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REVIEW

IMPROVEMENT OF RAPID CASSAVA PROCESSING METHODS AND TECHNOLOGY TRANSFER

Project: A0528

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ABBREVIATIONS

CBN	Cassava Biotechnology Network
FAO	Food and Agriculture Organisation
FSR	Farming Systems Research
HCN	Hydrogen Cyanide
NGO	Non-governmental Organisation
NRI	Natural Resources Institute
PRA	Participatory Rural Appraisal
RIPS	Rural Integrated Project Support
RALDO	Regional Agriculture Livestock Development Officer
RMO	Regional Medical Officer
TFNC	Tanzania Food and Nutrition Centre

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AIM OF THIS REVIEW

1. The aim of this review to summarise research and development activities on cassava processing in East Africa. The approaches taken by relevant projects that are currently underway in Tanzania, Uganda and Mozambique will be considered. These projects are used to highlight the fundamental issues concerning the development of appropriate technology and its successful transfer to end users. The review will be used as part of the development of a work programme for the improvement of cassava processing in Tanzania.

INTRODUCTION

Importance of cassava in the farming system

2. Bitter cassava varieties are an important staple crop in many drought prone areas of East Africa because they yield better than other staples under the prevailing environmental conditions (Essers *et al.* 1992). The designation of bitter or sweet varieties depends on the taste which is associated with the levels of cyanogenic glucosides in the roots (Sunderesan *et al.* 1987, Neville *et al.*, 1995). The bitter or sweet distinction is relative since roots can become bitter with increased cyanogenic glucoside levels because of environmental factors such as drought, pests, diseases, etc. The presence of the cyanogenic compounds in plants acts as a deterrent to predation. Farmers will continue to cultivate bitter cassava varieties as they recognise them as providing higher yields and as being more resilient to pest, diseases and theft (Thro, 1994).

3. Although the presence of cyanogenic glucosides may be considered advantageous, under exceptional circumstances, they have been implicated in reports of health disorders. The cyanogenic glucosides in cassava roots must be removed by efficient processing methods before consumption. Exposure to high levels of cyanogens[1] can cause acute intoxications (Mlingi *et al.* 1992), whilst consumption of low levels over extended periods have been implicated in chronic disorders such as aggravated goitre (Bourdox *et al.* 1978) and a paralytic disorder, konzo (Tylleskär *et al.* 1992). Outbreaks of disorders related to the consumption of insufficiently processed cassava typically occur during times of food insecurity whether due to edaphic or economic stress (Mlingi *et al.* 1992, Howlett *et al.*, 1992, Banea *et al.*, 1992) or where high cyanogenic varieties of cassava are introduced in the absence of appropriate processing methods (Westby & Bockett, 1996).

4. Whilst farmers prefer to maintain bitter, highly cyanogenic varieties, issues of food safety may only be addressed in the short term by providing consumers with processing techniques that will provide good quality products particularly during periods of food insecurity. Long term solutions lie in the development of acceptable "safe" varieties by plant breeders working together with farmers and end users (Rosling, 1987).

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[1] Collective term for the cyanogenic glucosides and their cyanogenic breakdown products, cyanohydrins and free cyanide.

Cyanogenic compounds in cassava

5. In order to rationally develop or improve processing methods, it is important to understand the biochemistry of cyanogen removal from cassava roots. In fresh roots, the cyanogenic potential consists of the glucosidic forms alone. However, when the root tissue is disrupted the endogenous enzyme linamarase comes into contact with the cyanogenic glucoside. This enzyme catalyses the hydrolysis of the glucosides to their corresponding cyanohydrins and a sugar molecule (Vasconcelos *et al.*, 1990). The cyanohydrins will spontaneously decompose at pH values above 5 to release volatile hydrogen cyanide (HCN) that is rapidly lost from the system (Cooke *et al.* 1978). The cyanogenic glucosides, cyanohydrins and HCN are collectively known as cyanogens.

