarter of the quantity they claimed they would.

| Table 6. Sensitivity analysis using different levels of overclaim | | | | |
|---|---|---|---|---|
| | Level of overclaim | | | |
| | 0% | 25% | 50% | 75% |
| Potential demand in 4 urban centres (tonnes) | 17,100 | 9,700 | 4,300 | 1,000 |
| Source: Authors' estimations using GLSS4 and RI datasets | | | | |

75% overclaim would be an unexpectedly large rate, whereas 0% would be extraordinarily low. We can therefore state that, providing our estimates of the number of Ghanaian households that fall into the LSM 5 to 10 category is accurate, the true potential market size probably lies between 1,000 and 17,600 tonnes per annum.

Although the sensitivity analysis in the previous section describes a large range in which the true market potential probably lies, the point of the exercise was to establish whether there is significant potential demand for instant *fufu* and therefore a substantial derived demand for cassava roots for processing into cassava flour. Taking the smallest estimate of 1,000 tonnes and assuming that cassava flour constitutes 40% of the instant *fufu* powder[2], the equivalent demand for cassava roots would be approximately 2,000 tonnes a year[3]. At 17,100 tonnes of instant *fufu* powder consumed per year, the equivalent demand for cassava roots would be about 34,200 tonnes. Credible estimates of the total quantity of cassava that is traded in Ghana are hard to come by. However, by taking GLSS4 information on the value of cassava sold during the survey year (1998/99) and dividing it by the average price of cassava for that year (also generated by GLSS4) one arrives at a figure of 260,000 metric tonnes of cassava traded per annum (fresh root equivalent, rounded to the nearest 10,000 tonnes)[4]. Assuming this to be a reasonably accurate estimate, the potential increase in demand for cassava roots generated by the exploitation of the domestic instant *fufu* market lies between 0.8% and 13.2%.

Clearly, if 17,100 tonnes of instant *fufu* could be supplied to the market, this would represent a large opportunity both for food manufacturers and cassava farmers in production areas that could supply cassava roots cost effectively and reliably. Because instant *fufu* contains a large proportion of plantain flour (approximately 60%), there would also be an opportunity for similarly capable plantain farmers. Even the lowest estimate of potential demand represents a modest, but significant opportunity for Ghana's food manufacturing industry. Although accurate figures for the industry's current maximum output are not available, we estimate that 1,000 tonnes represents an increase of two thirds over current maximum output. This assumes that all current manufacturing capacity is

[2] Most of the manufacturers currently use 40% cassava starch in their instant fufu mixes. One of the aims of research is to convince manufacturers that they can replace the imported cassava starch with domestically produced cassava flour, thereby benefiting Ghana's balance of payments and providing market opportunities for Ghanaian farmers.

[3] This assumes a 20% conversion of fresh roots to cassava flour.

[4] According to GLSS4, approximately 21.5% of all cassava that is harvested is sold.

devoted to instant *fufu* production, whereas in reality, a substantial portion is devoted to producing other foods such as *kokonte* (100% fermented *kokonte* flour) and *banku* (1:1 cassava to maize flour).

In practice, sales of instant *fufu* and other cassava-based foods will be influenced by the effectiveness of promotional campaigns. A minority of RI respondents (39%) were aware of at least one of the manufactured cassava food products. Other factors will also influence the degree to which market potential will be realised. The quality of the products and the degree to which they live up to consumers' organoleptic requirements will have a significant influence on sales. Similarly, product pricing will have a major impact. The RI respondents who tried the instant *fufu* during the product placement trial were asked whether they would buy the product *assuming* that the price was "right".

This analysis has concentrated on the domestic market. However, to date, the export market has absorbed an estimated 95% of manufactured cassava food output, yet almost certainly still holds unrealised potential. Export marketing requires very little effort because the manufactured cassava products tend to sell themselves to ex-patriate West-Africans[5]. In this light, the business risk of expanding output diminishes somewhat and investments look more promising.

*Modified cassava processing technology developed to produce products that meet consumer requirements*

A large body of data has been collected and analysed for this output. Therefore, only a selection of results has been included to illustrate some of the key findings.

Tables 1 and 2 show scores for two key sensory attributes – smoothness and elasticity – of plantain *fufus* formulated with cassava starch and cassava flour from four Ghanaian high yielding cassava varieties at different levels of inclusion. It is clear that Abasa fitaa and Gblemo duade varieties performed significantly better than Afisiafi and Tek bankye. Further, performance of cassava flour was optimised at the 50% inclusion level, where it compared favourably with cassava starch.

Figures 2 and 3 compare experimental plantain and cocoyam fufus formulated with cassava starch and cassava flours of Abasa fitaa and Gblemo duade, with four commercial fufu products sold on the Accra market. For plantain fufu, experimental products outperformed commercial ones. For cocoyam fufu, Gblemo duade performed poorly, but the Abasa fitaa product scored equally well as (and in some cases better than) commercial products.

Table 1. Panel mean scores for **smoothness** of cooked plantain *fufu* formulated with plantain flour and cassava starch or cassava flour from four Ghanaian high yielding cassava varieties

| | Inclusion level (%) | Mean scores for smoothness of instant plantain *fufu* made from starch and flour of four cassava varieties | | | |
|---|---|---|---|---|---|
| | | ***Abasa fitaa*** | ***Afisiafi*** | ***Gblemo duade*** | ***Tek bankye*** |
| **Starch** | **30** | **7.95 *a*** | **7.51 *a*** | **8.35 *a*** | **7.67 *a*** |
| | **40** | **8.24 *b*** | **7.62 *a*** | **8.61 *b*** | **8.30 *b*** |
| | **50** | **8.20 *b*** | **8.27 *b*** | **8.91 *c*** | **8.08 *c*** |
| **Flour** | **30** | **6.65 *c*** | **7.51 *a*** | **7.35 *c*** | **7.28 *a*** |
| | **40** | **7.94 *b*** | **7.62 *a*** | **8.11 *b*** | **8.20 *b*** |
| | **50** | **8.20 *b*** | **7.77 *a*** | **8.41 d** | **8.08 *c*** |

Values in the same column followed by the same letter did not differ significantly at P< 0.05

[5] The major export difficulty is finding an agent or wholesaler who is willing to play fair and pay by letter of credit either on presentation of documents or on receipt of goods. However, commercial difficulties also exist in the domestic market, where the supermarket buyers are often poor payers.

Table 2. Panel mean scores for **elasticity** of cooked plantain *fufu* formulated with plantain flour and cassava starch or cassava flour from four Ghanaian high yielding cassava varieties

| | Inclusion level (%) | Mean scores for elasticity of instant plantain *fufu* made from starch and flour of four cassava varieties | | | |
|---|---|---|---|---|---|
| | | ***Abasa fitaa*** | ***Afisiafi*** | ***Gblemo duade*** | ***Tek bankye*** |
| **Starch** | **30** | **7.36 *a*** | **6.03 *a*** | **7.51 *a*** | **5.93 *a*** |
| | **40** | **6.85 *b*** | **7.37 *b*** | **6.77 *b*** | **6.79 *b*** |
| | **50** | **6.96 *b*** | **6.98 *c*** | **6.69 *b*** | **5.96 *a*** |
| **Flour** | **30** | **6.21 *a*** | **6.03 *a*** | **6.51 *c*** | **5.03 *c*** |
| | **40** | **6.85 *b*** | **7.37 *b*** | **6.77 *b*** | **6.79 *b*** |
| | **50** | **6.96 *b*** | **6.48 *d*** | **6.69 *b*** | **5.96 *a*** |

Values in the same column followed by the same letter did not differ significantly at P< 0.05

