C

NRI
Natural Resources Institute

The Relationship between Quality and Economic Value of Fresh Sweet Potato and Dried Cassava Products in Mwanza, Tanzania

M Thomson, G. T Ndunguru, T.D.R. Waida,
E. Rwiza, S. Jeremiah

June 1997

Project A0500

Tanzania Food and Nutrition Centre
PO Box 977
Dar es Salaam
Tanzania

Natural Resources Institute
University of Greenwich
Central Avenue
Chatham
Kent ME4 4TB
United Kingdom

ARI-Ukiriguru
Box 1433
Mwanza
Tanzania

Contents

Acronyms and Abbreviations	3
Acknowledgements	3
Summary	4
1. Introduction	6
2. Participatory methods for dried cassava	7
3. Participatory methods for sweet potato	16
4. Statistical methods for sweet potato	25
5. References	35
Appendices	36

Acronyms and Abbreviations

Kg	Kilogram
TFNC	Tanzania Food and Nutrition Centre
TShs (/=)	Tanzanian Shillings US$ 1 = 600/= approx. UK£ 1 = 1,000/= approx.

Acknowledgements

The authors of the report wish to thank Dr. Regina Kapinga of ARI-Ukiriguru for valuable comment and guidance, and for arranging a vehicle for the fieldwork performed in Mwanza town. The help of Dr. G. Ndossi, the Director of Food Science and Nutrition at TFNC, was also greatly appreciated. Special thanks are given to the market masters and sweet potato market traders in Mwanza, without whose assistance the survey work would not have been possible. Also, thanks to Lushinge Ngwegwe and Joseph Vincent for driving us safely wherever we ventured.

This report is an output from a research project funded by the United Kingdom Department for International Development. However the Department for International Development can accept no responsibility for any of the information provided or views expressed. [R6508; Crop Post-Harvest Programme.]

Summary

(i). This report outlines the relationship between quality and economic value for fresh sweet potato and dried cassava in the urban markets of Mwanza in north west Tanzania. These two crops form an increasingly important part of food security and, through the marketing of surpluses, of income generation for poor householders. The work reported in this report used a combination of participatory and more formal statistical methodologies in order to gauge relationships between quality and value of the marketed produce.

(ii). Two major dried cassava products are marketed in Mwanza town. These are *udaga* (a heap fermented product) and *makopa* (a non-fermented product). For both of these, traders and customers prefer a product that is as white as possible as this gives better tasting and more visually appealing *ugali* flour. Perceived valuations show a 30 - 50% discount for dark *udaga* compared to white *udaga*, with higher discounts apparent in the peak season when buyers can be more choosy about quality. *Makopa* is valued approximately 10% below *udaga* of similar colour and particle size.

(iii) Moulds of various colours appear on *udaga* during the rainy months. In Mwanza, no visible mould is liked, but some types are disliked more than others. Average valuation discounts are 10 - 15% for orange coloured mould, 20 - 25% for green coloured mould and 35 - 40% for black coloured mould. If mould were scraped off the roots after fermentation the potential value of the product would therefore be increased.

(iv) Preferences relating to the particle size of dried cassava were less consistent. As produce is sold by the bucket not by weight, a fine consistency gives a larger quantity of cassava and is preferred by some buyers. However, if fine material is dark, many people fear dirt contamination and will prefer a larger pieced product.

(v) Produce is currently ungraded when it enters the market. The results suggest that if *udaga* was well graded when it entered the market, rather than selling at a standard price, significant price differentiation could be made. The average product price would probably stay the same, but product quality would be more predictable and consumers would be given more choice. Those who wanted a better quality product could pay more, and those who were satisfied with (or could only afford) poorer quality could pay less.

(vi) Quality characteristics for sweet potato can conveniently be divided into variety, size and damage categories. Much is already known about variety preferences for sweet potato and size is only a minor quality factor. This report therefore focuses on the valuation of the various types of damage commonly found in sweet potato markets - breaks, cuts, shrivelling, surface weevil and deep weevil attack. No rotten sweet potato are sold in markets and these have no value.

(viii) Various participatory ranking and valuation exercises were performed in different markets within Mwanza town and at different times of the year. The experiments show that both traders and customers consistently place lower valuations on damaged sweet

potatoes than on undamaged ones. Evidence of weevil attack leads to the greatest reduction in value, with average discounts of around 30 - 40% for surface attack and over 50% for deeper attack. Smaller but still significant discounts of between 10 - 30% occur if a potato is shrivelled, cut or broken.

(ix) A more statistical analysis of sweet potato heaps on sale in the markets showed that a high proportion of sweet potato entering the market place are damaged in some way. The results also suggest that overall there is a significant reduction in the value of sweet potato if they are damaged. This reduction varies according to the type of damage with cuts and weevil attack having the largest impact on value, indicating that measures to reduce these types of damage will be most appreciated in the market place.

(x) There is also evidence to suggest that there is significant variation in the value of sweet potato by variety. Results show that yellow skinned varieties are preferred and sell at an average premium of 10% above the price of reddish purple skinned ones. This suggests that farmers should attempt to supply more of the Njano variety of sweet potato to the Mwanza markets.

(xi) Overall, the results suggest that efforts to improve the quality of sweet potato should focus firstly on reducing the number of weevil damaged potatoes entering the market, especially deep burrowing weevil. A second priority area should be to reduce breaks, cuts and shrivelling. However, any post-harvest intervention that reduces sweet potato damage will have a significant positive impact on quality perceptions in the market place.

1. Introduction

1. Sweet potato and cassava are important staple food crops in several areas of Tanzania. Increasing amounts of fresh sweet potato and dried cassava products in particular are being marketed, providing important sources of income for rural producers and offering important sources of food to the rapidly expanding urban population. However, despite the increasing utilisation of sweet potato in urban areas, very little is known about the relationships that exist between the quality and the value of sweet potato products in these areas. Without this knowledge it is not clear whether any advantage is to be gained by improving the quality of the marketed product.

2. This study forms part of an United Kingdom Department for International Development Crop Post-Harvest Programme Research Project 'Improving the Quality and Value of Non-Grain Starch Staples'. It was performed in three stages in December 1996, April 1997 and June 1997 in Mwanza, Tanzania. Mwanza is the second largest urban centre in Tanzania. Both fresh sweet potato and dried cassava products are marketed throughout the year. Stage 1 focused on the development and testing of methodologies, whilst stages 2 and 3 focused on data collection in low and high seasons respectively.

3. The objectives of this study were:

   a. To determine the quality criteria used by traders and customers in Mwanza urban markets to assess fresh sweet potato and dried cassava products.

   b. To obtain market value estimates for products of varying quality.

   c. To use most valued quality characteristics as the basis for recommending improvements in the crop post-harvest systems for fresh sweet potato and dried cassava.

4. This report is broken down into three main sections that reflect the products researched and the methodologies used. Section 2 looks at dried cassava products, whilst sections 3 and 4 both focus on sweet potato. Sections 2 and 3 explain the participatory methods that were used for both the crops, covering seasonality calendars, informal discussions and various quality ranking and valuation exercises. These methods involved the active participation of traders and customers in the experiments. Section 4 outlines a more formal method for investigating the relationship between quality and value of sweet potato using regression analysis and other statistical techniques. This methodology is suitable for a crop such as sweet potato that can be assessed by the piece, but not for a crop sold in bulk like dried cassava. A comparison of all the results is included in the summary to this report.

2. Participatory methods for dried cassava

2.1 Dried cassava products

5. Care is needed when describing dried cassava products because different people give different names to the same product and, more confusingly, sometimes give the same name to different products. The main products are known locally as *udaga* and *makopa*. *Udaga* is normally used to describe fermented dried cassava, but is occasionally used for all dried cassava products in small pieces. *Makopa* is generally used to describe non-fermented dried cassava, but sometimes refers to any dried cassava product in large pieces. In this report *udaga* is used to describe any fermented cassava product whilst *makopa* refers to the unfermented product. These are the most common descriptions in Mwanza town.

6. During the production process for *makopa*, cassava roots are typically peeled and sun dried for 3 to 5 days. The roots are then broken, packed into sacks and marketed. For *udaga*, roots are peeled and partially sun dried for only 1 to 2 days. However, the process continues by heaping the sun-dried roots, covering them with grass and leaving them to ferment for 5 to 7 days, normally inside. There is then generally a further sun drying stage of 3 to 5 days before the *udaga* is broken, packed into sacks and transported. It is possible to ferment the roots by soaking them in water, but this method is very rare in and around Mwanza.