6. The hydrolysis of the cyanogenic glucosides is assisted in lactic and fungal fermentations by root softening brought about by enzymes produced by the micro-organisms. Tissue softening facilitates the action of endogenous (and to a lesser extent exogenous) enzymes to degrade the cyanogenic compounds (Ampe & Brauman, 1995; Essers *et al.*, in press).

7. In understanding the factors that influence cyanogen removal, it has been shown that tissue disruption to hydrolyse the cyanogenic glucosides and efficient drying to volatilise the non-glucosidic cyanogens are key to efficient processing of cassava roots (Mlingi *et al.*, 1995). Efficient processing methods use tissue disruption to increase the removal of cyanogens.

The need for rapid processing methods

8. The reasons why health disorders occur have been the subject of recent investigations. Outbreaks of such disorders are usually localised and are usually the result of extreme conditions. Edaphic or economic factors that influence food security contribute to the problems of cassava food safety. For example, in Southern Tanzania drought resulted in severe food shortages. During this time the processing methods adopted were not the normal process taking 1-2 weeks process, but a method that provides flour in one day (Mlingi *et al.*, 1992). In Democratic Republic of Congo the construction of new road opened up new markets to rural processors. In order to meet demand, short-cuts to the routine processing method were taken (Banea *et al.*, 1992). Both of these examples indicate that problems occur when changes to the routine methods are made or when rapid methods are adopted in the need to provide food quickly. Clearly, there is a need for improved rapid processing methods that efficiently remove cyanogens from cassava.

9. A robust safety margin should be an in-built aspect of any improved method, whereby the most highly cyanogenic varieties may be processed effectively within the natural variations of practices that processors will use. These processing methods would then be appropriate for extension to farmers who have recently adopted high cyanogen cassava such as in some areas of Uganda or where adverse conditions have resulted in the dominance of bitter varieties as has occurred in Tanzania and Mozambique. Development of cassava processing methods will have to take into account consumer acceptability of both the end product and the method and overcome physical and labour constraints.

Efficient processing

10. Residual cyanogens can be reduced to negligible levels through efficient processing. The recommended limit of 10 mg HCN equiv./kg dry weight set by FAO in 1988 is achievable by the use of processing techniques that bring about a high degree of cellular disruption and thorough drying to a moisture content below 12 % (Mlingi *et al.*, 1995). Two examples of efficient processing methods are those used for "gari" that is produced in West Africa and "farinha de mandioca" produced in South America. These both include grating of fresh roots and toasting over a fire to produce roasted granules These methods result in products that have low residual cyanogen levels and vary in sensory characteristics due to the presence in the former of a lactic fermentation step.

Geographical focus of the project

11. The importance of cassava in the farming systems of East Africa has increased significantly due to its adaptability to marginal conditions. Unlike West Africa, where cassava (and its products) is accepted as an important staple and marketable commodity. In East Africa, the crop is considered a poor substitute for preferred crops such as maize and rice by rural, and in particular, urban consumers. Technologies that bring about improvements to quality and food safety may further improve the status of cassava products in the marketing system. The increased marketability of cassava may provide income generating opportunities for women who are the main contributors to the cultivation, processing and marketing of this crop.

CONSIDERATIONS IN TECHNOLOGY DEVELOPMENT AND TRANSFER

12. Cassava is important in providing food security to communities farming marginal agricultural lands. The development and transfer technology of technologies to these farmers/processors requires a knowledge of their resources, goals and attitudes. Resource poor farmers operate a diversified system of production in which food security and cash income intakes are crucial (Prah and Okeyo, 1989). Typically subsistence farmers are risk averse and therefore reluctant to invest in unfamiliar technologies which may require substantial changes in household resource allocation (Deuson and Day, 1990). Bearing these factors in mind, there are a number of factors that require consideration in order to bring about sustainable improvements to cassava processing technologies. These are detailed below.

