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The use of needs assessment methodologies to focus technical interventions in root and tuber crop post-harvest systems: A case study to improve the marketing and post-harvest handling of cassava entering Dar es Salaam, Tanzania

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ABSTRACT

The accurate targeting of research and technology transfer strategies within root and tuber crops post-harvest systems is essential to ensure that developmental funds within national programmes are used to maximum advantage. Needs assessment studies have important roles to play in initially defining problem areas. Such procedures must be cost effective and generate genuine information quickly and efficiently.

This paper describes the use of an urban demand/needs assessment strategy to define the problems evident in the marketing of fresh cassava roots in Dar es Salaam, Tanzania. By examining secondary data and collecting primary information from key participants in the marketing chain, the principal constraints and sources of cassava wastage within the system were identified as were opportunities for possible technical interventions.

As a result of these assessments, a more detailed case study was undertaken to quantify the losses of cassava within the system and, thereafter, an adaptive technology transfer programme was initiated to test, adapt and later disseminate elements of the low cost

ambient storage technology derived from protocols developed by the Centro Internacional de Agricultura Tropical (CIAT) and the Natural Resources Institute (NRI). Observations made suggest that the adoption of the ambient storage techniques will help reduce financial losses (both physical and financial) to the benefit of producers, marketing agents and consumers.

INTRODUCTION

For centuries in sub-Saharan Africa, a spectrum of root crops has supported and contributed to the nutritional requirements of both rural and urban communities. With increasing populations, the role of root crops is destined to become even more critical, not only to provide sustenance, but also as a vehicle by which those involved in the production and trading of these commodities can generate income. The present and future challenge is to tally possible improvements in the productivity of root crops on the farm with more efficient post-harvest handling systems that will minimise wastage in terms of physical loss, quality depreciation and monetary value.

The work presented here forms part of an Overseas Development Administration funded Regional Africa project entitled "Transfer of Needs Assessment Methodologies and Post-Harvest Technologies for Non-Grain Starch Staple Food Crops in Sub-Saharan Africa". The project is managed by the Natural Resources Institute (NRI) and the Tanzania Food and Nutrition Centre (TFNC) is the counterpart organisation for East Africa. One aspect of the project is the validating of needs assessment methodologies through case studies and the follow though of these studies with technology transfer activities. The results presented here demonstrate this approach and its benefits. In this case study, work commenced in 1993 to address the following issues:

(a) to examine typical marketing systems for cassava which link areas of production with urban markets;

(b) to assess the major needs and opportunities for greater efficiency within these post-harvest systems;

(c) to assess the level of losses and quantify the depreciation of fresh cassava entering urban markets;

(d) to validate and assess the feasibility of using modified handling techniques to ameliorate losses within the system; and

(e) to adapt and disseminate appropriate post-harvest handling methods to key individuals and organisations.

BACKGROUND

Cassava (*Manihot esculenta* Crantz) together with potato, sweet potato, cooking banana and plantain are the main non-grain starch staples in Tanzania. The production of cassava has tended to fluctuate over the last 8 years for which data are available (1985/86 to 1992/93), but overall production increased by 17.5% over the period (Ministry of Agriculture, 1994). For many, cassava represents food security and an inexpensive source of daily calories particularly for those in low income groups.

In Tanzania, and especially in urban areas, cassava is consumed mainly as a fresh cooked product. Significant quantities of cassava are also processed in rural areas. Traditionally, cassava is grown as a domestic, subsistence crop for home consumption. Trends in urbanisation, however, have opened up a new and growing demand for fresh cassava in towns and cities. With high urbanisation rates, for example the population of Dar es Salaam was considered in 1992 to be expanding at 4.5% per annum (Government of Tanzania), the demand for cheap staple produce such as cassava is expected to rise considerably in the years ahead. This will place even greater strains on current marketing systems; a problem exacerbated by the perishable nature of fresh cassava itself.