2.2 Product uses

7. Most *udaga* in Mwanza is made into the staple stiff porridge called *ugali* although some is used to make beer. *Makopa* is also used for *ugali*, but as it is not fermented. It is not used for alcoholic products. Both *udaga* and *makopa* need to be machine-milled or hand-ground into flour before use in the final product. For *ugali*, most people claim to prefer flour that is as white as possible as darker material is said to produce a bad smelling end product. Some people claim that hand-ground *ugali* flour is better than machine-milled flour in terms of taste or texture.

8. *Udaga* flour is used either on its own or mixed with maize or sorghum flour. *Makopa* flour is inferior and is almost always mixed with other types of flour. One trader said that it is usually mixed with maize flour in the ratio of 2 maize: 1 *makopa*, another indicated a ratio of 3:1. *Makopa* flour which is not mixed with other flour produces sweet *ugali* which consumers do not like.

2.3 Dried cassava markets

9. Visits to major markets suggest that high volumes of dried cassava are sold in Mwanza town, especially at Zimbabwe market, but also at Mwaloni and Kirumba. Produce arrives in sacks by boat or lorry on a sporadic basis, leading to marked fluctuations in supply and hence prices on a day to day basis. As produce is not graded when it arrives at the market, there is a standard price for a sack of dried cassava for any

delivery, negotiated by the seller and the buyers depending on overall market conditions. However, buyers inspect each sack before it is unloaded, using a hollowed out metal rod that allows a sample of the product to be extracted from anywhere in the sack. Buyers look at the colour of the produce in particular, preferring white and disliking darker colouring. They also check for the presence of sand and soil particles. If the buyer is dissatisfied he will try to negotiate a discount off the standard price.

10. Traders sell the product by the sack or, more commonly, by the bucket. A standard bucket of dried cassava known as a 'plastic' weighs between 11 and 14 kg depending on the size of particles and the resulting compactness, although produce is sometimes sold in smaller buckets. It is said that each sack is equivalent to an average of seven 'plastics', giving an estimated sack weight of around 75 to 100 kg. Traders sometimes attempt to grade the produce, but often sell buckets of mixed colouring and particle size.

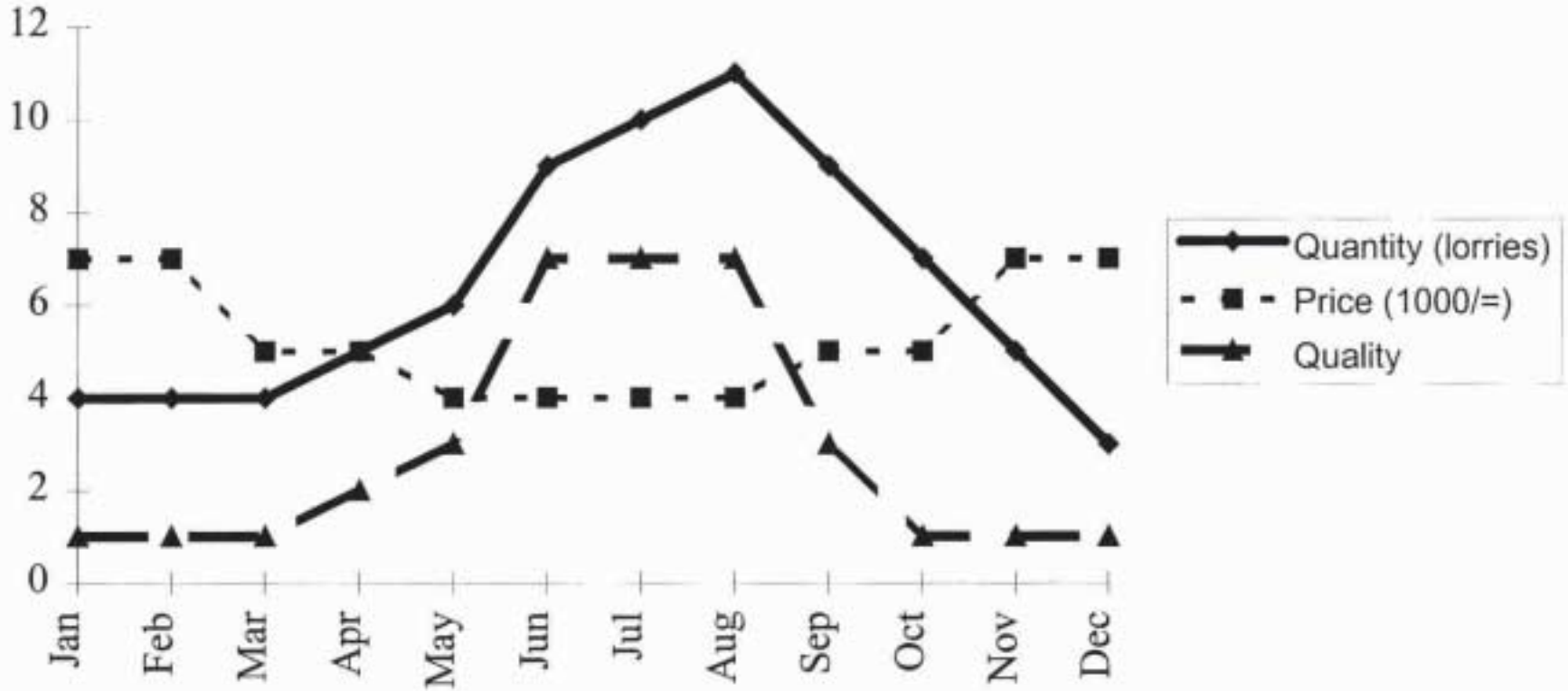
2.4 Dried Cassava Calendar

11. To gain a quick annual overview of cassava markets, two key traders at Zimbabwe market were asked to complete a calendar matrix for produce quantity, price and quality as shown in Table 1. The traders were asked to rank each of the three factors on a monthly basis using a board and a bag of beans for counters. It helped to deal with each factor separately, to begin with the month in which it was lowest and to work month by month from this point. The process was further facilitated when each bean was assigned a more concrete value such as one lorry load or TShs 1,000. The traders were encouraged to explain the trends and relationships between variables and to make adjustments to the rankings as they proceeded. In this way, the exercise generated very valuable incites into the seasonality of market conditions.

12. The matrix suggests that quantities traded are lowest between November and April, rise to a peak between June and September (when most cassava is harvested) and then fall. Estimates suggest that peak volumes on a number of lorries basis are three or four times the low season figures. Prices bear a very close relationship to quantity with lowest prices at harvest time and highest prices between November and February, approximately double the peak season levels. Trends in product quality follows trends in quantity very closely. This is because most cassava is harvested in the dry season when dried cassava products are less spoiled by rain. Little is harvested when it is raining and the quality of the dried product declines.

13. Taking an annual perspective, there appears to be a negative correlation between product price and product quality. Prices are highest when quality is worst and lowest when quality is best. At any given time however, a better quality product can be expected to be valued more higher than a lower quality one.

Table 1: Relative relationship between quantity, price and quality for dried cassava entering Zimbabwe market, Mwanza



Notes: Graph indicates changes in variables from month to month as perceived by two key dried cassava traders in December 1996. Quality line gives rough indications of changes, but cannot be used to measure absolute values. For prices, each scale unit represents approximately 1,000/= on the average wholesale price of a sack. For quantity, each scale unit represents approximately one lorry of average 7 tonnes capacity.

2.5 Quality characteristics and preferences

14. Discussions with a sample of traders and customers together with visual inspections of produce suggest that the two most important quality attributes for dried cassava are colour and particle size.

15. As a first step in the analysis of quality, a sample of 10 buckets of dried cassava products were taken from Zimbabwe market, three each from sacks of white (grade 1), medium (grade 2) and dark (grade 3) coloured *udaga*, and one from a sack of *makopa*. Care was taken to ensure that the bags contained a uniform colouring throughout and that there was no evidence of product mixing. For each grade of *udaga*, the three buckets were emptied, resorted and refilled, one with fine particles, one with large particles and one with a mixture of particle size. As the *makopa* on display was fairly uniform in terms of both colour and particle size, only one bucket was sampled. The 10 buckets were labelled and various sub-group ranking exercises performed among a sample of three traders and three customers[1].

16. It soon became clear that both colour and particle size can have an impact on product preferences. All six people ranked the three buckets of fine *udaga* in exactly the same order, i.e. white, then medium and then dark. The major determinant of *udaga* preference therefore appears to be colouring of the product with whiter grades preferred. There was also major agreement on the ranking of large particle products. Everyone ranked large white *udaga* and *makopa* ahead of large medium coloured *udaga*, followed by large dark *udaga*.