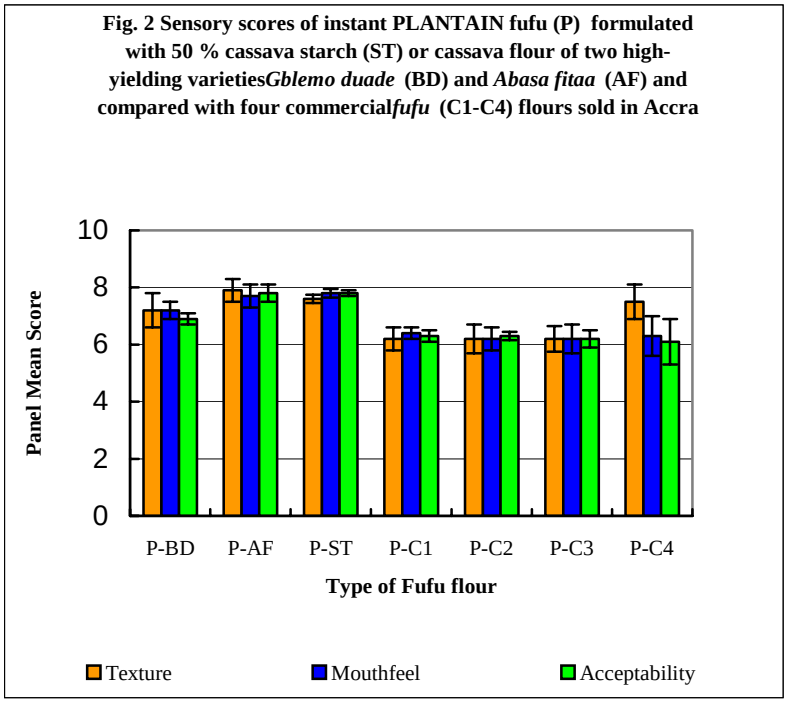
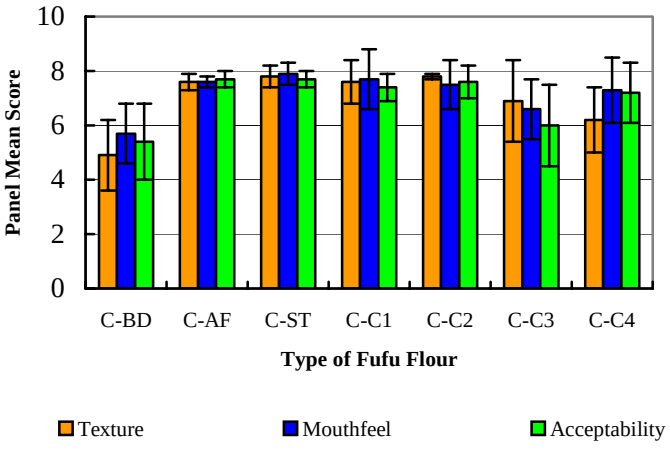


**Fig. 3 Sensory scores of instant COCOYAM fufu (C) formulated with 50% cassava starch (ST) or cassava flour of two high-yielding varieties*Gblemo duade* (BD) and *Abasa fitaa* (AF) and compared with four commercial instant *fufu* (C1-C4) flours sold in Accra**




Tables 3 and 4 demonstrate the effect of potato starch on the smoothness of instant *fufus* prepared from plantain and cocoyam. It is clear that potato starch helps to retain the smooth texture of fufu for a significantly longer time period after its preparation.

Table 3. Effect of potato starch (at 10% level) on the smoothness of plantain fufu (formulated with cassava starch or cassava flour at 40%), assessed 10, 120 and 240 minutes after preparation

| | | **Average** | | **Panel** | | **Score** | | |
|---|---|---|---|---|---|---|---|---|
| Time/min | Starch plus potato | % change | Starch control | % change | Flour plus potato | % change | Flour control | % change |
| 10 | 7.6 | | 7.6 | | 6.7 | | 7.3 | |
| 120 | 7.6 | -0.8 | 7.1 | -6.7 | 6.4 | -3.3 | 6.1 | -17.1 |
| 240 | 6.8 | -10.7 | 6.4 | -15.6 | 6.3 | -5.5 | 5.9 | -19.5 |

Table 4. Effect of potato starch (at 10% level) on the smoothness of cocoyam fufu (formulated with cassava starch or cassava flour at 40%), assessed 10, 120 and 240 minutes after preparation

| | | **Average** | | **Panel** | | **Score** | | |
|---|---|---|---|---|---|---|---|---|
| Time/min | Starch plus potato | % change | Starch control | % change | Flour plus potato | % change | Flour control | % change |
| 10 | 7.8 | | 7.0 | | 7.3 | | 7.4 | |
| 120 | 7.6 | -2.1 | 5.9 | -15.3 | 6.1 | -16.4 | 6.6 | -10.5 |
| 240 | 7.3 | -6.6 | 5.1 | -26.8 | 6.1 | -16.3 | 5.7 | -22.4 |

Table 5 shows results of the Home-Use-Test for cocoyam fufu formulated with Abasa fitaa flour. The product achieved a high level of consumer satisfaction, with 63% of consumers rating it as "highly acceptable".

Table 5. Home-Use-Test assessment of instant cocoyam *fufu* flour formulated with 50% cassava flour (var. *Abasa fitaa*)

| | | Percentage | Acceptability | Rankings | |
|---|---|---|---|---|---|
| Sensory attributes | Highly acceptable | Acceptable | Slightly acceptable | Slightly unacceptable | Not acceptable |
| Colour | 10.9 | 38.2 | 45.6 | 5.3 | 0.0 |
| Taste | 23.2 | 32.8 | 31.6 | 12.4 | 0.0 |
| Texture | 54.6 | 23.5 | 15.6 | 6.3 | 0.0 |
| Mouth feel | 39.3 | 21.9 | 23.9 | 14.9 | 0.0 |
| Overall acceptability | 63.1 | 23.3 | 6.5 | 7.1 | 0.0 |

Source: survey data.

Figures 4.11 and 4.12 show the moisture content of cocoyam fufu prepared with cassava flour and cassava starch stored over a period of 5 months. Shelf-life studies were carried out using three packaging materials – vacuum packaging (CFV and CSV), local high density polythene packaging (CFG and CSG) and food grade high density polythene imported from the UK (CFB and CSB). It is clear that vacuum packaging was most effective at delaying moisture uptake by the product. However, no significant difference emerges between imported and locally available packaging materials. Further, there does not appear to be a significant difference between the rate of moisture uptake by cassava flour and cassava starch.

**Fig 4.11 Moisture content of instant cocoyam fufu flour formulated with cassava flour (var. *Abasa fitaa*), in three different packages during storage at 31 ± 1°C and 84 % RH**

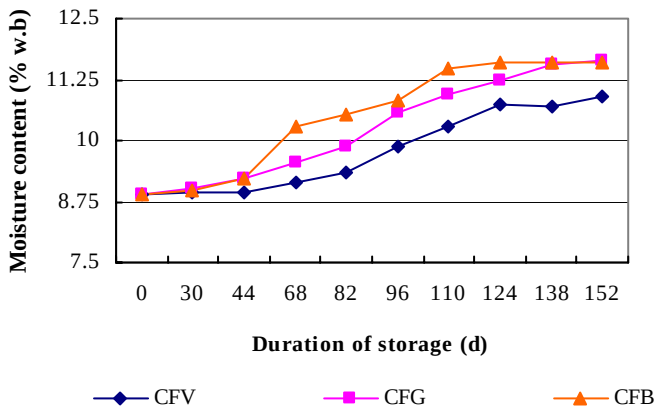
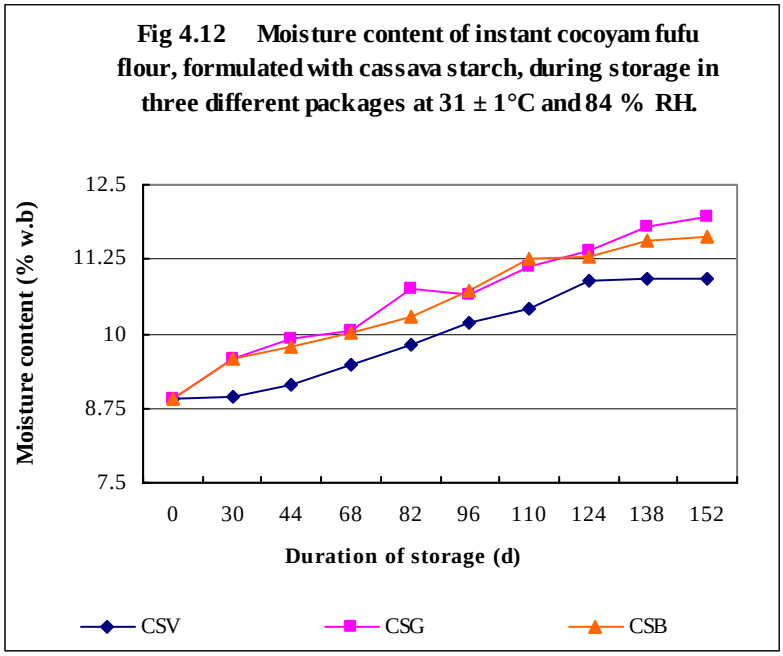
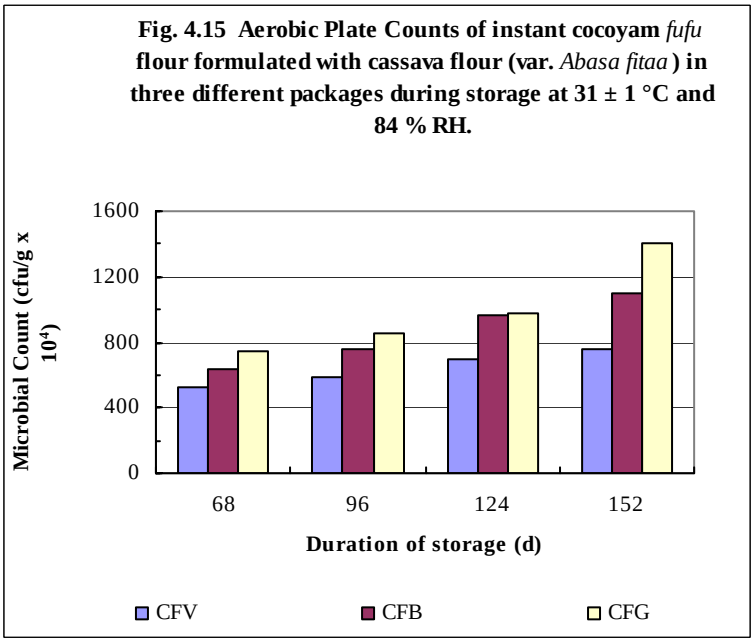