METHODS

Needs assessment study

The first stage of the study was the identification and characterisation of marketing channels. Urban markets were selected on the basis of their role and function in the marketing system, with a cross section of major wholesale/retail markets (such as Kariakoo, Tandale, Tandika and Buguruni) and smaller retail markets (such as Urafriki and Ubungo). The major supply areas were identified on the basis of information provided by market traders. The study focused on the marketing chain between Kisarawe District in Coast Region and Dar es Salaam, which is an approximate distance of 30 kilometres.

Secondary information, collected to supplement and support the primary data, included that concerning market prices, production and household expenditure. The sources of this information included the Marketing Development Bureau, the Bank of Tanzania and the City Council.

Primary data collection was largely based upon individual and group interviews (methods described in IIED 1995) with purposively sampled representatives at key stages of the marketing chain. Key informants included: consumers, market masters, retailers, wholesalers, cooking vendors, country buyers, village traders and farmers. The number of informants with which discussions were held was judged on the basis of ensuring the information collected was deemed consistent and valid. The survey team consisted of two food scientists, one marketing economist and one socio-economist.

Check lists of key issues were prepared for each of the informants identified. Observation was used as a key tool to cross check information elicited during the interviews and as a means of facilitating discussion with interviewees.

The outcome of the needs assessment study (Ndunguru *et al.* 1994) was presented at a national project co-ordination workshop. As a result, potential post-harvest interventions were identified and a number of sub-projects initiated. One of these was to reduce the losses of fresh cassava which occurred during marketing.

Loss assessment case study

In order to measure and confirm the extent of post-harvest losses of cassava in the market environment, data were gathered from consignments of cassava delivered to an urban market situated to the north of central Dar es Salaam. Where possible, the number, size, source, age and varietal content of cassava consignments were determined on a daily basis. Records of unit (sack) weight, pricing profile of units over time (0-48 hours), size distribution of roots recovered from sample sacks, and an assessment of external damage and internal quality of the roots were also monitored. Natural splits, insect bore holes, bruised skin (not broken), gashes, sharp cuts and ragged tears were the categories of wounds observed most often. Note was made of their frequency and location relative to the stem and distal end of the root and finally the incidences of superficial rots were also recorded.

The internal condition of roots was assessed by scoring their cortical tissues for five different characteristics: physiological deterioration, physiological browning, evidence of internal microbial rots, extent of dry corky tissue and potential sale category as defined by market traders. Scores taken from sections along the root were used to determine which part was more prone to damage.

Baseline data on quality and losses was collected over a 3 week period. Routinely, sample sacks were chosen randomly, weighed and their contents examined in detail. Both the external and the internal condition of the roots were assessed at this time (1-2 days after harvest). For comparison purposes, additional sacks were purchased and held back for a number of days prior to inspection. In this way, it was possible to determine the likely rate of quality depreciation over time (from 2-8 days).

Low-cost fresh cassava storage technology

In the 1980's, as an alternative to traditional techniques, a project initiated by the Centro Internacional de Agricultura Tropical (CIAT) and the NRI developed a simple conservation strategy based on cassava root storage in polyethylene bags combined with a chemical treatment to control secondary microbial (fungal) rotting. Storage times of two weeks or more were achieved. This was sufficient to permit the provision of fresh, high quality product to consumers and for at least one week at home storage. This system proved suitable for the marketing of cassava in Latin America. In recent years, NRI in collaboration with the Ministry of Food and Agriculture has worked to adapt the technology to conditions in Ghana.

The original CIAT/NRI technology consists of harvesting and selecting high quality, relatively undamaged roots from low cyanide cassava varieties. The roots are washed or cleaned and then dipped or sprayed with the fungicide, thiabendazole, which is widely used as a post-harvest treatment for banana and potato. The drained roots are then placed in polyethylene bags that are sealed. The environment within the bag as a result of root respiration is characterised by high relative humidity and high temperatures, which permit root curing thereby promoting an extension of shelf life (CIAT, 1989).

Experience gained in Ghana suggests that, for most practical purposes, simply dipping sound roots in water and maintaining them at high humidity for several days in the shade will extend the useful shelf-life of fresh cassava for periods of 7 to 10 days without the necessity to use fungicide.