17. Rankings among individual colours of *udaga* were much more variable. Some people prefer large particles and some people fine ones within a given colour category. There appears to be a trade-off for customers between the greater weight contained in a bucket of denser packed finer material and the higher chance of sand/dirt contamination which can to some extent be disguised in these finer grades. However, for very white *udaga* impurities can be more easily seen and if the product appears to be totally white then fine material is preferred to larger particles for weight reasons. It should be remembered that all grades are pounded/milled into flour before use.

2.6 Valuation of preferences

18. The ranking exercises suggested that for both traders and customers there is a consistent difference in perceptions of dried cassava quality in relation to colour, with whiter products / grades being preferred to darker ones. Preferences based on particle size are less consistent.

19. Three separate experiments were performed at various times of the year to assign valuations to the various quality characteristics and preferences. These took place in December 1996 after the short rains when quantities of dried cassava were low, in April 1997 during the main rainy season when quantities were slightly higher,

[1] A full analysis of all the rankings is given in Thomson *et al* (1996)

and during June 1997 just after the main harvesting season when conditions were dry and quantities were very high. Note that general inflation was quite high (possibly more than 20%) over the period covered so it is impractical to compare absolute prices from one season to the next.

2.7 Low season valuations

20. Three dried cassava traders and 15 customers in Zimbabwe market were asked to estimate the values of ten sample buckets, arranged into three groups of same particle size but different colour. The results are summarised in Table 2.

21. The traders readily gave different value judgements for the sample buckets and, as expected from the earlier ranking exercises, whiter products were given the highest values. Customers found it more difficult to assign values and so to assist them they were given a set of 9 cards covering all prices from 800/= to 1600/= in steps of 100/=. This gave a manageable number of cards, one at the current general price for dried cassava products of 1200/=, and four either side. The range also covered the approximate range of prices noted by the traders from 750/= to 1,600/=. Each customer was asked to assess the three sub-groups of buckets in turn and to place one of the value cards on each bucket. All the price cards were carefully displayed before hand so that the customer was fully aware of the range and any three of the 9 cards could be used for each of the three valuation exercises.

Table 2: Low season valuations of dried cassava

	Average Valuation (TShs per Bucket)	
Product Quality	Traders	Customers
Udaga, fine, white	1367	1440
Udaga, fine, medium colour	1200	1220
Udaga, fine, dark	1000	993
Udaga, large, white	1267	1360
Udaga, large, medium colour	1167	1140
Udaga, large, dark	900	940
Makopa, large	1167	1293
Udaga, mixed, white	1267	1387
Udaga, mixed, medium colour	1100	1147
Udaga, mixed, dark	917	967

Notes: Data obtained from Zimbabwe market, Mwanza town during December 1996. A bucket is the standard measure for dried cassava, containing 11 to 14 kg depending on the size of particles. Full sample details are shown in Appendix 1.

22. The customer valuations are fully consistent with earlier rankings and are also broadly in line with the average trader perceptions of value. The results suggest that customers perceive top grade, white *udaga* to be worth around 200/= more per bucket than the medium colour, which in turn is valued at around 200/= more than the lowest, darkest grade. Dark *udaga* is therefore valued at an average discount of around 30% when compared to the white *udaga*. *Makopa* is consistently valued in-between the top two grades of *udaga*, equivalent to an estimated 10% discount on the value of white *udaga*.

2.8 Peak season valuations

23. A second valuation exercise was performed in June 1997, a month in which there is much more dried cassava in the market place. This time, the methodology was simplified to include only five samples of produce - fine white *udaga*, large-pieced white *udaga*, fine dark *udaga*, large-pieced dark *udaga* and *makopa*, arranged in small buckets. Produce of intermediate colour and mixed particle size was excluded so as to focus more specifically on the extremes of quality. It was possible to find more traders at this time of the year, so a sample of 7 traders and 13 customers were asked to rank the five samples in terms of preference and then to give a valuation of the produce for a large plastic bucket. The results are shown in Table 3.

Table 3: High season valuations of dried cassava

	Average Valuation (TShs per Bucket)	
Product Quality	Traders	Customers
Udaga, fine, white	2271	2038
Udaga, fine, dark	1500	1146
Udaga, large, white	2129	2062
Udaga, large, dark	1643	1308
Makopa, large	1914	1869

Notes: Data obtained from Zimbabwe market, Mwanza town during June 1997. A bucket is the standard measure for dried cassava, containing 11 to 14 kg depending on the size of particles. Full sample details are shown in Appendix 2.

24. The results from this experiment again show that the whiter the product, the higher the valuation. Trader valuations show an approximate 35% discount for fine dark *udaga* when compared with the fine white product, while customers give around a 50% discount. These results are slightly above the low season discounts, perhaps reflecting the fact that people can be more choosy when more produce is available. Darkness discounts for the finer product are larger than those for larger pieced variety because fine *udaga* can hide a lot of sand and other dirt. Finally, as with the low

season experiments, *makopa* is valued above dark *udaga*, but at an estimated 10% discount below large pieced white *udaga*.

2.9 Wet season valuations

25. Experiments were performed in April 1997 focusing specifically on moulds which are very common during the rainy season. Three colours of mould were seen on dried cassava - orange, green and black.

26. A black mould commonly grows during heap fermentation of the roots. This is sometimes scraped off the roots before packing and transportation. Although none was seen, a white mould can sometimes grow during fermentation, possibly being the initial stage of black mould growth. An orange mould grows if the product is not well dried before the fermentation process starts. This can also be scraped off before packing. A green mould develops on dried cassava that is not deliberately fermented, but which gets wet during storage or transport. A sack of dried cassava arriving at the market can contain products bearing all types of mould as there is generally little grading of dried cassava and traders can mix products purchased from different farmers and produced under different conditions.

27. To obtain value perceptions of different moulds, four similar sized pieces of cassava were selected, one having orange mould, one with green, one with black and one without any mould. A sample of 5 traders and 10 customers were requested to rank each of the four pieces on the basis of personal preference and to explain their reasons. Participants were then asked how much they would be prepared to sell or buy a bucket of dried cassava for if all the product were of the same quality as each individual piece.

28. The results shown in Table 4 are remarkably consistent between traders and customers. No mould is liked, but there is a definite order of dislike. Average valuation discounts are 10-15% for orange mould, 20-25% for green and 35-40% for black. A few people claim to like the taste of orange mould, saying that it makes nice tasting *ugali*, but no one claimed to like the taste of green or black mould. The discount for black mould is very similar to the discounts recorded during the low and peak season experiments for dark coloured *udaga*.

Table 4: Wet season valuations of dried cassava moulds

	Average Valuation (TShs per Bucket)	
Product Quality	Traders	Customers
No mould	2360	2290
Orange mould	2050	2030
Green mould	1810	1790
Black mould	1500	1440

Notes: Data obtained from Zimbabwe market, Mwanza town during April 1997. A bucket is the standard measure for dried cassava, containing 11 to 14 kg depending on the size of particles. Full sample details are shown in Appendix 3.

2.10 Discussion of preferences

29. During the course of the valuation exercises, participants were encouraged to discuss their preferences and several interesting pieces of qualitative information were obtained.

30. One trader identified three types of buyer. The first are people who buy relatively large quantities of the product and mill it into flour for sale (sometimes mixing it with maize flour). These customers are said to prefer a product that is as white as possible. The second group are home *ugali* consumers who are reported to prefer a fermented product (*udaga*) rather than the unfermented one (*makopa*), preferably as white as possible. The third type are the brewers who are fewer in number, but prefer the fermented, darker *udaga* which is said to produce beer (*pombe* or *grid*) of higher alcoholic content. These observations are in line with the results of the valuation exercises in that most customers appear to prefer a white product, especially *udaga*.

31. Traders commented that darker product grades take longer to sell than whiter grades. It is bought by brewers and by *ugali* consumers when whiter *udaga* is not available. It is relatively easy for traders to 'hide' darker *udaga* by covering it or mixing it with whiter material, but traders are reluctant to do this much in case they lose regular customers who discover the darker material when they get home. Another option is to give darker material as the 'top-up' that most customers demand.

32. Some customers prefer produce of small particle size because the weight contained in the bucket is higher than that for more loosely packed bigger pieces. Also, one consumer stated that large particles are more fibrous and not liked. Another reason for preferring very fine material is that it does not have to be milled. However, many customer suspect a high sand content in the finer product, especially if it is dark in colour, and therefore prefer to buy larger pieces. One person commented that larger particles are more easily sorted in the home, making it possible to remove very dirty ones. Also, bigger pieces of *udaga* appear to be more acceptable if they are easily breakable, indicating good fermentation. These observations help to explain the mixed particle size preferences discovered during the valuation exercises.