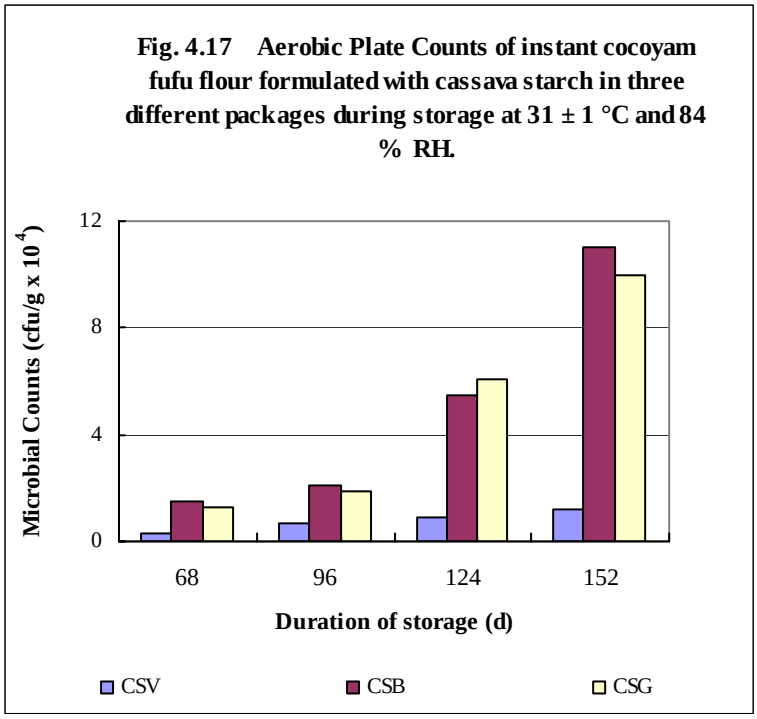
**Fig 4.12 Moisture content of instant cocoyam fufu flour, formulated with cassava starch, during storage in three different packages at 31 ± 1°C and 84 % RH.**




Figures 4.15 and 4.17 show aerobic plate count of cassava flour and cassava starch fufus during the shelf-life study. It is clear that vacuum packaging has significantly retarded the growth of microorganisms in the product. There is also a significant difference between microbial loads in cassava flour and cassava starch products. The cassava flour clearly had a significant microbial load at the outset of the study. The cassava starch product on the other hand started off with a very low microbial load, and microorganisms only started to proliferate after 124 days (4 months) of storage. Even so, the microbial load was still significantly lower in the cassava starch product than the cassava flour one at the end of the shelf-life study.

**Fig. 4.15 Aerobic Plate Counts of instant cocoyam *fufu* flour formulated with cassava flour (var. *Abasa fitaa*) in three different packages during storage at 31 ± 1 °C and 84 % RH.**






Figures 4.19 and 4.21 show yeast and mould counts in cassava flour and cassava starch fufus during the shelf-life study. The results show an increase in yeast and mould count at 124 days (4 months) of storage. Interestingly, there is already a visible increase in yeast and mould count at 96 days in the cassava starch product (in non-vacuum packaging materials), whilst the count in the cassava flour product remains low. This is attributed to the lower aerobic microbial load in the cassava starch product, thus providing less competition for yeast and mould growth.

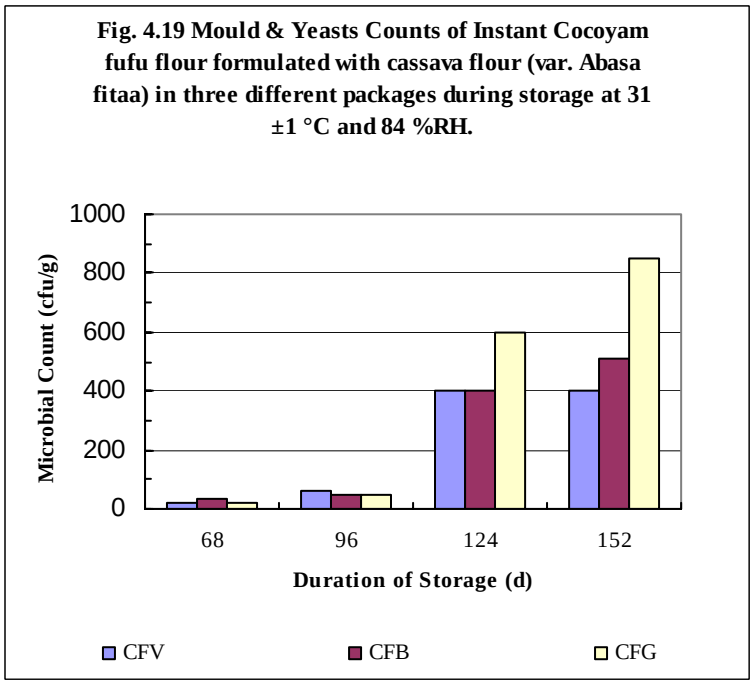


**Fig. 4.21 Mould & yeast counts of instant cocoyam *fufu* flour formulated with cassava starch in three different packages during storage at 31 ± 1 °C and 84 % RH**

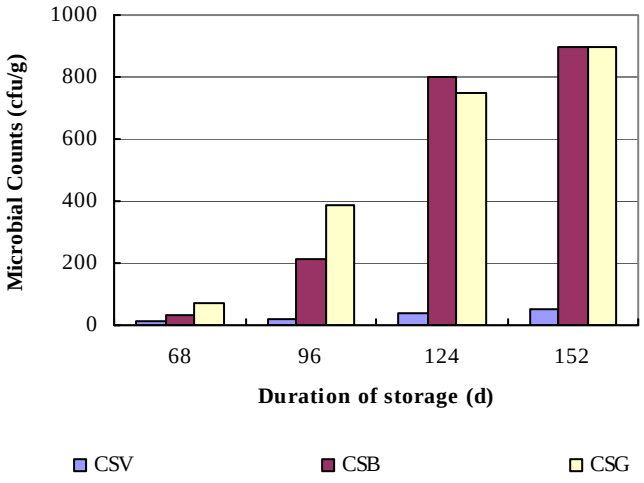



Figure 4.22 below shows a drying curve for cassava chips of three different thicknesses, dried initially in a mechanical drier, and finished off in a solar drier. Rate of loss of moisture is directly correlated to chip thickness i.e. the thinner the chip, the faster the moisture loss. The rate of drying in the different sized chips is also related to their microbial load, depicted in Table 6. Aerobic plate count, yeast and mould count and coliforms all increase with increasing chip thickness. However, the presence of coliforms could be an indication of poor hygienic practices rather than slow drying. It would depend if the coliforms were of plant or microbial origin. More attention must be paid to food safety issues in the processing operation.