Labour demand

13. A major factor affecting technology adoption is labour scarcity and the cost of hiring labour. The family/household provides most of the labour required in African farming communities (Prah and Okeyo, 1989). Labour investment in novel technologies is assessed against the returns obtained from its adoption. Several issues may be of importance here. In agro-processing activities women perform the majority of tasks. The importance of understanding the perceptions of women when assessing technology developments must be emphasised. In rural households where the work load is high, consideration of labour saving techniques is crucial. This is of particular importance during periods of food shortage when low calorie intake requires more time to be devoted

to rest. Seasonal peaks in the labour demand may also influence the adoption of the technology. The ability of new technology to transfer labour demand from peak to slack periods is a positive criterion for selection.

Availability of resources

14. Another important factor influencing technology acceptability is simply whether the end user possesses or has access to the capital to invest in the technology. Acceptance will depend on whether the returns on the investment exceed other opportunities. Risk aversion is a key coping strategy in marginal regions, farmers will assess the risk of using a technology in addition to a general conservatism in food habits.

15. Additional constraints to technology adoption may involve constraints in the physical environment. Processing may be hindered by adverse weather condition. This was found to be a constraint by processors that rely on sun-drying as a key processing step (Bainbridge *et al.*, 1994). Lack of resources such as water, firewood and other energy sources may also be considered a constraint. Technologies that can overcome these limiting factors will be positively assessed.

Important considerations for technology development summarised

16. New technologies must satisfy basic criteria if they are to be successfully adopted. They should (Bachmann, 1991):

- start from traditional systems and be adapted to the knowledge and skills of the local population
- use least the expensive processing techniques possible and produce food which can be afforded by people from medium and low income brackets
- use tools and equipment which are manufactured, serviced and repaired in the locality of their use
- use locally available, inexpensive energy resources which are, where possible, renewable and non-polluting
- recycle effluent and solid waste as far as possible thus avoiding pollution
- require formal and informal extension services in place to disseminate and monitor the spread of the technology.

Market incentives

17. Investment in a new technology is dependent not only on the additional inputs required but also on markets for the products. A technology that provides a product that has a potential or steady market niche and provides a profit incentive may provide a strong incentive to adoption. Processing technologies for agricultural commodities such as cassava can provide income generating opportunities in rural areas (Bachmann, 1991) as is the situation for cassava products in West African countries (Nweke, 1994).

CASE STUDIES OF CASSAVA PROCESSING TECHNOLOGY TRANSFER

18. The following section will provide a brief resume of each of the projects on cassava processing that are currently underway in Tanzania, Uganda and Mozambique. These projects can be considered as case studies which describe the circumstances that have led to the adaptive research and development of rapid cassava processing methods. Each case study provides a perspective on the different approaches adopted and lessons learnt. The table below summarises the current status of developments in the adaptive transfer of cassava processing in Tanzania, Uganda and Mozambique.

Table 1: Status of developments in adaptive transfer of cassava processing technologies (Sources of information are given in subsequent text).

Problems/ Opportunities	Tanzania	Uganda	Mozambique
Cassava safety problems encountered	Health disorders first reported in Southern and Lake Zones as a result of food insecurity In 1988 and 1984/5 respectively.	Occasional reports of health disorders, recently due to the spread of more highly cyanogenic varieties as a result of loss of ACMD susceptible, low cyanogenic varieties.	Widespread health disorders reported in the last decade due to severe food shortage and the loss of low cyanogenic varieties commonly used.
National Co-ordinating organisation for research and development	Tanzania Food and Nutrition Centre and the National Root and Tuber Crops Programme.	National Root and Tuber Crops Programme.	Ministry of Health.
Research and development in cassava processing	- Surveys undertaken to identify the underlying issues. - Critical steps in cassava processing studies completed.	- Needs assessment study undertaken. - Research and development of appropriate processing technology. - Participatory assessment of technologies with end users. - Impact assessment of technologies.	- Research and development of appropriate processing technology. (further details not known)
Dissemination of information/ technologies to end users	-Research findings and information on processing disseminated.	-Technologies ready to disseminate and develop through participation with end users.	- Widespread dissemination of technology. (further details not known)
Impact of technology transfer activities to date	Detail not known.	Technologies taken up by strong coercive women's group in pilot study areas.	Detail not known.
National policies in place concerning release of cassava varieties		Bitter cassava varieties to be released in areas where processing is practised.	