33. One consumer claimed that she would only use *makopa* as *ugali* flour when there was nothing else as it makes very sticky and sweet *ugali*. Another liked the white colour of *makopa* and preferred it to dirty *udaga* which gives bad-smelling *ugali*. One trader stated that he liked *makopa* as it tended to be bought by the sack (not bucket) by people who mill it together with maize to produce a composite flour for sale.

2.11 Conclusions

34. In Mwanza town, there appears to be a marked preference for dried cassava that is as white as possible. Darker products give *ugali* that is less appealing to the eye and that some say has an inferior taste and are generally only bought by brewers, by poorer individuals who negotiate discounts or by other customers if better quality produce is not available.

35. The analysis indicates that if *udaga* was well graded when it entered the market, rather than selling at a standard price, significant price differentiation could be made. The average product price would probably stay the same, but product quality would be more predictable and consumers would be given more choice. Those who wanted a better quality product could pay more, and those who were satisfied with (or could only afford) poorer quality could pay less.

36. It has been shown that most customers in Mwanza town do not like any of the visible moulds that appear on dried cassava, moulds which are most prevalent during the rainy season, but which occur throughout the year. If mould were scraped off the roots after fermentation, the potential market value of the product would be increased.

3. Participatory methods for sweet potato

3.1 Products

Almost all of the sweet potato sold in Mwanza markets are sold in fresh form. No dried products were seen in the markets. Fresh sweet potato is most commonly boiled or steamed, but sometimes roasted or fried.

3.2 Market mechanisms

The highest volumes of sweet potato in Mwanza town are sold at Central, Zimbabwe, Mwaloni and Kirumba markets. There are few fixed delivery times for produce entering the markets, leading to marked fluctuations in supply even on a daily basis. Much produce is transported by sail boat over Lake Victoria from other parts of the mainland, mainly Sengerema and Geita districts and from the islands, especially Ukerewe. Wind direction and strength mean that journeys can take anywhere between one and four days. Other potatoes arrive by lorry or bus, again from Sengerema and Geita. Supplies of sweet potato are delivered in sacks weighing an average of 70 to 80 kg. These are stuffed with grass to protect the produce during transportation. A 10 tonne lorry can carry about 120 sacks at a time, boats 70 sacks or more, whilst people travelling by bus generally bring only one or two sacks.

On any one day, there is one general or standard price for a sack of produce. The main reason for this is that, as most farmers grow several varieties of sweet potato and pack more than one into a single sack, it is difficult for traders to assess variety (and quality) of any one sack. The standard price per sack can fluctuate widely from day to day depending on the existing supply conditions and the general quality of the deliveries that day. It is sometimes possible to find a sack of the same variety, and when this does occur it can lead to price differentials. Buyers sometimes take samples from sacks and will negotiate discounts if the product is particularly damaged or old. At Mwaloni, traders sometimes display sweet potatoes on the ground for inspection.

Unless sold by the sack, potatoes are generally sold by the heap. During the time of the study, a single heap was selling for 100/=, 200/= or 300/=. Cheaper heaps tend to be made up of smaller potatoes whilst more expensive heaps have larger potatoes. Most heaps appear to contain differences in the extent of potato damage (cuts, bruises, weevil attack, withering, rotting etc.) and sometimes contain different varieties of potato. With the exception of Ramadan when prices are higher, there is little fluctuation in the price of a heap from day to day and month to month, but the quantity in the heap does change to reflect variations in the purchase price and product

quality. Of course, periodically it is necessary to increase the general price of heaps to account for overall inflation.

Although the price of a heap is not normally negotiable, traders and customers often bargain by changing or more commonly adding the potatoes in the heap until a sale is made. It is very common for a trader to display the better quality product in heaps and to add a few smaller, less fresh and more damaged potatoes from 'behind the counter' to satisfy the customer. In this way it is possible for a trader to get rid of the inferior potatoes.

3.3 Quality attributes

The overall quality of a sweet potato is a combination of various factors which can be conveniently divided into three categories - variety, damage and size - as shown in Table 5.

Table 5: The quality characteristics of sweet potato

Variety	Damage	Size
Taste	Breaks	Ease of handling
Starchiness / texture	Cuts	Ease of peeling
Speed of cooking	Shrivelling	
Skin colour / appearance	Surface weevil	
	Burrowing weevil	
	Bruising	
	Rotting	

There have been several studies performed within Tanzania focusing on sweet potato variety preferences[1]. The main variety specific characteristics seem to be taste, texture, speed of cooking and appearance. It is not the purpose of this report to analyse specific reasons why some varieties are preferred but an assessment of market value differentials between varieties is made (see section 4.7). The study also assesses whether certain varieties are more prone to damage (see section 4.8).

Sweet potato damage is a complicated factor to assess, comprising of numerous factors as shown in Table 5 and is a major focus of this study. However, only cuts, breaks, shrivelling, surface (skin) weevil and burrowing (deep) weevil are assessed in detail. Following market observations and discussions with traders and customers, bruising and rotting have been excluded from the analysis. Minor bruising

[1] Of particular interest to this study are the results contained in Kapinga *et al* (1996).

is fairly common, but is not seen as a major quality issue. As for rotting, no significant examples were seen in any of the markets places in Mwanza town.

Sweet potato size is probably a less important quality attribute, but does affect ease of handling and peeling. For very small potatoes a high proportion of the product is wasted through peeling, whilst very large potatoes are more difficult to handle.

3.4 Sweet Potato Calendar

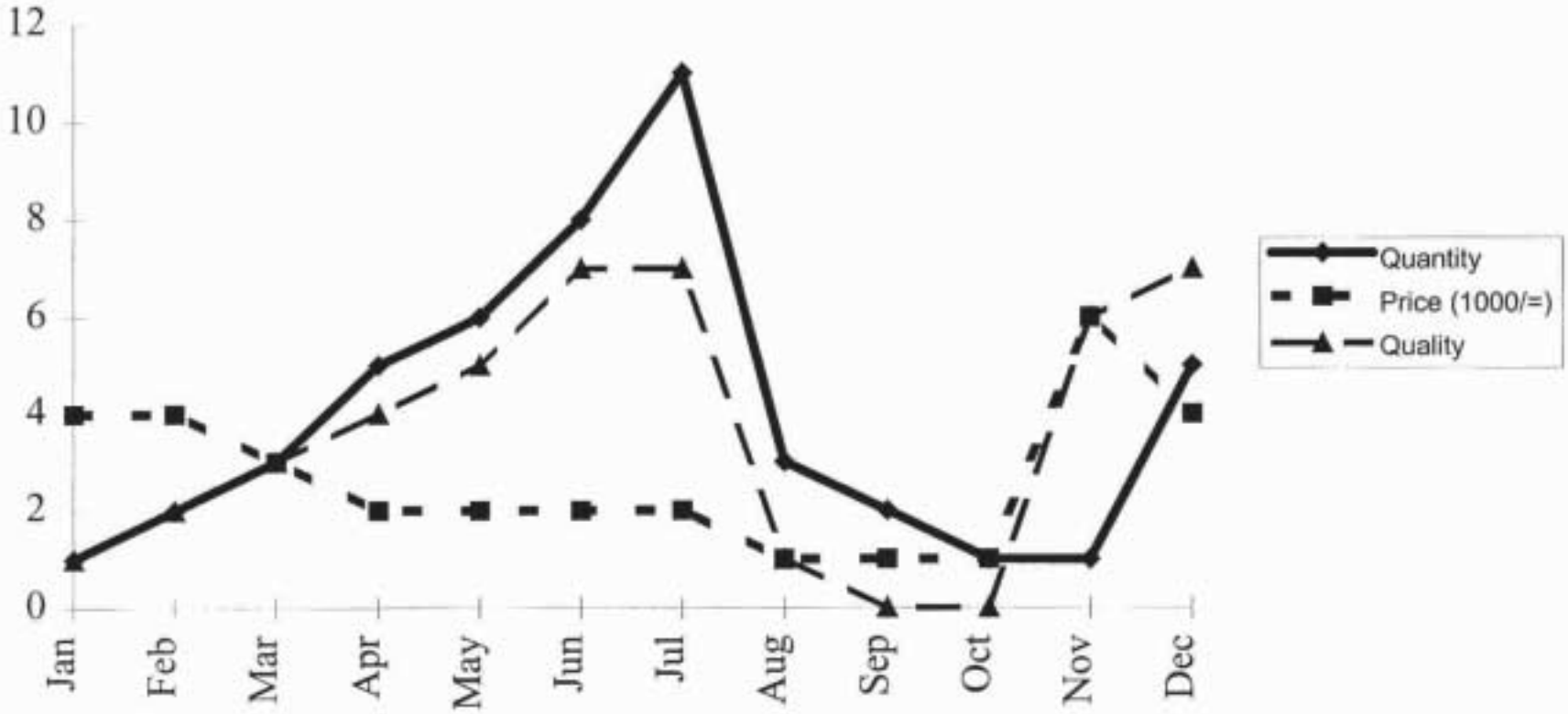
Preparing a calendar is a good way of gaining an overview of the sweet potato market in Mwanza. Using a board and a bag of beans for counters, two key wholesale sweet potato traders in Mwaloni market prepared the calendar shown in Table 6.