**Fig. 4.22 Moisture content profiles of cassava chips for kokonte dried initially in a mechanical dryer for 6 h and then in a solar dryer (av. 38 °C) for 2 days**

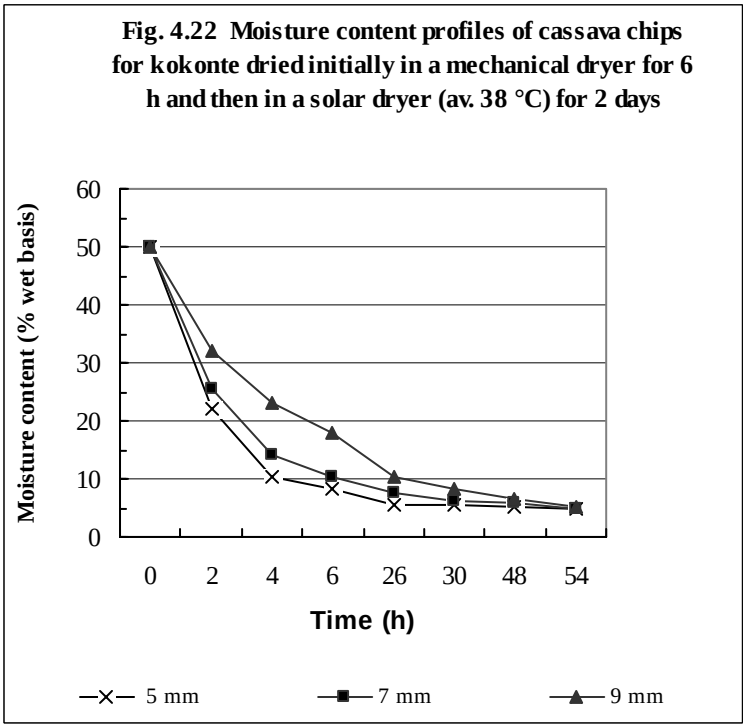


Table 6. Microbiological results of cassava slices dried in a mechanical drier at 70°C for 6 hours, followed by 2 days in a solar drier, av. temp. 38oC

| Size of Cassava Pieces (mm) | Aerobic Plate Count/ g NMKL 86 1999 | Moulds & Yeast Count/ g ISO 7954 1987 | Coliforms/ g NMKL 44 1995 | E. coli /g NMKL 1996 | Flora |
|---|---|---|---|---|---|
| 5 | $1.2 \times 10^5$ | $1.0 \times 10^1$ | $2.3 \times 10^2$ | $2.5 \times 10^2$ | Gram +ve rods, Gram –ve rods and Mucor |
| 7 | $1.4 \times 10^5$ | $1.8 \times 10^2$ | $1.4 \times 10^4$ | $3.5 \times 10^2$ | Gram +ve rods, Gram –ve rods and Mucor |
| 9 | $3.5 \times 10^5$ | $7.0 \times 10^5$ | $3.2 \times 10^6$ | $7.6 \times 10^4$ | Gram +ve rods, Gram –ve rods and Mucor |

*Model processing system developed such that a product of desired quality can be sustainable produced at a price acceptable to the market*

We have not yet been able to validate the processing system due to the reasons described in the previous sections of this report. This is being addressed in the CASSAVA-SMES project which this project is a part.

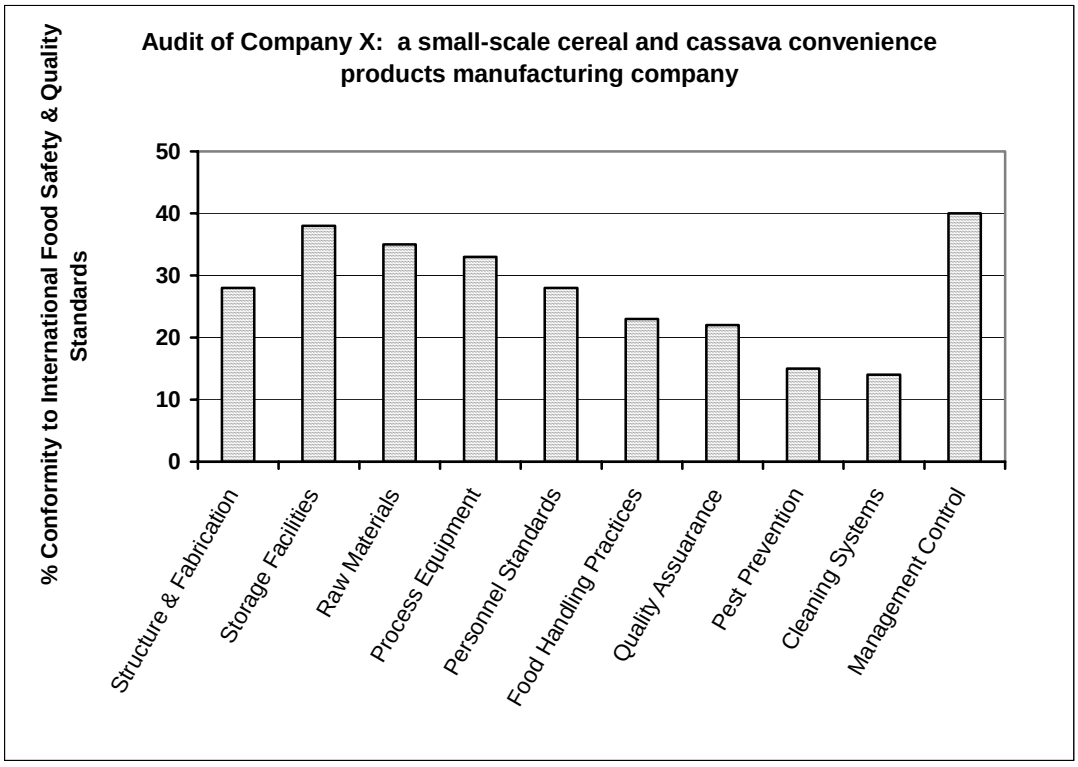
*Development and testing of a quality assurance system for cassava processing*

As explained in Section E, the manufacturers we have been working with have not reached the stage where they can adopt a full quality assurance and food safety system based on HACCP. Much work remains to be done in raising awareness of Good Manufacturing Practice (GMP) and Good Hygiene Practice (GHP). The baseline audit summarised below is a typical example of the small scale manufacturers who are producing improved cassava foods.

Summary of Main Non-Compliances to GMPs identified by audit team at Company X

- The surrounding space around the factory buildings is not well maintained.
- There is poor drainage and inadequate separation of dirty and clean areas.
- There is no separate finished goods facility.
- The bulbs are not protected by shatterproof plastic sleeve covers
- There are no adequate and sufficient hand-washing facilities at access to production area.
- The use of colour-coded equipment was not performed.
- The maintenance activities are not scheduled
- Changing facilities are not adequate
- Packaging area leads directly into the production area.
- There is no adequate ventilation in the baking and packaging area.
- Employees worn jewellery and watches
- Traceability system is not adequate; batch coding needs to be improved.
- Recall procedures should be improved

Summary of Good Manufacturing Practices Baseline Audit for Company X




Company X produces mainly for export. It is therefore vital that it improves upon its pre-requisite programmes in order to be in a position to implement HACCP, and maintain its overseas market. This is especially urgent since this system of quality assurance is becoming a mandatory requirement for food imported into the Americas and Europe. With this in mind, the audit identified a number of problems in the food safety and quality management systems of the company, and several key recommendations were made to improve the current situation:

- The company must pay particular attention to the GMPs and GHPs of the smaller rural-based artisanal processors who supply it with the raw and semi-finished materials. It would be advisable to arrange to give some basic training in food handling and food hygiene for these processors.
- Storerooms for the storage of raw materials must be better managed. The company must avoid storing raw materials on the bare floor. They should avoid keeping expired goods in the store.
- The sorting area is also not well designed. The place is too open and easily accessible to flying insects and dust.
- All operatives must be made to undertake medical examination periodically.
- Cleaning must be intensified. The walls in some parts of the production areas are dirty.
- Factory overalls must not be worn outside the processing areas. The processing halls must be equipped with hand washing facilities.
- The packaging area is presently not well ventilated. This could affect the health of the operatives working there. Since they are packaging flour, there is a risk of flour dust affecting their breathing and respiratory system.

*Outputs of research promoted to target organisations*

The project communicated on a regular basis with manufacturers, principally through informal channels, and on a one to one basis. As discussed earlier, we are not yet in a position to disseminate a full package of research findings to manufacturers. However, we have built up a strong relationship with them through regular dialogue and sharing of information. One of the most important issues to have come from these interactions is a detailed understanding of the major constraints facing the manufacturers. This has enabled us to address some of these issues in our research, and has made the project very responsive to manufacturers needs.

The following is a summary of key constraints identified by manufacturers of improved cassava food products, together with interventions the project has tried or will try to make to alleviate these.

**1. SUPPLY (PROBLEMS WITH RELIABILITY, COST, PRICE VOLATILITY AND APPROPRIATE VARIETIES)**
We plan to work with entrepreneurs who have expressed interest in developing intermediary processing plants to convert fresh cassava at the point of production into stable intermediary products such as high quality cassava flour and grits. These intermediary products will provide a reliable source of raw material to the manufacturers. The project will thus attempt to develop a supply chain rather than focusing only on the final products.

**2. HIGH COST OF PRODUCTION**
The project will test the economic and technical efficiency of a number of drying and processing techniques, and evaluate the cost effectiveness of each one.

**3. POOR PRODUCT QUALITY AND SAFETY (I.E. HYGIENE)**
The project will conduct trials on improving the quality and safety of cassava products (including consumer trials). In collaboration with manufacturers, we will develop appropriate quality assurance systems.

**4. WEAK LINKAGES BETWEEN R&D AND MANUFACTURERS**
Effective dissemination is essential to enable manufacturers to benefit from existing knowledge. Much information is already available but not easily accessible. The project will aim to develop linkages between manufacturers and various support/advisory agencies.