TANZANIA[2]

Background

19. There are four different zones that are the major producers of cassava in Tanzania, including the coastal, southern, Lake Tanganyika and Lake Victoria zones. In these cassava growing zones bitter and sweet varieties are distinguished by chewing small pieces from the peeled roots. The most common cassava processing method is direct sun-drying of peeled roots, but different types of heap fermentation are practised in certain zones. Products include *makopa* which is common in the coastal and southern zones, *udaga* in Lake Victoria zone, *baba* in coastal zone and *nyange* from Lake Tanginyika. The processing methods vary in their efficiency at removing the cyanogenic glucosides. However, it is generally considered that sun-drying is the least efficient method currently used (Mlingi *et al.*, 1995).

20. Typical of a region where cassava is a relatively new crop, processing technologies and utilisation practices in Southern Tanzania are limited. The predominant method used is sun drying of whole or split peeled cassava roots for over two weeks to produce a product known as *makopa.* The levels of residual cyanogens in *makopa* is dependent on the variety processed, environmental factors and the duration of sun drying and storage. Studies in Southern Tanzania have shown that sun-drying whole roots for two weeks into *makopa* reduced glucoside levels from 751 to 254 mg HCN equivalent per kg dry weight (Mlingi *et al.* 1995).

21. Masasi District in Southern Tanzania experienced severe food shortage in 1988 which resulted in an outbreak of acute intoxications attributes to insufficiently processed cassava. The established cassava processing method of making *makopa* was replaced by a short cut method which produces a product known as *chinyanya.* The rapid method provided flour within the same day by alternate pounding and sun drying of peeled cassava roots. Although this method was more efficient at reducing the cyanogenic glucoside content than *makopa* processing due to increased disruption of the cassava root tissue, the mean residual level of cyanohydrin remained high at 39 mg HCN equivalent per kg in the final *chinyanya* flours. This was attributed to short cuts in the drying time of the flour resulting in a high moisture content of 10-19% (Mlingi *et al.* 1992). Cyanohydrin levels in *chinyanya* can be reduced with sufficient sun-drying and/or the product stored at ambient temperatures to optimise the decomposition of the residual cyanohydrins.

22. The situation described above is not restricted to Southern Tanzania alone since Howlett *et al.* (1990) studied an outbreak of konzo in the Lake Zone of Tanzania. The factors leading to this incidence resulted in exposure to cassava cyanogens due to insufficient processing procedures adopted during food shortage. In this instance processors were practising a short cut method of solid state fermentation of cassava.

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[2] Source of information: Mlingi, N., 1995 PhD Thesis, Bainbridge, Z & Wellings, K., Final Technical Report on a Project to raise awareness to cassava processing and toxicity issues in southern Tanzania.

Dissemination of information on cassava processing

23. In order to raise the awareness of cassava farmers and the extension services to alternative cassava processing methods and the issues concerning the potential toxic nature of the crop, a project was funded by the ODA and implemented in southern Tanzania (Bainbridge *et al.*, 1994). Training workshops were held that involved the participation of the Extension Services of the Mtwara Region from regional to village level extensionists. Information concerning the cassava safety and health, the research findings obtained during studies in the region and the diversity of efficient processing methods used in Sub-Saharan Africa. A strategy for field testing and dissemination of this information to cassava farmers and consumers was developed and undertaken by extensionists. Improvement of cassava processing was integrated in to the Regional Household Sufficiency Policies. In addition, funds were obtained from UNICEF by the Region to continue the dissemination and adaptation of the technologies.