Beginning with product quantity, the traders were asked to place one counter for the month in which quantity is lowest and to increase the number of beans for other months in relation to increasing quantity entering the market. The traders were encouraged to discuss the scoring and were allowed to change the scores if they wanted. The same exercise was done for product price and quality. The exercise was very successful and generated much discussion and information that is noted elsewhere in this report.

Although the results are indicative only, the matrix suggests that quantities traded are highest between May and July, the main harvesting season. As can be expected, prices are relatively low at this time of year. There is a second (but lower) peak in quantity in December which coincides with a crop of sweet potato from paddy fields. Smaller quantities are traded in March and April (early harvest) and August and September (late harvest), with very little traded in other months (available due to in-ground storage and piece-meal harvesting).

Product quality is highest during the main harvest season when prices are relatively low and quantities high. Quality is lowest in September and October when potatoes have overstayed their optimum harvest time and become rather watery. Prices fall to compensate for poor quality at this time of the year. Therefore, the relationship between product value and quality does not appear to be constant throughout the year.

Table 6: Seasonal relationship between quantity, quality and price for sweet potato entering Mwaloni market



Notes:

Scale indicates changes in variables from month to month as perceived by two key sweet potato traders in December 1996. Scale for quantity and quality give rough indications of changes, but cannot be used to measure absolute values. For prices however, the scale represents approximately 1,000/= on the average wholesale price of a sack.

3.5 Participatory valuation of quality

Various experiments were performed in Mwanza town markets involving buyers and sellers of sweet potato. Rather than adopting a formal questionnaire type approach, participants were more directly involved in the research. This was considered to be more suitable since most of the experiments relied on the visual comparison of potatoes.

3.6 Characterisation of a whole sack of potatoes

A whole sack of sweet potato weighing around 80 kg was purchased at Mwaloni wholesale market and taken to Kirumba market for sorting. There were three varieties of potato in the sack and a mixture of potato sizes and damage. 18 heaps of potato were made out of all combinations of variety (Polista, Njano and Sinia), size (small, medium and large) and damage (yes and no). A further six heaps were formed out of a random mixture of variety, size and damage. Care was taken to ensure that each heap weighed around 1.75 kg, the average weight of a 200/= heap on sale during December 1996. Note that 'damage' in this experiment meant either cuts, breaks, shrivelling, weevil attack or any combination of these.

Taking the heaps in four groups of six, i.e. a group for each variety and the random group, a sample of three traders and three customers were asked to rank the heaps in each group in turn and to give their reasons for their preferences. The results from this experiment showed that undamaged sweet potato are preferred to damaged ones and that very small sweet potato are disliked.[2] However, the methodology proved cumbersome, time-consuming and expensive and was therefore changed.

3.7 Characterisation of heaps of potato

The second experiment worked much better and was performed once during the wet season in April 1997 and twice during the dry peak season in June 1997. In each case, a sample of traders and customers were asked to rank various heaps of sweet potato in terms of preference and to then give estimated valuations. To simplify the experiment, all heaps consisted of Polista potatoes, the most common variety in Mwanza markets. In addition, each heap consisted of 5 potatoes weighing a total of around 1.4 kg, the approximate average weight of a 200/= heap on sale. The heaps differed in that the potatoes were either all undamaged, all cut, all broken, all shrivelled, all showing skin (surface) weevil attack or all showing deep (burrowing) weevil attack. Thus, both variety and average potato size were held constant and the impact of potato damage was isolated.

---

[2] Detailed results of all the various rankings are contained in Thomson *et al* (1996).

After ranking the heaps using cards labelled from one to six, a further card marked '200/=' (the prevailing market price) was assigned to the number one ranked heap. Individuals were then asked to value the other heaps, working through the rankings. After each value was stated, a card corresponding to that price was placed on the heap to facilitate the process. Once all six valuations had been made, consistencies with the initial ranking exercise were checked and any discrepancies were rectified.

The results of the three trials are shown in Appendices 4, 5 and 6 and summarised in Table 7. It is clear that both traders and customers value damaged potatoes below undamaged ones. Approximate average discounts for damaged potatoes work out at 20 - 25% for breaks, 25 - 30% for both cuts and shrivelling, 30 - 40% for skin weevil and 45 - 50% for deep weevil attack. Traders tend to make slightly smaller discounts than customers in their valuations.

It should be noted that most data were collected during June, a month of relative high availability of sweet potato in the market place. It could be that people are more particular about quality when there is an abundance and therefore more choice of produce. In April, there was a lower supply of potato and discounts of only 10 - 20% were calculated for both broken and cut potatoes, and 40% for deep weevil attack. Unfortunately, data for shrivelling and skin weevil damage were not collected at this time.

Table 7: Market value assessments of sweet potato with various damage types

	Zimbabwe market				Zimbabwe market				Kirumba market							
	April 1997				June 1997				June 1997				Total			
	Traders		Customers		Traders		Customers		Traders		Customers		Traders		Customers	
Quality	No.	TShs	No.	TShs	No.	TShs	No.	TShs	No.	TShs	No.	TShs	No.	TShs	No.	TShs
Good (undamaged)	5	200	15	200	7	200	13	200	5	200	5	200	17	200	33	200
Shrivelled	n.a.	n.a.	n.a.	n.a.	7	153	13	157	5	116	5	132	12	138	18	150
Broken	5	166	15	167	7	156	13	145	5	160	5	112	17	160	33	150
Cut	5	186	15	167	7	136	13	126	5	144	5	118	17	153	33	143
Skin weevil attack	n.a.	n.a.	n.a.	n.a.	7	120	13	103	5	178	5	160	12	144	18	119
Deep weevil attack	5	128	15	123	7	86	13	84	5	104	5	110	17	104	33	106

Notes: Values are shown in TShs per heap where a heap consists of five Polista variety potatoes weighing around 1.4 kg in total.
Values represent trader and customer averages from the details shown in Appendices 4, 5 and 6.
n.a. = data not available.

3.8 Formation of heaps of potato

A third participatory experiment was conducted in Zimbabwe market in June 1997. Approximately 3 kg of Polista variety potato were purchased of each quality category noted above, i.e. undamaged, cut, broken, shrivelled, surface weevil attack, and burrowing weevil attack. A sample of four traders in Kirumba market were then asked to form a heap from each of the six categories and to state the price at which they would sell the heap. As an average heap weighs around 1.5 kg, the quantities of potatoes in each category allowed sufficient choice to be made when selecting the potatoes. The six heaps formed by each trader were weighed and selling price per kilogram calculated. The results are shown in Appendix 7 and summarised in Table 8.

Table 8: Trader formation of sweet potato heaps of various damage types

Damage type	Average valuation (TShs per kg)	Percentage of undamaged value
Undamaged	138.1	100
Shrivelled	117.1	85
Broken	102.7	74
Cut	99.2	72
Surface weevil	84.5	61
Deep burrowing weevil	61.6	45

Note: Data were obtained from Kirumba market in June 1997 and are analysed in Appendix 7.

The results shown in Table 8 suggest that valuation discounts compared to undamaged potatoes are around 15% for shrivelled potatoes, 25 - 30% for both cut and broken potatoes, 40% for surface weevil and over 50% for deep weevil. These results are very similar to those obtained during the heap ranking exercises in the same month with the exception of shrivelling which gave a higher discount of 25 - 30% in the earlier experiment. This is explained by the fact that the potatoes used in the heap formation exercise were several days older than the ones used in the heap ranking exercise.

3.9 Conclusions

The experiments show that both traders and customers consistently place lower valuations on damaged sweet potatoes than on undamaged ones. Evidence of weevil attack leads to the greatest reduction in value, with average discounts of around 30 - 40% for surface attack and over 50% for deeper attack. Smaller but still significant discounts of between 10 - 30% occur if a potato is shrivelled, cut or broken, with no consistent preference rankings between these three types of damage.

These results suggest that efforts to improve the quality of sweet potato should focus firstly on reducing the number of weevil damaged potatoes entering the market, especially deep burrowing weevil. A second priority area should be to reduce breaks, cuts and shrivelling. However, any post-harvest intervention that reduces sweet potato damage will have a significant positive impact on quality perceptions in the market place.