Validation of modified handling methods

Three storage trials were conducted during the period of November and December 1994 to demonstrate the feasibility and potential of different elements of the cassava storage technology. The first was conducted on two day old cassava to illustrate the ability of high humidity and fungicide (thiabendazole - Reg. Product STORITE) treatments to prolong the storage of fresh material for periods of one to two weeks. With the help of local wholesale agents, two further market based demonstrations were carried out to show the effectiveness of different elements of the storage technology. A five day investigation highlighted the contribution of shade to diminishing the rate of cassava deterioration and finally cassava traders were introduced to the concept of creating a cassava clamp using polyethylene sheets to conserve sacks of cassava in the open market. The internal conditions of sample roots derived from a range of different storage treatments were assessed at the end of each trial and categorised using several measurements, including their likely market value. Table 1 illustrates the experimental approach adopted throughout the trials.

Adaptation and dissemination strategy

The most appropriate means of disseminating improved handling and storage methodologies are considered to include three main areas of interaction. The first involves teaching representatives of those organisations that already have a remit to transfer knowledge and technical expertise to personnel working in the agricultural sector. The second area is that of direct interaction with individuals and communities involved in the production, trading and sale of cassava and cassava products. The third area of activity is to seek to publicise activities through various forms of mass media. Table 2 summarises the main elements of the dissemination campaign that is now (October 1995) being pursued.

Monitoring the effectiveness of the dissemination initiatives is an important element of the on-going work programme. By continually assessing the level of success and acknowledging failures, the Project seeks to refine its dissemination activities and remain flexible to new developments and opportunities. Activities monitored to this end include: the number of active trainers; the number of demonstrations organised by each trainer over a given period; the number of individuals within the community or market adopting and practising the storage methodologies over an extended period of time, and the periodic monitoring of key informants to assess their experience of the technology over time and under different marketing conditions.

RESULTS AND DISCUSSION

Needs assessment study

A schematic representation of the marketing chain from the producer to the consumer is shown in Figure 1. Representatives of each of the participants in this chain were interviewed and the system thereby characterised. This information is detailed in Ndunguru *et al.* (1994).

The needs assessment study confirmed that the cassava was mainly consumed in Dar es Salaam without processing. Fresh cassava is consumed in one of three forms: steamed/boiled, deep fried or roasted, with boiling the most common. The most important quality criteria as defined by consumers are summarised in Table 3.

The performance of the marketing system was assessed in two ways. The first examined marketing margins which, when combined with the information gained from each of the various marketing agents, may offer an indication of economic performance. The second assessed post-harvest losses throughout the marketing chain. Marketing margins are detailed and discussed in Ndunguru *et al.* (1994) and are not further discussed here.

The potential post-harvest losses are indicated by the consumers' quality criteria described in Table 3. Time is a key factor in all the quality changes. The level of price discounting associated with age is presented in Table 4 for each stage in the marketing chain. The quality changes associated with time include discoloration, mould growth and withering.

At the farm level, delays were associated with unreliable transport and were reported as a problem by farmers and village traders. Country buyers, who are often urban based, hire their own transport and largely circumvent the problem of relying on truck operators or buses. At the urban market, delays in selling produce were found to affect country buyers, village traders and farmers. The absence of an end user with predictable and regular requirements appears to contribute to the uncertainty of predicting market demand on a daily basis.

One of the conclusions from the needs assessment study was that there is significant price discounting for old cassava. Delays were possible at various stages in the marketing system. It was recognised that the needs assessment study only provided an indication that losses were an issue and a more detailed assessment of loss was recommended. If this study confirmed the losses then the possibilities for extending the shelf life of cassava should be examined.

Post-harvest losses evident in Dar es Salaam

Detailed statistical analysis of the results of the loss assessment exercise is still required. However, the principal results of the case study indicated that the perishability of fresh cassava was a major factor dictating both production and marketing strategies.