24. Dissemination of alternative technologies to the Region concentrated on *gari* processing. Both the farmers and extensionist felt that this had potential due to the favourable quality characteristics, flexibility of processing in all seasons and ready availability of resources. However, the increased labour demand for grating and the need for firewood were identified as limiting factors. Research is required to investigate and relieve these constraints.

25. A distance learning package to enable trainers of extensionists to disseminate information on cassava processing was developed and is currently in press (Bainbridge *et al.*, 1997).

Future work

26. The work that has been undertaken in Southern Tanzania has concentrated on identifying the underlying problems in processing cassava roots and on transfer of information. Processing methods that have been tested on the local varieties that have very high cyanogen levels requires further attention. In addition, consolidation of the technology transfer activities is required to further identify the potential role of improved products in the marketing system, develop further appropriate methods of processing, adapt these to the local conditions and evaluate their impact at household level and within the marketing system.

MOZAMBIQUE[3]

Background to dissemination of cassava processing technology

27. In 1981 there was an outbreak of more than 1000 cases of spastic paraparesis in northern Mozambique (Ministry of Health, Mozambique, 1984). Research was undertaken to identify the causes of this problem, the results of which strongly implicated insufficiently processed cassava and exposure to high dietary cyanide. Subsequent research has corroborated with these findings and the chronic disease has been named konzo. Severe food shortage, a reliance on bitter cassava varieties and lack of knowledge of safe and rapid processing methods where the cause of this outbreak. Those affected were rural farmers subsisting on marginal lands. Food shortage, social pressures and a lack of planting material resulted in the decline of commonly used sweet varieties and the predominance of bitter varieties. Suitable processing methods were either not known to the communities or normal practices were altered to meet immediate food requirements.

28. The method of processing cassava in the affected regions was direct sun-drying, whereby whole roots were peeled and dried whole or in split pieces. The product was known as *makaka*. Samples of dried *makaka*, contained mean cyanogen levels of 85 and 35 mg HCN equiv./kg dry weight for the bitter and sweet varieties respectively (Ministry of Health, Mozambique, 1984). In addition products of heap and soak fermentation were produced as minor products.

Research findings

29. The Ministry of Health Mozambique and the Dutch Government implemented a research project to develop and transfer a rapid method for processing cassava that would allow roots to be transformed to allow safe consumption within one day. Two methods were developed that were efficient at reducing the cyanogen levels from approximately 1000 to 10 mg HNCeq./kg dry weight. Illustrated in Figure 1, the first of these methods uses roasting, thus reducing the processing time. Alternatively, sun-drying was adopted due to the scarcity of fire wood in some of the provinces.:

Fresh cassava roots peeled and washed

↓

Roots grated using hand graters

↓

Cassava pulp heaped and left for 2 hours

↓

Pulp roasted
or sun-dried for 2 days **or until dry**

↓

Pound to a flour and store until required

Figure 1: Processing method for the *farina torrada*

[3] Source of information: Essers, S. 1995, Ph D Thesis; personal communication Ms A Gani, Ministry of Health, Mozambique.

30. Consideration was given to the poor resource levels of the households in the affected provinces. Using local materials, graters were built from small pieces of metal (35 x 25 cm) and later processors were encouraged to use empty oil tins. Sieves and baskets were prepared using local techniques, while pottery bowls were crafted for roasting.

31. In order to disseminate the technologies rapidly, a workshop for trainers was held, three participants were drawn from each of the five provinces. Each participant was provided with 500 pieces of metal sheeting and training on the construction of the graters, baskets and roasting bowls. Posters were produced that advertised the "safe" processing technologies in the local languages of the communities in the five provinces. Follow-up studies are currently being undertaken to monitor the uptake and correct application of the technologies.

Future work

32. The project continues to monitor and evaluate the impact of the technology transfer activities. Information concerning this phase of the project was not available to the authors of this report.

UGANDA[4]

Background to project

33. The project in Uganda was funded by the ODA as part of the Renewable Natural Resources Research Strategy. The project included in-part research and development of appropriate cassava processing technologies. A process approach was adopted whereby an initial needs assessment study was undertaken followed by processing technology development, preliminary development of improved equipment, technology adaptation with end users and monitoring and evaluation visits.