4. Statistical methods for sweet potato

4.1 Methodology

This section focuses on a statistical analysis of sweet potato quality and value based on a sample of heaps on sale at the major markets in Mwanza. The data collection exercise took place during April 1997 and June 1997, coinciding with periods of relative low and high market supplies respectively. Data were recorded using the pro-forma sheet shown in Figure 1.

Figure 1: Pro-forma data recording sheet

Location: Code:			Date: Code:		
Selling price per heap:			Variety: Code:		
Purchase price per heap:			Days at market:		
Heap:	For all scores: 0 = none, 1 = minor, 2 = major				
Weight (grams)	Breaks Score	Cuts Score	Shrivelling Score	Skin Weevil Score	Deep Weevil Score
Total weight:		Av. score:	Av. score:	Av. score:	Av. score:
Total number potatoes:		Number:	Number:	Number:	Number:

Location refers to the name of the market, which in Mwanza is either Central, Mwaloni, Kirumba or Zimbabwe. Selling price per heap was easy to ascertain with traders organising heaps into 100/=, 200/= and 300/= price categories at the time of the study, broadly consisting of small, medium and large sized potatoes respectively. Variety refers to the variety of potato in the heap, the most common ones in Mwanza town being Polista, Njano and Sinia with smaller quantities of Bilagara and Mwezi Moja. Note that to facilitate subsequent analysis, every sampled heap was comprised of potatoes of the same variety. Although mixed variety heaps are sometimes on display, these did not form part of the survey and if necessary traders were asked to form heaps of a single variety. Days at the market was taken as '1' if the potatoes arrived on the day of the survey, '2' if they arrived the day before the survey and so on. The top-up column is a reminder to ensure that all sales are included in the

sample, including those potatoes that are added to the heap on display from 'behind the counter' when a sale is made.

Each potato was weighed individually and assessed for five quality attributes: breaks, cuts, shrivelling, skin weevil and deep weevil, each measured as zero (score of 0), minor (score of 1) or major (score of 2). All the five attributes were assessed visually by one team member whilst another weighed the produce and a third person recorded the scores.

All the potatoes in each heap (and any top-up) were weighed together to give the total weight for the sale. Later, the total was checked to that of the sum of the individual weights and adjustments made to the weights of the largest potatoes if any rounding errors had arisen. This was judged the best way of dealing with the rounding errors.

The average scores for each of the five quality attributes were calculated back at the office as a weighted average of the scores for all the individual potatoes in the heap. In this way, a large damaged potato has more impact on the score than a small damaged potato. In addition, the total numbers of potato showing evidence of any damage for the five categories were recorded.

In order to obtain an overall sample of sufficient size and variation, 5 traders (or all traders if fewer than 5) were sampled in each market. For each trader, the details of 3 heaps (or all heaps if fewer than 3) were recorded for each selling price category of each variety. For example, if a trader was selling potatoes in heaps of 100/= and 200/= and had four varieties, a total of 3 x 2 x 4 = 24 heaps were sampled for that trader. 327 heaps were sampled in total, the characteristics of which are shown in Appendix 8.

The data were entered into SPSS (statistical package for social scientists) and the selling price per kg was computed for each heap as the measure of potato valuation. This value variable was then compared with 8 quality related variables: breaks score, cuts score, shrivelling score, skin weevil score, deep weevil score, potato size, age and variety through a series of simple regressions and other statistical tests. Further analysis was made of potato damage by variety. For more sophisticated multiple regression analysis, data were fed into the GENSTAT statistics package.

4.2 Trader assistance

For efficient conduct of the experiments it was necessary to obtain the assistance of market traders and to compensate them for any disruption caused to their

business. It was decided to purchase two heaps of potatoes from each trader who assisted in the survey, but to give the produce back again saying it was for their children. In this way, an amicable spirit of co-operation developed and the data collection progressed smoothly.

4.3 Selling price per kg

This variable was used to represent the value of potatoes in the market place. The distribution of heap values for the low season in April 1997 and the high season in June 1997 is shown in Table 9. Analyses of selling price by potato size and potato variety are made in sections 4.6 and 4.7.

Table 9: Distribution of selling price per kg of sweet potato

	Low season		High season		All data	
Price category (Tshs / kg)	Number of heaps	%	Number of heaps	%	Number of heaps	%
50 - 75	0	0	4	3	4	1
75 - 100	5	3	43	30	48	15
100 - 125	42	23	62	43	104	32
125 - 150	81	44	27	19	108	33
150 - 175	51	27	3	2	54	17
175 - 200	5	3	3	2	8	2
200 - 225	0	0	1	1	1	0
Total	184	100	143	100	327	100

Table 9 shows a wide range in the selling price per kilogram of sweet potato heaps. Price will be effected by numerous factors such as potato variety, average size, types of damage and location. Season also has an influence as is shown in the table with prices falling when there is more produce at the market.

4.4 Simple regressions of value against quality variables

The selling price per kg (the 'y' variable) was calculated for each of the 327 heaps and regressed against different independent 'x' variables for both seasons separately and for all data together as shown in Table 10. The table shows the correlation coefficients and the best estimates of regression constants 'a' and 'b' where $y = a + bx$.

Table 10: Regression of value (selling price / kg) against various variables

	Low season (n = 184)				High season (n = 143)				All data (n = 327)			
Variable	Corr. coeff.	Intcpt. a	Slope b	Conf. b (%)	Corr. coeff.	Intcpt. a	Slope b	Conf. for b	Corr. coeff.	Intcpt. a	Slope b	Conf. for b
Breaks score	- 0.13	143.7	-6.8662	91.4	+ 0.19	107.2	+12.722	**97.6**	+ 0.15 *	122.2	+10.180	**99.3**
Cuts score	- 0.14	142.2	-9.3135	94.5	+ 0.06	110.4	+5.3930	54.9	- 0.13 *	131.6	-11.198	**98.3**
Shrivelling score	+ 0.02	139.2	+1.3116	18.5	+ 0.16	108.6	+9.4870	94.4	- 0.08	129.4	-5.8665	85.9
Skin weevil score	n.a.	n.a.	n.a.	n.a.	- 0.16	115.7	-10.288	**95.1**	- 0.16	115.7	-10.288	**95.1**
Deep weevil score	+ 0.01	144.8	+1.2038	5.1	- 0.03	113.1	-2.0062	27.0	- 0.18 *	124.8	-15.050	**98.9**
Av. potato weight	- 0.15	145.6	-0.0299	**95.2**	- 0.38 **	134.8	-0.0709	**100.0**	- 0.43 **	150.0	-0.0882	**100.0**

Notes: n = number of sample heaps, a = regression intercept coefficient, b = regression slope coefficient.
corr. coeff. = correlation coefficient, conf. = confidence level based on t-test, n.a. = data not available.
For correlations, * = one-tailed significance of over 99%, ** = one-tailed significance of over 99.9%.

4.5 Analysis of value by potato damage

The results in Table 10 show the impact of five types of damage on the value of sweet potato: breaks, cuts, shrivelling, skin (surface) weevil and deep (burrowing) weevil. Each type of damage would be expected to have a negative effect on value in both seasons.

The results for breaks are surprising in that overall there is a positive relationship (with 99% confidence) between damage and value, i.e. people actually appear to pay more on a per kilogram basis for sweet potato that are broken than for those that are not. One possible explanation for this is that a badly broken potato of the same weight as a non-broken one can appear larger to the eye as it would have been a heavier potato before the break.

For cuts and both types of weevil damage, there is a strong negative relationship (with over 95% confidence) between damage and value as expected. The results for shrivelled sweet potato are less conclusive, perhaps because there are few badly shrivelled potatoes in the market place, but there does appear to be a fall in value as damage increases.

The results in Table 10 are not as good as was envisaged. The main reason for this could be the subjectivity involved in assessing sweet potato damage. Every care was taken to be consistent at all times, but some assessment error no doubt affects the results.

4.6 Analysis of value by potato size

Previous studies suggest that very small potatoes are not liked by consumers as there is a high proportion of waste when the potatoes are peeled. There is also some suggestion that consumers prefer medium sized potatoes to very large ones as they are easier to handle. Another factor to consider is that traders may give quantity discounts if a greater weight of potatoes are sold. It is therefore very difficult to forecast what the relationship between value and average potato weight will be.

Results from the simple regression in Table 10 for both seasons show with over 95% confidence that price per kilogram falls as potato weight increases. This suggests that, overall, the impact of quantity discounts offsets the combined effect of wastage and handling. However, the above analysis masks the full impact of the three price categories. Sales are made in heaps of 100/=, 200/= and 300/=, broadly comprising of small, medium and large sized potatoes respectively. An analysis of value based on these three categories is presented in Table 11.