In the absence of other storage methods, for the producer there is the option of retaining roots in the ground for a period following their optimal maturity. This may be a useful and sometimes necessary alternative to marketing; however, ultimately the central cortex of the cassava will become fibrous, corky and prone to rotting so diminishing the quality of the roots when ultimately offered for sale. Once harvested, neither transporters, traders, wholesalers nor retailers generally practise options that would help conserve the quality of the roots and those handling fresh cassava usually rely on a rapid turnover of produce before physiological deterioration degrades the quality of their produce. In most instances the greater proportion of roots delivered to the market are damaged to some degree that accelerates the rate of root deterioration. Much of this damage results from poor harvesting practice and could be either avoided or diminished.

In most instances deterioration becomes increasingly evident after 3 days and with the passage of time market traders could recognise some five categories of root quality:

- those with a premium price;
- those saleable at a discounted price;

- roots sold for makopa (dried cassava pieces) production;
- roots used for animal feed; and finally
- roots with extensive rots that retained no value.

In the markets trading cassava in Dar es Salaam, prices are extremely volatile with dramatic changes reflecting the balance of supply and demand over time. When cassava supplies are abundant, unit prices fall and customers demand cassava of the highest quality. Conversely when cassava is in short supply, prices rise and wholesalers and retailers are still able to sell their produce despite the fact that the produce may show signs of advancing physiological deterioration.

Impact of the low-cost cassava ambient storage technology

In general, observation of the external condition and the incidence of superficial damage to cassava roots fails to provide a reliable impression of the physiological quality of the internal tissue of cassava roots. Only by dissection can the quality of the roots be determined. An assessment of material recovered from the storage trials suggests that uncleaned/undressed roots have a much less wholesome appearance when recovered from store. Treatment with STORITE is able to ameliorate this to a certain extent but such a process represents an expensive option in comparison to storage in ordinary sacks alone. Table 5 provides an indication of the variable scores recovered from roots stored under different conditions.

The mean score values show quite clearly the benefit of shade and fungicide treatment on the physiological condition of roots stored for 8 days. In comparison to roots stored in the open market under the sun, cassava treated with STORITE and held in a clamp showed no microbial deterioration. Scores given by market traders indicated that cassava retained in the market outside the storage clamp was unlikely to be used for anything other than animal feed whereas material recovered from the clamp was considered to be of almost the same grade as fresh roots. The present results indicate that post-harvest treatments had no great impact on either the level of secondary browning or incidence of dry desiccated areas within the cortical tissue of stored cassava. Provided cassava consignments are relatively free from serious physical damage or have had such damage components cut away, storage in sacks under plastic or canvas tarpaulin will extend the storage life of the produce by 4 to 5 days at least. Under normal circumstances, the use of the fungicide STORITE can be circumvented unless cassava consignments need to be stored for periods in excess of 10 days. This is not a normal requirement at the present time.

Cognisant of the limited financial resources available to the cassava traders and retailers, a judgement of the feasibility of the cassava storage technology focused on the likely provision of water, man-made fibre sacks and polyethylene sheeting (the routine use of the fungicide, thiabendazole, was not considered to be a viable option at this stage). All these materials are essentially available to those working in or from the urban markets at affordable prices and hence, from a purely technical point of view, the methodologies have the potential to make a considerable impact on the storability of fresh cassava. For the practices to be adopted successfully, much will depend on a sensitive dissemination campaign to demonstrate the benefits of modifying existing handling practices. To this end a programme of activities has been established whereby TFNC staff will work with harvesters, traders, commissioning agents, retailers and street vendors, all of whom could implement some of the elements of the technology to their own advantage.

Dissemination strategies

The low cost storage of fresh cassava technology was demonstrated to a group of traders at one of the large markets, Tandale. Nine traders were involved in the exercise that was participatory in nature. One to two days old cassava roots were purchased in the market for demonstration. Traders were shown on how to grade the roots, clean and treat them with water and thiabendazole. Treated roots were stored in either polythene bags, hessian bags or both. The roots were sampled weekly and scored for physiological condition, microbiological quality, browning and desiccation for three days, after which data were analysed. Materials used included fresh cassava, polyethylene bags, hessian bags, water, thiabendazole, knives and weighing scales.