**5. POOR MARKETING, PROMOTION AND DISTRIBUTION OF PRODUCTS**
The project will test innovative marketing, promotional and distribution strategies, and assess their effectiveness in terms of increased demand for products.

**6. LACK OF INDUSTRY FORUM FOR INFORMATION SHARING AND LOBBYING**
The project will attempt to convene meetings of all interested manufacturers on a regular basis in order to share project findings. We also plan to produce a news bulletin for circulation to industry members.

For projects aimed at developing a device, material or process, and considering the status of the assumptions that link the outputs to the purpose, please specify and justify:

What further market studies need to be done?
Market analysis has indicated a good potential demand for improved cassava products. However, appropriate marketing strategies need to be designed to raise awareness of these products, and identify appropriate distribution channels.

How the outputs have been made available to intended users?
Please see sections above. The project has maintained close contact with manufacturers of improved cassava foods. However, we are not yet in a position where we can disseminate a package of research findings.

What further stages will be needed to develop, test and establish manufacture of a product by the target institution?
The key step is the establishment of an intermediary processing facility which can produce intermediate, shelf-stable raw materials that will be supplied to manufacturers on a regular basis at a competitive price.

This will establish a complete supply chain between rural producers and urban manufacturers. In additional, further research needs to be conducted on the cassava based products themselves. Specifically, sensory work needs to be underpinned by an investigation of the functional properties (particularly pasting characteristics) of the different flours used, to ascertain the reasons behind observed differences in sensory properties. This will assist in the development of a product with consistent (and acceptable) sensory properties.

## How and by whom, will the further stages be carried out and paid for?

The new EC funded project (CASSAVA-SMEs) will bring together and further validate and expand to a broader range of products the results of this project and R7495. The two CPHP projects will co-fund CASSAVA-SMEs. This means that the CPHP projects will benefit from the outputs of the EC funded work. Further work is planned on optimising product quality, assisting manufacturers to develop integrated quality assurance systems, further reducing costs, promoting the products and developing a linkage between rural producers and urban manufacturers. A private sector company is participating in the EC project with the express intention of setting up such a linkage. A no cost extension of this project to March 2005 with an interim FTR prepared now has been requested to ensure that the maximum benefit is gained from this relationship.

## Have they developed plans to undertake this work? If yes, what are they? If why not?

The EC funded Cassava SMEs project has developed a detailed set of activities which will dovetail into, and expand the scope of, the existing work. Please see above for details.

**ANNEXES**

I Project Logical Framework
II Results of end of project workshop (guidance needed)
III Target Institution's workplan for adopting project outputs
IV Feedback on the process from collaborating institution(s) and farmers (where appropriate) (Criteria needed)
V List of publications
VI A catalogue of data sets and their location

## Annex I Project Logical Framework

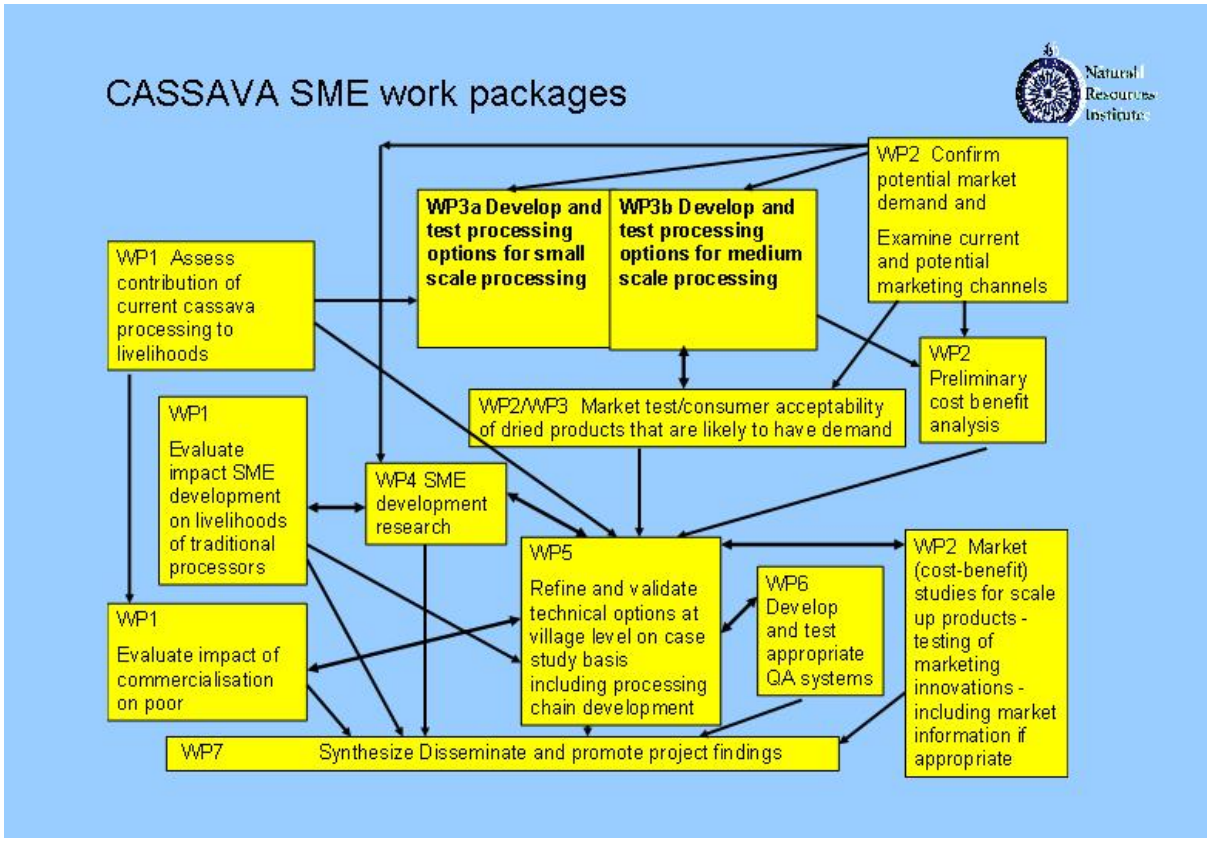
Improved cassava chip processing to access urban markets Updated June 2000

| Narrative Summary | Objectively Verifiable Indicators | Means of Verification | Important Assumptions |
|---|---|---|---|
| **Goal** | | | |
| Poor people benefit from new knowledge applied to food commodity systems in forest-agriculture interface areas. | - By 2002, increased numbers of poor households, in two target countries, who use improved storage and agro-processing techniques in an environmentally sustainable manner.<br>- By 2002, increased numbers of poor households, in two target countries, benefit from improved marketing and credit systems.<br>- By 2005, increased contribution to nutrition of poor households from own produced food.<br>- By 2005, increase in income from the sale of fresh and processed crops by poor households, in two target countries. | National and local adoption rate surveys.<br>National food security data. | Poor people invest benefits to improve choices and options for livelihood strategies. |
| **Purpose** | | | |
| Strategies developed which improve food security of poor households through increased availability and improved quality of root crop and horticultural foods and better access to markets. | 1.3 By 2002, more efficient and cost-effective methods of small-scale processing validated.<br>1.5 By 2002, new market opportunities validated, capable of increasing value of commodities produced by the poor. | Annual Research programme reports.<br>External refereeing.<br>External O/P reviews at .<br>Target institutions' reports. | Resources managers, producers and processors are able to adopt new knowledge.<br>Enabling environment exists for widespread adoption of new knowledge.<br>Capabilities of target institutions maintained at least at current levels.<br>Food production constant or increasing. |
| ***Outputs*** | | | |
| 1. Potential urban market for high quality dried cassava products assessed | 1.1 Urban market demand determined by December 2000. | Project technical report | Season(s) studied typify the general situation |
| 2. Modification of cassava mini-chip processing technology to produce a product that meets consumer requirements. | 2.1 Trails completed and reported on by December 2001. | Project level O/P reviews<br>Project technical reports<br>Project publications | Season(s) studied typify the general situation<br>Conditions do not exist which make case study sites atypical of the general situation |
| 3. Model processing system developed such that a product of desired quality can be sustainably produced at a price acceptable to the market | 3.1 Technical studies completed by December 2001.<br>3.2 Optimum system organisation identified by July 2002<br>3.3 Processing system validated on a case study basis by February 2003. | Project level O/P reviews<br>Project technical reports<br>Project publications | As above. |
| 4. Development of a quality assurance system for cassava chip processing. | 4.1 Appropriate quality assessment approach identified by July 2002.<br>4.2 Quality system tested by September 2002. | Project level O/P reviews<br>Project technical reports<br>Project publications | As above |
| 5. Outputs of research promoted to target organisations | 5.1 Appropriate project linkages established on an on-going basis – but summarised annually. | Project level O/P reviews<br>Project technical reports<br>Project publications | |