Table 11: Average selling price per kilogram by heap selling price

	Low season			High season			All data		
Price (Tshs /heap)	No. of heaps	Potato av.wt grams	Price (TShs / kg)	No. of heaps	Potato av.wt grams	Price (TShs / kg)	No. of heaps	Potato av.wt grams	Price (TShs / kg)
100	57	109.1	130.4	25	136.9	105.1	82	117.6	122.7
200	107	223.3	145.4	104	333.6	111.4	211	277.4	128.7
300	20	391.7	133.1	14	466.4	135.0	34	422.4	133.9
Total	184	206.2	138.7	143	312.1	112.6	327	252.4	127.7

Table 11 shows that 300/= heaps are more expensive than 200/= heaps which in turn are more expensive than 100/= heaps on a selling price per kilogram basis. As more expensively priced heaps contain heavier potatoes, this appears on first sight to contradict the regression results which state that selling price falls as weight increases. However, it is the strong negative relationship between value and weight within each heap selling price category that gives the overall regression result.

c4.7 Analysis of value by potato variety

There were marked differences in average selling prices per kg for different potato varieties as shown in Table 12 below.

Table 12: Average selling prices by potato variety

	Low season		High season		All data	
Variety	No. of Heaps	TShs / kg	No. of Heaps	TShs / kg	No. of Heaps	TShs / kg
Polista	86	134.0	79	117.1	165	126.5
Sinia	21	153.0	27	105.5	48	126.1
Njano	62	144.0	23	118.4	85	137.7
Mwezi Moja	4	137.5	-	-	4	141.3
Bilagara	11	119.3	14	91.8	25	102.8
Total	184	138.7	143	112.6	327	127.7

The results shown in Table 12 suggest that of the three main varieties of sweet potato in Mwanza markets, Njano is the most preferred overall, selling at an average premium of 10% above the price of both Polista and Sinia. The data for Sinia appear slightly strange as it was easily the most preferred variety in the low season, but the least valued of the three major varieties in the high season. Further investigation of

this suggests that throughout the experiments there may have been some mis-recording of variety between Polista and Sinia. Both these varieties have reddish purple skin, are easily confused and so the similar valuation for Polista and Sinia overall is not totally surprising. Njano has a pale yellow skin and is easily distinguishable.

4.8 Analysis of potato damage by variety

Tables 13 and 14 give a break down of potato damage by variety of potato. The results do not differentiate between minor and major damage and should be treated with caution.

There is evidence of slightly more breaks in the low season and slightly more cuts in the high season, but the reasons for this are unclear and may simply reflect sampler subjectivity or random factors. Larger differences are apparent for shrivelling and weevil damage. 36% of sweet potato show evidence of shrivelling in the high season as opposed to only 15% in the low season. This probably reflects a slower stock turnover when there is more produce in the market place, giving longer periods for shrivelling to develop, and the drier conditions coinciding with the high season. 17% of sweet potato suffered from deep weevil attack in the high season compared to almost none in the low season. This is because the dry conditions in the high season allow weevils to penetrate the soil and to burrow into sweet potato, whilst the soil is generally too wet for this in the low season. Finally, there is little overall evidence to suggest that damage varies significantly between varieties of sweet potato.

Table 13: Analysis of potato damage by variety in the low season

	Total with breaks		Total with cuts		Total with shriv-elling		Total with skin weevil		Total with deep weevil		Total potatoes	
Variety	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Polista	237	40	161	27	98	17	n.a.	n.a.	0	0	590	100
Sinia	63	41	15	10	23	15	n.a.	n.a.	4	3	155	100
Njano	204	48	80	19	63	15	n.a.	n.a.	2	0	421	100
Mwezi Moja	11	55	6	30	4	20	n.a.	n.a.	0	0	20	100
Bilagara	42	65	4	6	4	6	n.a.	n.a.	0	0	65	100
Total	557	45	266	21	192	15	n.a.	n.a.	6	0	1251	100

Note: Figures do not add across since some potatoes have more than one type of damage.

Table 14: Analysis of potato damage by variety in the high season

	Total with breaks		Total with cuts		Total with shriv-elling		Total with skin weevil		Total with deep weevil		Total potatoes	
Variety	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Polista	169	35	158	32	189	39	68	14	76	16	489	100
Sinia	56	36	48	31	37	24	43	28	33	21	154	100
Njano	35	25	47	34	62	45	31	22	34	24	139	100
Mwezi Moja	-	-	-	-	-	-	-	-	-	-	-	-
Bilagara	20	27	27	36	22	30	26	35	5	7	74	100
Total	280	33	280	33	310	36	168	20	148	17	856	100

Note: Figures do not add across since some potatoes have more than one type of damage.

4.9 Multiple regression analysis on low season data

The GENSTAT statistical package was used which performs a series of regressions adding or removing variables to arrive at the best model for the data being analysed. This package allows the inclusion of continuous variables such as the various damage scores and discrete ones such as potato variety. The results of the 'best-fit' multiple regression for the April data are shown in Table 15.

Note that June data are not used in this analysis as the sample regression results shown in Table 10 gave unexpected coefficients for breaks, cuts and shrivelling damage.

Table 15: Multiple regression analysis for low season data

Estimate of regression coefficients:				
Variable / constant	Estimate	Standard error	t statistic	
Constant	144.16	4.88	29.56	
Sinia variety	12.43	4.88	2.55	
Njano variety	8.61	3.06	2.81	
Mwaloni market	0.22	4.31	0.05	
Kirumba market	12.15	5.17	2.35	
Zimbabwe market	-4.46	3.95	-1.13	
Breaks score	-8.17	3.78	-2.16	
Cuts score	-9.99	4.93	-2.03	
Notes: Based on Polista as the standard variety and Central as the standard market (see text). The analysis excludes 11 heaps of Bilagara and 4 heaps of Mwezi Moja varieties as these constitute insufficient data for meaningful analysis.				
Accumulated analysis of variance:				
Variable	Mean sum of squares	Variance ratio	F statistic	Confidence level
Variety	3414.5	10.71	<0.001	>99.9%
Market	1265.4	3.97	0.009	99.1%
Breaks score	1304.2	4.09	0.045	95.5%
Cuts score	1309.4	4.11	0.044	95.6%

The F statistics shown in Table 15 show that we can be over 95% confident that each of variety, market, breaks score and cuts score has an impact on selling price. The regression coefficient estimates can be used to make best estimates of selling price ('y') for Polista variety potatoes in Central market based on the following standard formula:

$$y = 144.16 - 8.17(avbreak) - 9.99\ (avcuts)$$

where 'avbreak' = weighted average heap score for breaks damage
'avcuts' = weighted average heap score for cuts damage

This standard formula needs to be adjusted for other varieties and other markets. For estimates of Sinia and Njano varieties in the same market (Central) we need to add 12.43 and 8.61 respectively to estimates obtained from the above formula. Similarly, for estimates in other markets we need to add or subtract the relevant coefficients from Table 15. As an illustration, the estimated selling prices for unbroken (and uncut) and badly broken (but uncut) potatoes for all combinations of market and variety are shown in Table 16.

Table 16: Estimated selling prices (TShs/kg) for broken and unbroken potato varieties in each market during April 1997

	Variety and damage type					
	Polista		Sinia		Njano	
Market	Bad breaks	No breaks	Bad breaks	No breaks	Bad breaks	No breaks
Central	127.82	144.16	140.25	156.59	136.43	152.77
Mwaloni	128.04	144.38	140.47	156.81	136.65	152.99
Kirumba	139.97	156.31	152.40	168.74	148.58	164.92
Zimbabwe	123.36	139.70	135.79	152.13	131.97	148.31

Note: Estimates based on the regression analysis shown in Table 15.

The results displayed in Table 16 show that broken potatoes are expected to sell at a significant discount to unbroken ones. The same is true for cut as opposed to uncut ones, although a full illustration is not given here. In broad terms, the discounts for damaged potatoes range between 10 and 15% of the value of the undamaged product.

Table 16 also illustrates the variation in the price of sweet potatoes based on both variety and market location. Price differentials by variety are to be expected due to differences in taste, ease of peeling, speed of cooking etc. Price variations by market will relate to such factors as the size of the market, its location and the degree of competition. Notably, Zimbabwe is the main arrival market for potatoes in Mwanza where prices are lowest, whilst Kirumba has the fewest traders, is furthest away from the initial delivery point and has the highest prices.

4.10 Conclusions

The results of this section show that a high proportion of sweet potato entering the market place are damaged in some way. The results also suggest that overall there is a significant reduction in the value of sweet potato if they are damaged. This reduction varies according to the type of damage with cuts and weevil attack having the largest impact on value. Measures to reduce these types of damage will be most appreciated in the market place.