At the end of the demonstration, it was found that cassava could be stored more than twenty days at the market. Traders have started using the technology, though not using the chemical thiabendazole but water alone. Regular follow-ups visits are being made to the traders in order to monitor the adoption of the technology.

CONCLUSIONS

A needs assessment study using rapid rural appraisal was used to identify problems and opportunities in the cassava marketing chains in Dar es Salaam. Losses as a result of the delays in the marketing chain were identified as a major issue and a programme of adaptive technology transfer of elements of the low cost cassava storage technology were initiated.

All the various elements of the cassava storage technology (shading, wound-dressing, high humidity storage - afforded by the use of polyethylene bags or a clamp established underneath plastic sheeting or canvass, and the optional use of thiabendazole (STORITE) as a fungistat) showed considerable benefits relative to control treatments. Observations also indicated that some categories of small and damaged roots formerly excluded by the CIAT protocols can be stored successfully for a week under Tanzanian conditions. This is important as small roots and cassava pieces even of poor internal quality are sought by certain client groups.

The trials conducted in the market alerted the cassava merchants to the possibility of storing cassava for periods of at least a week even without recourse to chemical controls. The lessons learnt in the market need also to be promoted further down the chain towards the retailer and street-vendor where small scale temporary storage of cassava in plastic bags is also likely to prove beneficial. At the producer/trader end of the marketing chain, benefits will also arise from improved harvesting techniques. It is suggested that a great deal of the damage seen on roots arriving in the market could either be avoided by changes in harvesting practices or their effects otherwise diminished by simple wound-dressing in the field prior to sack filling.

The conclusion of the work to date is that technically the elements of the cassava storage protocol, applied either as a composite set of operations or treatments applied in series, have the potential to increase the storage life of cassava roots entering the urban centres in Tanzania. Whether the system as a whole is "feasible" is unlikely to depend so much on the availability or otherwise of the materials or labour necessary to carry out these procedures but rather whether individuals and groups are sufficiently motivated to change their existing handling practices.

In general terms, this programme of work has demonstrated how the use of relatively low cost needs assessment techniques has led to the adaptation of a known post-harvest technique to the demands of the marketing system in Tanzania.

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Figure 1. Fresh cassava marketing chain

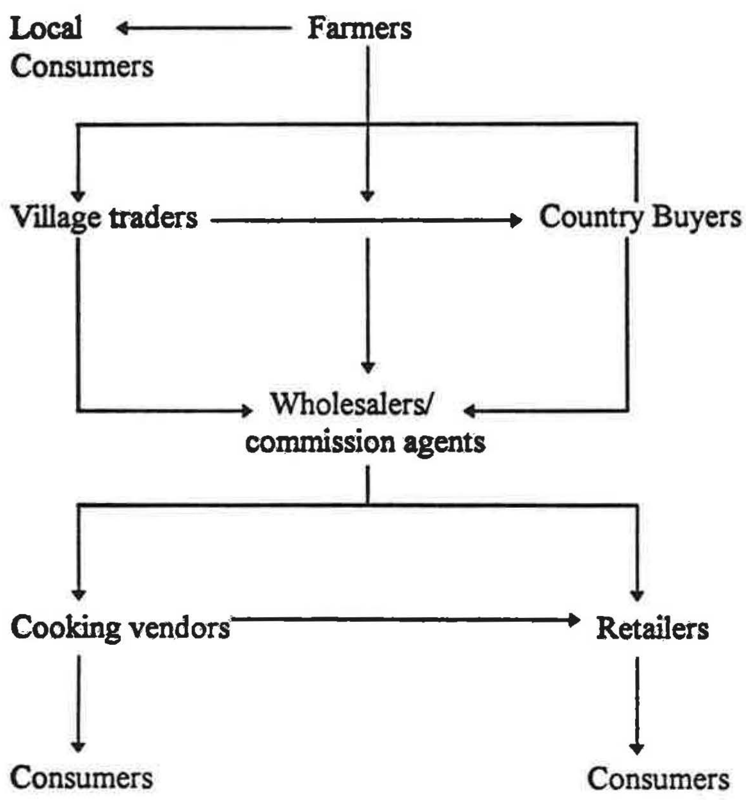

Table 1. Summary of experimental design used to assess quality of cassava over a 7 day period at Tandale Market, Dar es Salaam, Tanzania. The cassava was one day old after harvest. It was of the variety Mkunungu from Tanga Region. Assessments were made after purchase (1 day old) and at 8 days old)