34. The research into improved processing methods for cassava was initiated following reports that the ingestion of fresh roots of certain improved varieties of cassava were causing health related problems. The widespread loss of commonly used varieties due to the African Cassava Mosaic Virus has lead to a shift in the cultivation to tolerant varieties some of which are bitter. To assess the extent of the problem and identify constraints farmers in two districts of Uganda were interviewed The major issues identified were: lack of awareness of relevant issues concerning "bitterness" and "toxicity"; and lack of knowledge of processing techniques that provide a food safety margin and can be achieved within a short time period.

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[4] Source of information: Westby & Bockett, G. (1996) Final technical report for Non-Grain Starch Staple Research and Technology Transfer Project in Uganda (A0302 and A0425) and associated reports.

Research findings

35. Development of improved processing methods was undertaken by means of on-station and on-farm trials. The most bitter roots available in Uganda were used with cyanogenic potential of <1000 mg HCNequiv./kg dry weight. A rapid processing method based on a South American method known as *farhina de manioca* was found to effectively reduce the cyanogenic potential to acceptable levels of 10-70 mg HCNequiv./kg dry weight within one day. The method involves grating fresh cassava roots, dewatering the pulp and roasting over a fire to form granules. This method is similar to that of *gari*, commonly used in West Africa but does not include a fermentation period and as such does not have an acidic flavour. Most importantly it can be undertaken within one day (refer to Figure 2). Research was undertaken to determine the optimum grating surface using readily available materials and the incorporation of a holding period prior to roasting to optimise the reduction of the cyanogen levels by endogenous enzyme activity.

36. The stages of the improved processing method were as follows:

Fresh cassava roots peeled and washed

↓

Roots grated by hand or mechanical graters

↓

Cassava pulp heaped and covered for a minimum of 3 hours

↓

Pulp dewatered and sieved

↓

Pulp sun-dried for 2-3 hours

↓

Partially dried pulp roasted to complete the drying process

Figure 2: Processing method for the "improved" *farinha de manioc*

37. The following points were made on the development of an improved processing method and feedback from the impact assessment studies (summarised from Westby & Bockett, 1996):

Engineering efficiency of the prototypes grating methods:

- Grating surfaces with a higher density of nails produce smaller particles.
- The pattern of nails and punches can influence the cyanogen content of the final farinha samples
- Graters which produce relatively smaller particles have a lower output.

General conclusions about the *farhina de manioca* method:

- The cyanogenic glucosides are hydrolysed by the action of endogenous enzymes which are released as a result of the grating.
- After a 3 hour incubation and dewatering, more than 90% of the cyanogenic glucosides had been hydrolysed to release the non-glucosidic cyanogens.
- Ninety eight percent of the non-glucosidic cyanogens were removed during the dewatering step and roasting.
- The cyanogenic content of farinha samples representing a 97 % reduction of total cyanogens was generally below 30 mg CN eq/kg dry weight and mostly in the glucosidic form.
- The roasted product consisted of very fine cream coloured particles.
- Moisture levels in the dewatered pulp were between 40 to 20 % (optimal for roasting) and approximately 12 % in the roasted flour.

Dissemination of the method

- Critical points to note include: *a fine grater and thorough roasting are crucial in producing a safe product*; timing of each step in the process is also very important.
- Creating awareness and training farmers and artisans in the new technique and especially in manufacturing the graters is essential.
- Regular follow-ups should be made in order to monitor a possible spread of the new technology.

38. The method of producing *farinha de manioc* was demonstrated to members of women's groups in three case study villages in one District of Uganda. Sufficient training was provided to enable the processors to undertake the method without further input from the researchers. A follow-up was made two months after the initial demonstration. It was found that there were three distinct scenarios emerging.