| | | | |
|---|---|---|---|
| | 5.2 At least two dissemination outputs produced by February 2003. | | |
| ***Activities*** | **Budget** | **Means of Verification** | **Important Assumptions** |
| 1.1 Assess demand for high quality cassava products. | Staff costs £93.9<br>Overheads £72.7<br>Capital equipment £17.9<br>T &S £31.6<br>Miscellaneous £26.8<br>Total (Ex. VAT) £242.9 | Project quarterly and annual reports. | Householders in the villages, SMEs, and producer groups identified are willing to participate on the project. |
| 2.1 Conduct participatory on-farm trials to examine how product acceptability is affected by variety and modifications to processing technique<br>2.2 Undertake sensory and rheological studies on samples obtained. | | | |
| 3.1 Undertake studies to optimise cassava chip production technology<br>3.2 Undertake studies to identify the optimum system organisation<br>3.3 Validate selected processing system<br>3.4 Assess profitability of selected system<br>3.5 Assess the needs for links to credit sources<br>3.6 Assess potential impact of new market on cassava farmers | | | |
| 4.1 Using the HACCP approach identify critical points in cassava chip processing systems developed to ensure safety and quality<br>4.2 Identify an appropriate quality control system for use by small and medium scale processors<br>4.3 Test and evaluate quality control system. | | | |
| 5.1 Establish and development appropriate project linkages<br>5.2 Promote projects outputs though appropriate means | | | |

## Annex II Results of end of project workshop (guidance needed)

The end of project workshop was the launch workshop for the CASSAVA-SMES project held in Nigeria in March 2003. The workshop was attended by the Regional Coordinator of the CPHP, Dr Ben Dadzie. The end result was the operationalisation of the CASSAVA-SMES work packages which are detailed in the following slide. Annex IV shows the relationship between the CASSAVA-SMES project and this project.

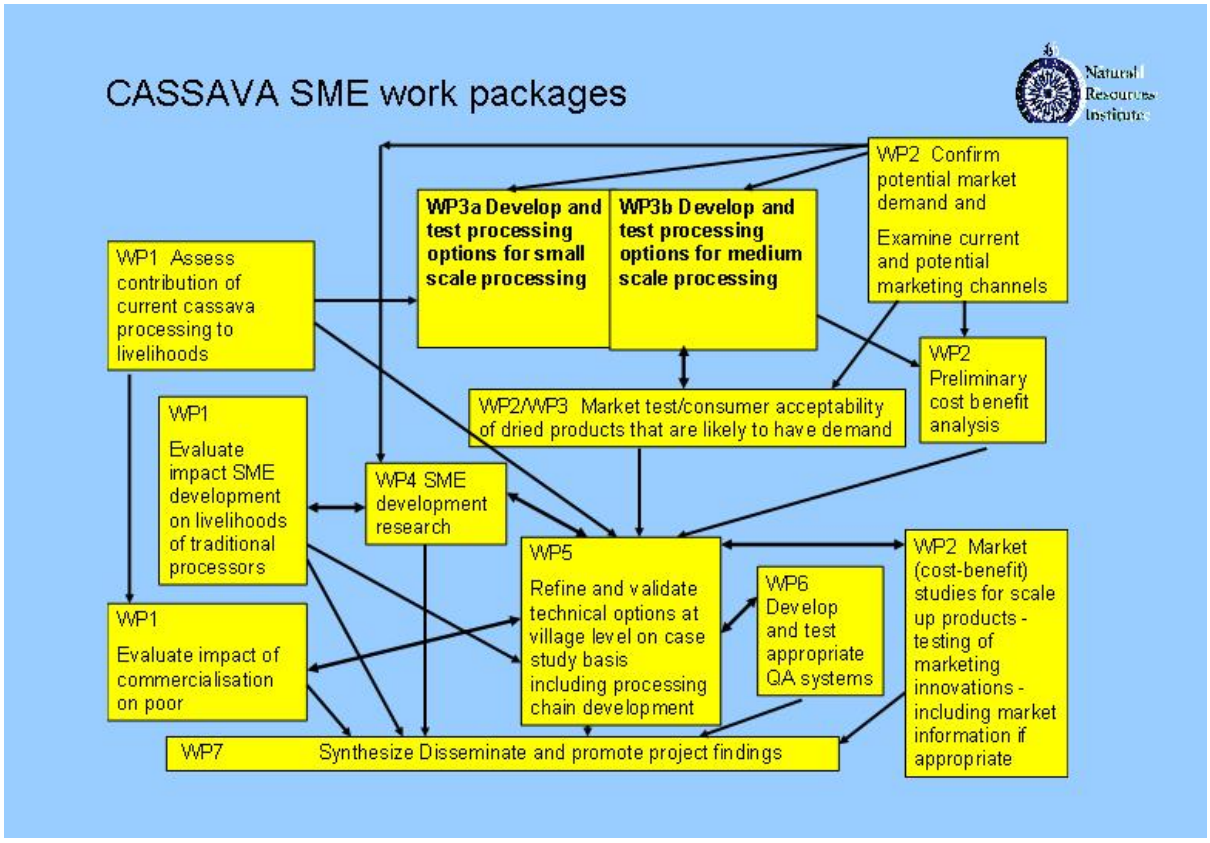


## Annex III Target Institution's workplan for adopting project outputs

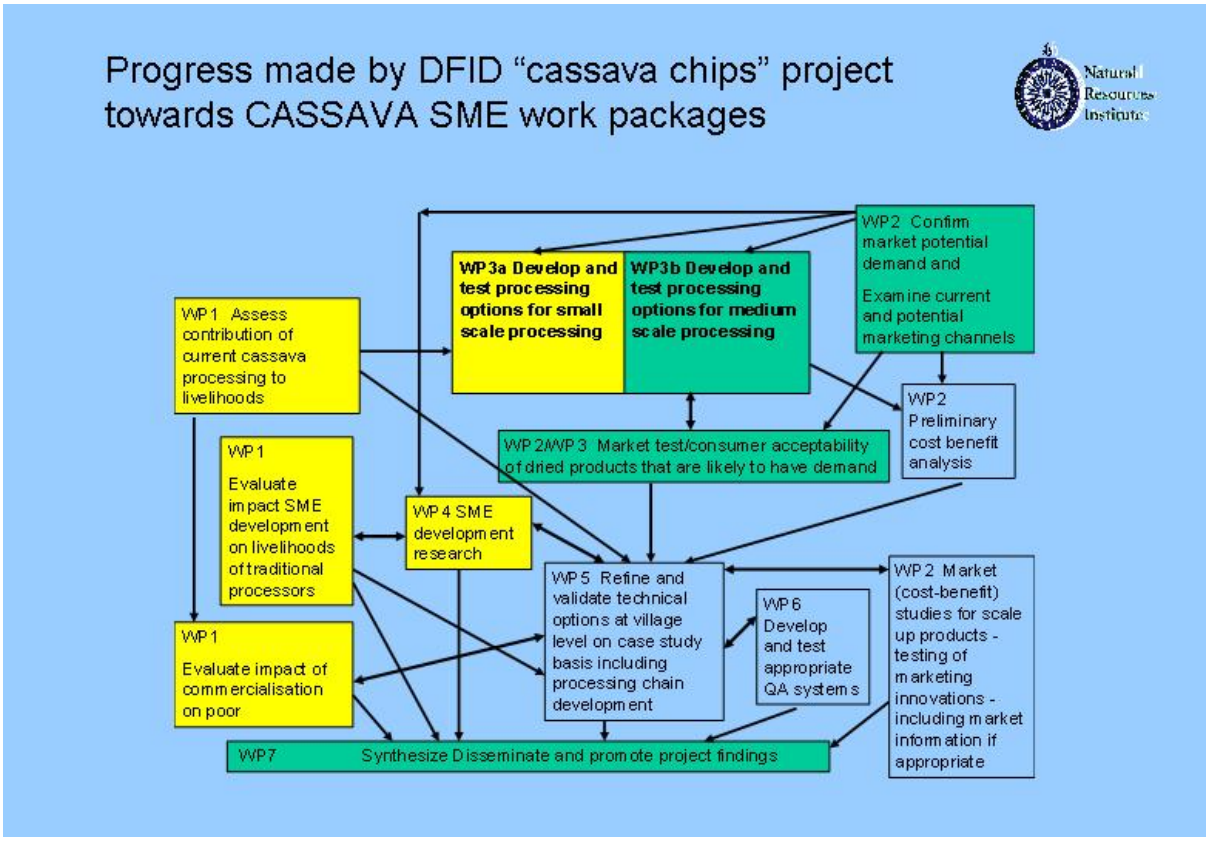
The adaptation of the project outputs is tied up with the implementation of the European Commission funded CASSAVA-SMES project.