Factors				Treatment number	Assessment at day 1 - No of replications	Assessment at day 8 - No of replications	Roots per replicate	No of roots assessed per replicate
Root Condition	Storage location	Wash treatments	Packaging					
1. Undressed roots	1. Transported	1. Dry	1. Fresh roots	1	x1	x1	Full sack	14
	2. Open Air	1. Dry	2. Traditional	2		x1	Full sack	5
	3. Plastic covered	1. Dry	2. Traditional	3		x1	Full sack	5
	3. Plastic covered	2. Water drenched	2. Traditional	4		x1	Full sack	5
	3. Plastic covered	3 Water washed	3. Rice sacks	5		x2	Half sack	5
	3. Plastic covered	4. STORITE washed	3. Rice sacks	6		x2	Half sack	5
2. Dressed roots	3. Plastic covered	1. Dry	3. Rice sacks	7		x2	Half sack	5
	3. Plastic covered	2. Water drenched	3. Rice sacks	8		x2	Half sack	5
	3. Plastic covered	3 Water washed	3. Rice sacks	9		x2	Half sack	5
	3. Plastic covered	4. STORITE washed	3. Rice sacks	10		x2	Half sack	5
	3. Plastic covered	3. Water washed	4. Polyethylene sacks	11		x2	Half sack	5
	3. Plastic covered	4. STORITE washed	4. Polyethylene sacks	12		x2	Half sack	5

Table 2. Major elements of dissemination campaign to improve handling and storage methodologies.

1. On-station demonstration and workshop
2. Training of trainers in non-governmental organisation and government services (as appropriate)
3. Integration of dissemination initiatives with existing community developments programmes
4. Support for trainers during extension initiatives
5. Urban market demonstrations
6. Village demonstrations
7. Generation and dissemination of leaflets and support literature
8. Audio-visual displays and presentation (slides and videos etc)
9. Radio, newspaper and magazine coverage

Table 3. Quality criteria recognised by consumers in Dar es Salaam.

Characteristic	**Description**
Freshness	1-2 days old
Colour	White, avoid browning or discoloration
Absence of Mould	Mould is a sign of deterioration
Damage	Absence of cuts
Size	Small-medium roots (dislike fibres in larger roots)
Variety	Look for sweet and not bitter varieties
Cooking quality	Cooks soft when boiled

Table 4. Time related value changes for cassava at different stages in the marketing chain.

	Time	Price per unit (TShs)	Discount
Farmer	"fresh" 2 day 3 day >3 days	2000 1500 1000 <500	 25% 50% >70%
Country buyer	"fresh" 2-3 days >3 days	4500-5000 500-1000 <500	 80% >90%
Wholesaler	"fresh" 2-3 days >3 days	6000-7000 1500-2000 600-1000	 75% 90%
Retailer	"fresh" 2-3 days > 3 days	3-5 pieces (30 TShs) 5-6 pieces (30-50 TShs) negotiable	 up to 50%

Note: "fresh" refers to cassava roots which are uprooted and sold the same day or one day later.

Table 5. A preliminary assessment of the internal condition of roots stored under various conditions 7 days after arrival at market (8 days post-harvest) at Tandale Market, Dar es Salaam. Details of the trials are given in Table 1.

Storage treatment	Physiological	Microbiological	Browning	Desiccation	Traders category
In sun	4.3	2.7	2.0	1.2	3.6
In shade	2.9	1.2	1.9	1.6	2.1
Chemical treatment in polyethylene bags and in shade	2.5	1.0	1.7	1.2	1.3

Scores shown are mean values of five determinations along length of single roots selected at random.

Scores: Physiological scores rage from 1 to 6. Other scores range from 1 to 5. A score of 1 indicates no defect Higher scores represent poorer quality.