Case study No. 1. A well organised progressive women's group with strong and coercive leadership. Some degree of adoption of the technology and some interesting innovations to help contextualise the technology. Highly probable that group members will continue practising the new method. This group was followed up in more detail and this is presented below.

Case study No. 2 . An informal group of independent, individual refugees, with highly conservative food habits and preferences. They had an effective current processing technology - both for slow and quick processing which resulted in complete rejection of the new technology as there was no need to change processing practice.

Case study No.3. An informal group of rural processors from the small scale farming sector. Relatively conservative food habits and preferences. Current cassava processing practices included fungal fermentation. Insufficiently motivated by the demonstration exercises to think of ways of using it given the equipment that they have available. This is despite the fact that the farmer with links with the cassava research programme, had apparently managed to undertake processing with improvised equipment. Although it is not impossible that they will try to use the technology, the probability is very low unless they are provided with some external stimulus.

Excerpt from Westby & Bockett, 1996

Technology transfer impact assessment

39. It was the opinion of the research team (Westby & Bockett, 1996) from the findings of the needs assessment and follow up work that successful uptake of the technology is most likely to occur where there is a strong coercive force as in case study one, however, the typical scenario of low uptake would be represented by case study three.

40. The limited uptake of the method was not due to technical aspects of the *farinha de mandioca* process alone. It seemed that the greatest constraint was the lack of desire or need to change current practice and not the lack of ability to innovate and undertake the new processing method. Additional contributing factors to the poor uptake of the technology included: the high labour demand although over a short period of time and the distinct differences in characteristics of the improved and current process. It was felt by the author that although ability to process in one day would have an important advantage during periods of food shortage, that the general uptake of the technology would depend on the real needs for alternative processing methods.

41. However, two scenarios were identified where technology uptake would be high. In case study one, a possible niche for the *farinha de manioc* technology was identified amongst the more progressive and better resourced rural processors. In addition, the rapid processing of bitter roots was considered a constraint especially during food shortage. Identification of areas where the later scenario existed would address the problems of a wider cross section of rural processors. The results of this study emphasise the importance of needs assessment surveys to identify areas and groups where there is no traditional processing of "bitter" roots, but where these are being introduced.

Future work

42. The processors have indicated the need for further adaptation of equipment to meet their own needs. Adaptive research continues on the development of mechanised graters and transfer of technology to areas where new, potentially bitter varieties are introduced to areas where processing is not practised. Information leaflets are currently being developed that can be disseminated to the extension services and NGOs active in disseminating planting material for improved cassava varieties.

KEY POINTS

43. To summarise, the key points in development of cassava processing technologies, highlighted from the experience obtained during the implementation of the case studies covered are listed below.

- It is important to identify processor groups that are constrained in processing bitter cassava roots and thus have a need to improve their current processing techniques. It is important to stress the critical processing steps that ensure good product quality.

- The process of technology transfer is facilitated by identifying and working with processor entrepreneurs that have recognised a market niche for the rapidly processed cassava products.

- Technology development through effective participation with key target groups, where farmers are encouraged to formulate ideas and innovations to processing, will ensure the development of appropriate processing solutions.

- It is crucial to develop appropriate processing methods by taking into account labour saving devices and the use of readily available cheap resources.

- Novel processed products must have quality characteristics that are acceptable to consumers including taste, texture, food safety, cookability and storability. Priority should be given to modifications to improve the food quality of currently processed products.

- Monitoring and evaluation must be an important feature of the technology development process, this will allow the ideas and innovations of the processors to be fed back into the process.

SUMMARY

44. This review has enabled key points to be identified that will guide the research and development of rapid processing techniques for bitter cassava varieties in marginal regions of Tanzania. The focus of the research will be the development of methods appropriate to household that are constrained by time consuming and inefficient processing of cassava and also the development of products which are marketable and provide income generating opportunities.

45. The following section provides a summary of the research strategy for the first year of the ODA funded "Improved cassava processing in Tanzania" project. It has been developed bearing in mind the findings of this review.