In this respect, it is important to explain the relationship between this project R7495 and the on-going cassava-SMES project.

The work packages in the EC funded CASSAVA-SMES project are as follows:

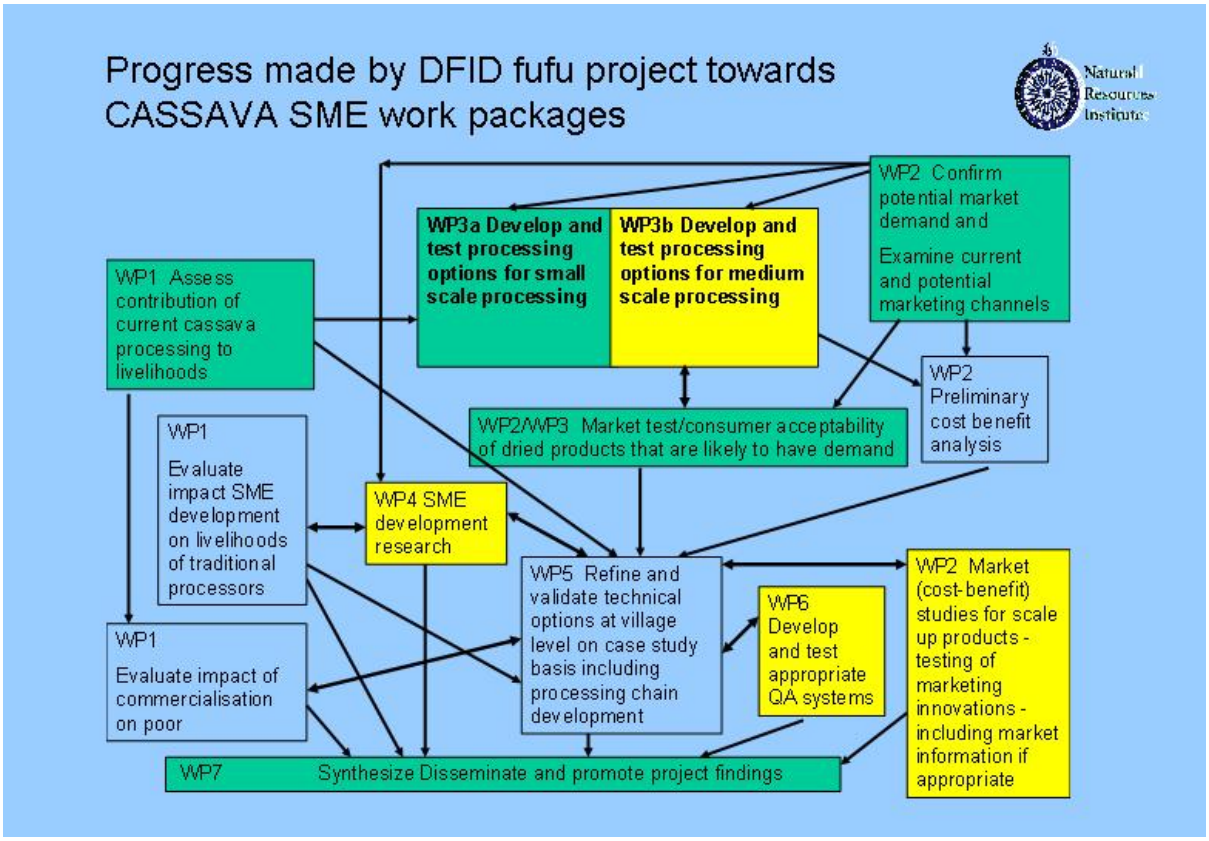


This project addresses the following of these workpackages in Ghana




Boxes highlighted in yellow are not covered in this project. Boxes highlighted in green show a major contribution and those in blue in lesser contribution. The aim of the CASSAVA-SMES project is to take up and use the outputs of R7580 in a more comprehensive regional project.

For information, this is how the related project R7595 contributes to the CASSAVA-SMES project in Nigeria.




The labelling scheme is the same as that used in the previous project.

**Annex IV** Feedback on the process from collaborating institution(s) and farmers

Project work on the EC funded CASSAVA-SMES project continues until December 2005. This project and that project are interconnected.

It is also important to look at the outputs in a wider context. Root and tuber crops research and development activities have greatly developed over the past 10 years. This project has formed a part of this process. The main change is that root and tuber crops research has become demand/market orientated. Professor Westby has played a main role in this process – partly in the guise of the Global Cassava Development Strategy (http://www.fao.org/ag/AGP/AGPC/gcds/GCS.htm). These changes were for example reflected in the nature of papers given at the International Society for Tropical Root Crops – Africa Branch meeting in Mombassa in November 2004. The international feedback on this work (as a part of a body of work) supported by the DFID Crop post-Harvest Programme is reflected in the following invited presentations


Westby, A., White, J., Ngendello, T., Oyewole, O., Dziedzoave, N.T., Graffham A. and Van Oirschot Q. (2001). Approaches for the development of small scale cassava processing and local food industries that meet the needs of the poor. In Pp. 9-12.. Root Crops: the Small Processor and Development of Local Food Industries for Market Economy. Proceedings of the Eighth Triennial Symposium of the International Society of Tropical Root and Tuber Crops: Africa Branch (ISTRC-AB), 12-16 November 2001. Edited by M.O. Akoroda. Ibadan: ISTRC-AB.

Westby, A. (2004) Linking farmers to markets with HarvestPlus focus commodities in Africa. Keynote invited paper presented at the Harvest Plus Challenge Programme Meeting on "Reaching End Users", May 2004, IPGRI, Rome.

Westby, A., van Oirschot, Q., Tomlins, K., Graffham, A., White, J., Gallat, S., Collinson, C., Ndunguru, G., Ngendello, T., Kapinga, R., Sanni, L., Ayinde, I., Mlingi, N., Adebayo, K., Johnson, P., Oyewole, O., Jumah, A. (2004) Innovative approaches for cassava R&D: Post-harvest in Africa Invited keynote presentation. http://www.ciat.cgiar.org/biotechnology/cbn/sixth_international_meeting/pdf_presentations/Andrew_Westby.pdf

Westby, A., Van Oirschot, Q., Tomlins, K., Ndunguru, G., Ngendello, T., Kapinga, R., Sanni, L. and Oyewole, O. (2003) Root and tuber crop post-harvest systems: lessons learned and future Interventions to contribute to food security and poverty alleviation. Invited thematic paper presented at the 13th triennial Symposium of the International Society for Tropical Root Crops, 8-15 November 2003, Arusha, Tanzania. http://www.istrcsymp-tz.org/ISTRC%20Presentation4.pdf

Westby, A. Van Oirschot, Q., Tomlins, K. Ndunguru, G., Ngendello, T., Sanni, L., Pessey, D.,and Oyewole, O. (2004) Bridging the gap between post-harvest technology development and commercialization of root and tuber crops in Africa**.** Invited thematic paper at the ISTRC-Africa Branch Triennial Symposium, 31 October – 5 November 2004, Mombasa, Kenya.

**V** List of publications

COLLINSON, C. and GALLAT, S. (2000) Project promotional leaflet.

COLLINSON, C.C., VANDYCK, G., GALLAT, S. and WESTBY, A. (2001) Urban market opportunities for high quality cassava products in Ghana. Poster submitted for the International Society of Tropical Root and Tuber Crops: Africa Branch, 12-16 November 2001, IITA, Ibadan, Nigeria.

COLLINSON, C.C., VANDYCK, G., GALLAT, S. and WESTBY, A. (2001) Urban market opportunities for high quality cassava products in Ghana. 198-199. Proceedings of the Eighth Triennial Symposium of the International Society of Tropical Root and Tuber Crops: Africa Branch (ISTRC-AB), 12-16 November 2001. Edited by M.O. Akoroda. Ibadan: ISTRC-AB.

COLLINSON, C., GALLAT, S., JOHNSON, P. and WESTBY, A. (2003) Estimating potential urban demand: a case study of the size of the Ghanaian domestic market for instant fufu. FOOD-AFRICA Internet forum. (Currently http://foodafrica.nri.org/conference/documents/internetpaperexample.doc )

WESTBY, A., WHITE, J., COLLINSON, C., KAPINGA, R. and GRAFFHAM, A. (2002) Matching the potential of root crops as commercial commodities with the needs of the poor. P. 14. In: *Proceedings of the Twelfth Symposium of The International Society for Tropical Root Crops: Potential of Root Crops for Food and Industrial Resources, Tsukuba, Japan 10-16 September 2000* Ed. M. Nakatani and K. Komaki. ISTRC.

**5. Internal Reports:**

ANON (2001) Background document: Commercialisation of traditional cassava products for growing urban markets. Workshop Background Document. pp. 8.