PROPOSED STRATEGY FOR ADAPTIVE RESEARCH IN CASSAVA PROCESSING FOR TANZANIA - 1996/97

46. The project will address the need of improved rapid processing methods for cassava roots. A process approach will be used that takes into account the key issues from the case studies covered in the review.

SITE SELECTION FOR PILOT STUDY

47. The objective is to identify households, entrepreneurs, women's groups and missionary groups that have a need for improved processing. The information obtained will be used to focus the pilot study towards those groups that have an interest and requirement for improved rapid processing methods.

48. The specific aims of the study will be to:

- follow up pervious interventions on the introduction of new processing methods by the extension services;
- characterise the cassava processing techniques currently being used and product qualities required;
- identify groups of women that will be interested in improved and new processing methods;
- identify 3 pilot areas that would be willing to participate in the evaluation of improved and new cassava products and their processing methods.

49. Three villages in each district will be surveyed using participatory rural appraisal (PRA) techniques. Information on cassava processing of bitter cassava roots, rapid methods used and reasons for using them, limitations of current practices and ideas for improving processing will be covered. Marketing chains for cassava products will be followed and characterised, information on seasonality of cassava marketing, price fluctuations, stakeholders in the system, profit margins etc will be obtained.

50. Advice will be obtained from the Regional Agriculture and Livestock Development Office (RALDO), Farming Systems Research Group at Naliendele, Rural Integrated Project Support (RIPS) Programme and the Regional Medical Officer (RMO) on site selection and approach to be adopted. The team will include members with local knowledge and language abilities. Secondary information will enable three representative areas to be selected. Geographical, food security, ethnicity, involvement in marketing and access to markets will be considered. The following criteria will be used for selection of those villages/groups that will be involved:

- villages where previous processing methods have been introduced
- villages where the use of rapid processing methods are commonly used and the prevalence of bitter varieties is high;
- villages with organised women's groups;
- access to markets and involvement in marketing of cassava products
- presence of missionary and NGO enterprise groups;
- presence of the RIPS Programme village artisan project.

ON-STATION CASSAVA PROCESSING TRIALS

51. Processing trials will be undertaken on-station to investigate the safety margin of a rapid processing method commonly used in the Mtwara Region. Improvements to current practices by the incorporation of the following treatments will be investigated with respect to the reduction of cyanogen levels:

- influence of drying time of grated and pounded roots;
- incorporation of an short incubation period prior to drying of grated and pounded cassava roots;
- incorporation of a fermentation period of 12 and 24 hour prior to drying;
- a comparison of roasting and sun-drying as a means of dehydrating grated and pounded roots.

52. Fresh cassava roots will be obtained from local farmers. The roots will be of bitter varieties as perceived by the farmer. Three bitter varieties will be used in the study and five replicates of each. This will allow analysis of variance.

53. Through discussions with the RIPS Programme Co-ordinators, consideration will be given to undertaking some of the trials on-farm in order to obtain the preliminary evaluation of the technologies and concepts of detoxification.

54. The trials will provide definitive information concerning the efficiency of current and improved processing methods. Recommendations will be made on how best to undertake the acceptability of the products and on-farm evaluation of the technologies.

55. Analysis will include: cyanogen content; dry weight determination; pH; water activity

CONSUMER ACCEPTABILITY STUDY

56. Those products of processing technologies that are validated and shown to be efficient in the removal of cyanogens will be tested for consumer acceptability. Consumers from a range of tribal groups will be requested to evaluate the products. This will provide information on the variation of preferences in terms of product quality and taste and will allow a more strategic approach to the adaptation and evaluation of the processing methods.

57. Evaluation of the products will include cooking of *ugali* (cassava flour paste) and tasting of the product as it is normally consumed. Characteristics that have been mentioned as important will be scored using PRA techniques. Advice on the approach will be obtained from the RALDO, FSR and RIPS.

58. On-farm testing and adaptation of cassava processing technologies and equipment that are found to provide acceptable products will be undertaken in the following financial year.

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