ANON (2001) Urban marketing study of high quality cassava products in Accra, Kumasi and Sekondi-Takoradi. Working Report. Accra: Research International/Natural Resources Institute. 111pp.

ANON (2001) Final report on processed and packaged cassava based foods market survey. Accra: Research International/Natural Resources Institute. 82pp.

COLLINSON, C., GALLAT, S. and JOHNSON, P. (2002) The potential size of the Ghanaian Domestic Market for Instant Fufu. Joint NRI/FRI report, NRI Report Number 2707, Chatham, UK. *pp.10*

JOHNSON P-N. and GALLAT, S. (2001). Summary of workshop held with small and medium scale cassava enterprises. Food Research Institute, Accra/Natural Resources Institute, Chatham. pp1

JOHNSON, P-N. and GALLAT, S. (2002). Review of cassava research achievements under the Crop Post Harvest Programme 1995 – 2002. Presentation at workshop for manufacturers and other stakeholders, Accra 29th May 2002

JOHNSON, P-N., GALLAT, S. and WESTBY, A. (2002) The economics of alternative drying systems for kokonte, and their effect on the microbiological and sensory properties of the product. Progress report, *Food Research Institute, Accra* 12pp.

JOHNSON, P-N., GALLAT, S., ODURO-YEBOAH, C. and WESTBY, A. (2002). Functional and sensory characteristics of instant fufu flour formulated from cassava starch and four high yielding Ghanaian cassava varieties (paper in preparation).

JOHNSON, P-N., GALLAT, S., ODURO-YEBOAH, C., and WESTBY, A. (2002). Functional and sensory characteristics of instant fufu flour formulated from cassava starch and four high yielding Ghanaian cassava varieties (paper in preparation).

JOHNSON, P-N., GAYIN, J., FEGLO, P and ESSEL, K. (2002). Baseline quality and safety management systems audit for Praise Export Services Ltd. *Food Research Institute, Food and Drugs Board, Accra. pp11*

JOHNSON, P-N., GAYIN, J., FEGLO, P and ESSEL, K. (2002). Baseline quality and safety management systems audit for Praise Export Services Ltd. *Food Research Institute, Food and Drugs Board, Accra. pp11*

JOHNSON, P-N., ODURO-YEBOAH, C., OSEI-YAW, A., GALLAT, S. and WESTBY, A. (2002). Functional, sensory and shelf life characteristics of instant fufu flour from cassava starch and cassava flour of four high-yielding Ghanaian cassava varieties (progress report, 20 pages).

JOHNSON, P-N., ODURO-YEBOAH, C., OSEI-YAW, A., GALLAT, S. and WESTBY, A. (2002). Functional, sensory and shelf life characteristics of instant fufu flour from cassava starch and cassava flour of four high-yielding Ghanaian cassava varieties. Progress report, *Food Research Institute, Accra* 64pp.

JOHNSON, P-N., ODURO-YEBOAH, C., OSEI-YAW, GALLAT, S. and WESTBY, A. (2002). Functional, sensory and shelf life characteristics of instant fufu flour from cassava starch and cassava flour of four high-yielding Ghanaian cassava varieties. *Food Research Institute, Accra* 64pp

WESTBY, A., WHITE, J., COLLINSON, C., KAPINGA, R. and GRAFFHAM, A. (2000) Matching the potential of root crops as commercial commodities with the needs of the poor. *Plenary session paper presented at the Triennial Symposium of the International Society for Tropical Root Crops, Tsukuba, Japan. 10-16 September 2000*

JOHNSON, P-N.T and ODURO-YEBOAH, C. (2001) Summary report on activities (Workshop with private sector, laboratory studies on dried fufu and kokonte. Project internal report. (7 Pages).

WAREING, P.W. (2001) Review: The application of HACCP to SME's in the processed root and tuber sector in Ghana (with specific reference to kokonte and fufu). Project Report. Chatham: Natural Resources Institute. pp. 12 (C).

**Other Dissemination of Results:**

ANON (2002) Development of the small and medium scale enterprise sector producing cassava based products to meet emerging urban demand in West Africa (CASSAVA-SMES). Project summary prepared for EC INDO-CAT 1pp.

WESTBY, A. and GRAFFHAM, A.J. (2000) Improving cassava processing - approaches for achieving impact in a new millennium. Invited special paper at the International Symposium on Tropical Root and Tuber Crops: Root and tuber crops - concerns and development strategies for the new millennium. Thiruvananthapuram, India. 19-22 January 2000.

WESTBY, A., WHITE, J., NGENDELLO, T., OYEWOLE, O., DZIEDZOAVE, N.T., GRAFFHAM A. AND VAN OIRSCHOT Q. (2001). Approaches for the development of small scale cassava processing and local food industries that meet the needs of the poor. In Pp. 9-12.. Root Crops: the Small Processor and Development of Local Food Industries for Market Economy. Proceedings of the Eighth Triennial Symposium of the International Society of Tropical Root and Tuber Crops: Africa Branch (ISTRC-AB), 12-16 November 2001. Edited by M.O. Akoroda. Ibadan: ISTRC-AB.

WESTBY, A. (2004) Linking farmers to markets with HarvestPlus focus commodities in Africa. Keynote invited paper presented at the Harvest Plus Challenge Programme Meeting on "Reaching End Users", May 2004, IPGRI, Rome.

WESTBY, A., VAN OIRSCHOT, Q., TOMLINS, K., GRAFFHAM, A., WHITE, J., GALLAT, S., COLLINSON, C., NDUNGURU, G., NGENDELLO, T., KAPINGA, R., SANNI, L., AYINDE, I., MLINGI, N., ADEBAYO, K., JOHNSON, P., OYEWOLE, O., JUMAH, A. (2004) Innovative approaches for cassava R&D: Post-harvest in Africa Invited keynote presentation. http://www.ciat.cgiar.org/biotechnology/cbn/sixth_international_meeting/pdf_presentations/Andrew_Westby.pdf

WESTBY, A., VAN OIRSCHOT, Q., TOMLINS, K., NDUNGURU, G., NGENDELLO, T., KAPINGA, R., SANNI, L. and OYEWOLE, O. (2003) Root and tuber crop post-harvest systems: lessons learned and future Interventions to contribute to food security and poverty alleviation. Invited thematic paper presented at the 13th triennial Symposium of the International Society for Tropical Root Crops, 8-15 November 2003, Arusha, Tanzania. http://www.istrcsymp-tz.org/ISTRC%20Presentation4.pdf

WESTBY, A. VAN OIRSCHOT, Q., TOMLINS, K. NDUNGURU, G., NGENDELLO, T., SANNI, L., PESSEY, D. and OYEWOLE O. (2004) Bridging the gap between post-harvest technology development and commercialization of root and tuber crops in Africa**.** Invited thematic paper at the ISTRC-Africa Branch Triennial Symposium, 31 October – 5 November 2004, Mombasa, Kenya.

**Dissemination outputs associated with CASSAVA-SMES where some activities are attributable to this project.**

Anon (2004) Development of the small and medium scale enterprise sector producing cassava based products to meet emerging urban demand in West Africa. Contact number: ICA4-CT-2002-1006. First Annual Report Covering Period from 1 January 2003 – 31 December 2003. CASSAVA-SMES project. 95 Pages.

Anon (2004) Development of the small and medium scale enterprise sector producing cassava based products to meet emerging urban demand in West Africa. Contact number: ICA4-CT-2002-1006. Six month activity report covering Period from 1 January 2004 – 30 June 2004. CASSAVA-SMES project. 19 Pages.

Johnson, P.N., Gallat, S and Westby, A. (2003) Sensory properties of instant *fufu* flour formulated from cassava starch and cassava flour of four high-yielding Ghanaian varieties. Poster presented at FoodAfrica International Working Meeting, 5-9 May 2003, Yaounde, Cameroon.

Westby, A. (2003) Traditional cassava foods for urban markets in West Africa. Keynote lecture at CASSAVA-SMES Project Inception Workshop, 24-28 March, 2003 at the University of Agriculture, Abeokuta, Nigeria.

Johnson, P. and Gallat, S. (2003) Development of Cassava Products for Urban Markets in Ghana. Presented at Project Inception Workshop, 24-28 March, 2003 at the University of Agriculture, Abeokuta, Nigeria.

A workshop was held in Nigeria (24-28 March 2003) to promote the project outputs to date and to develop the new CASSAVA-SMEs project into which the outputs from this project will sit.

**ANNEX VI** A catalogue of data sets and their location

The main datasets are the raw data from the market surveys and various laboratory and pilot plant studies of cassava processing. It is the project participants intention to make available in the public domain all of the data generated – either through making available project reports or through NRI's or the CPHP's web-site after due time has been given for the partners to publish their work either through international meetings or through peer reviewed journal articles.