There is also evidence to suggest that there is significant variation in the value of sweet potato by variety. Results show that yellow skinned varieties are preferred and sell at an average premium of 10% above the price of reddish purple ones. This suggests that farmers should attempt to supply more of the Njano variety of sweet potato to the Mwanza markets.

5. References

Kapinga R.E., E.J. Rwiza, S.C. Jeremiah and D. Rees (1996) 'Preference and selection criteria of sweet potato varieties at urban level in the Lake Zone of Tanzania'.

Thomson M.R., G. Ndunguru and E. Rwiza (1996) 'Development of methodologies for testing the relationship between quality and economic value for fresh sweet potato and dried cassava products based on fieldwork performed in Mwanza, Tanzania'.

Appendix 1: Low season valuations of dried cassava (page 1/2)

Product Quality	Trader Number 1	2	3	Average	%
Udaga, fine, white	1400	1500	1200	1367	100.0
Udaga, fine, medium colour	1200	1200	1200	1200	87.8
Udaga, fine, dark	900	1000	1100	1000	73.2
Udaga, large, white	1300	1300	1200	1267	92.7
Udaga, large, medium colour	1200	1200	1100	1167	85.4
Udaga, large, dark	800	800	1100	900	65.8
Makopa, large	1300	1000	1200	1167	85.4
Udaga, mixed, white	1300	1300	1200	1267	92.7
Udaga, mixed, medium colour	1000	1200	1100	1100	80.5
Udaga, mixed, dark	900	750	1100	917	67.1

Notes: Figures shown are in TShs per bucket. A bucket is the standard measure for dried cassava, containing 11 to 14 kg depending on the size of particles.
Data obtained in Zimbabwe market, Mwanza town during December 1996.
To ease the valuation exercise, the products were assessed in the three groups shown.

Appendix 1: Low season valuation of dried cassava (page 2/2)

Product Quality	Customer Number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Av.	%
Udaga, fine, white	1600	1600	1200	1600	1600	1600	1600	1600	1500	1300	1300	1000	1500	1000	1600	1440	100
Udaga, fine, medium colour	1500	900	900	1500	1500	1200	1500	1500	1400	1500	1000	900	1300	900	800	1220	84.7
Udaga, fine dark	800	800	800	800	1000	1500	900	1400	1300	1200	900	800	1000	800	900	993	69.0
Udaga, large, white	1600	1000	1500	1500	1400	1500	1500	1100	1500	1400	1200	1100	1500	1000	1600	1360	94.4
Udaga, large, medium colour	1500	900	1000	900	1500	1300	900	900	900	1600	1000	900	1400	900	1500	1140	79.2
Udaga, large, dark	800	800	800	800	1200	1100	800	800	800	1500	800	800	1100	800	1200	940	65.3
Makopa, large	900	1500	1400	1600	1600	1600	1600	1300	1400	1000	900	1000	1200	1100	1300	1293	89.8
Udaga, mixed, white	1600	1100	1500	1600	1600	1600	1600	1200	1500	1200	1100	1100	1400	1100	1600	1387	96.3
Udaga, mixed, medium colour	1500	900	1200	900	1400	1500	1300	900	900	1500	900	900	1200	900	1300	1147	79.7
Udaga, mixed, dark	800	800	800	800	1100	1400	1100	800	800	1600	800	800	900	800	1200	967	67.2

Notes: Figures shown are in TShs per bucket. A bucket is the standard measure for dried cassava, containing 11 to 14 kg depending on the size of particles.
Data obtained in Zimbabwe market, Mwanza town during December 1996.
To ease the valuation exercise, the products were assessed in the three groups shown.

Appendix 2: High season valuation of dried cassava

Quality	Trader Number 1	2	3	4	5	6	7	Trader average	%	Overall average	%
Fine white *udaga*	2200	2500	2300	2500	2400	2000	2000	2271	100.0	2120	100.0
Large white *udaga*	2000	1800	2000	2300	2500	2400	1900	2129	93.7	2085	98.3
Makopa	1800	1500	1800	2000	2300	2300	1700	1914	84.3	1885	88.9
Large dark *udaga*	1500	1300	1600	1800	2000	1800	1500	1643	72.3	1425	67.2
Fine dark *udaga*	1600	1200	1400	1500	1800	1700	1300	1500	66.0	1270	59.9

Quality	Customer Number 1	2	3	4	5	6	7	8	9	10	11	12	13	Customer Average	%
Fine white *udaga*	2300	2200	2500	2500	2200	1000	1500	2200	1400	2000	2500	2000	2200	2038	98.9
Large white *udaga*	2400	2100	2400	1800	1800	1500	2000	2000	2500	2300	1800	2200	2000	2062	100.0
Makopa	2200	2000	1800	2000	1500	2500	2500	1800	900	2200	1200	1900	1800	1869	90.7
Large dark *udaga*	2100	1800	1500	1700	800	800	1000	1700	1200	1500	800	1200	900	1308	63.4
Fine dark *udaga*	2000	1500	900	1500	1000	600	800	2100	1000	1200	500	1000	800	1146	55.6

Notes: Figures shown are in TShs per bucket. A bucket is the standard measure for dried cassava, containing 11 to 14 kg depending on the size of particles. Data obtained in Zimbabwe market, Mwanza town during June 1997.

Appendix 3: Wet season valuations of dried cassava moulds

	Trader Number					Trader		Customer										Cust.	
Cassava quality	1	2	3	4	5	Average	%	1	2	3	4	5	6	7	8	9	10	Average	%
No mould	2500	2500	2200	2200	2400	2360	100.0	2500	2500	2500	2400	2400	2000	2200	2200	2000	2200	2290	100.0
Orange mould	2000	2200	2000	1800	2250	2050	86.9	2400	2000	2400	2200	2000	1800	1900	2000	1600	2000	2030	88.6
Green mould	1800	1750	1800	1500	2200	1810	76.7	2200	1500	2300	2100	1700	1500	1600	1800	1500	1700	1790	78.2
Black mould	1500	1400	1500	1000	2100	1500	63.6	2000	1300	1900	1500	1000	1300	1400	1200	1300	1500	1440	62.9

Notes: Figures shown are in TShs per bucket. A bucket is the standard measure for dried cassava, containing 11 - 14 kg depending on the size of particles. Data obtained in Zimbabwe market, Mwanza town during April 1997.

Appendix 4: Low season valuation of sweet potato

	Trader Number					Trader		Customer Number															Customer		Overall	
Quality	1	2	3	4	5	Av.	%	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Av.	%	Av.	%
Good	200	200	200	200	200	200.0	100	200	200	200	200	200	200	200	200	200	190	200	200	200	200	200	200.0	100	200.0	100
Cuts	180	190	180	190	190	186.0	93.0	160	170	190	190	150	130	120	140	150	200	180	190	180	180	170	166.7	83.4	171.5	85.8
Breaks	150	180	140	180	180	166.0	83.0	190	180	180	180	130	150	150	180	170	180	170	170	170	160	150	167.3	83.7	167.0	83.5
Deep Weevils	130	120	120	150	120	128.0	64.0	140	120	120	120	120	120	130	120	120	120	130	130	120	120	120	123.3	61.7	124.5	62.3

Notes: Values are in TShs per heap. All heaps weighed around 1.4 kg and contained five Polista variety potatoes.
Data obtained in Zimbabwe market, Mwanza town during April

Appendix 5: High season valuation of sweet potato (market 1)

	Trader Number							Trader		Customer Number													Customer		Overall	
Quality	1	2	3	4	5	6	7	Av.	%	1	2	3	4	5	6	7	8	9	10	11	12	13	Av.	%	Av.	%
Good	200	200	200	200	200	200	200	200.0	100	200	200	200	200	200	200	200	200	200	200	200	200	200	200.0	100	200.0	10
Shrivelled	190	170	180	100	190	180	60	152.9	76.4	90	160	150	180	190	100	150	180	150	180	160	180	170	156.9	78.5	155.5	77.
Broken	180	150	150	130	170	160	150	155.7	77.9	140	140	90	130	150	150	100	150	140	170	180	160	180	144.6	72.3	148.5	74.
Cut	170	100	100	150	180	150	100	135.7	67.9	100	120	100	150	130	80	90	120	130	160	170	140	150	126.2	63.1	129.5	64.
Skin Weevils	150	70	130	80	160	170	80	120.0	60.0	150	100	80	100	80	60	60	70	100	150	150	100	140	103.1	51.5	109.0	54.
Deep Weevils	160	50	80	50	140	70	50	85.7	42.9	50	80	60	90	50	50	50	100	120	120	140	80	100	83.8	41.9	84.5	42.

Notes: Values are in TShs per heap. All heaps weighed around 1.4 kg and contained five Polista variety potatoes.
Data obtained in Zimbabwe market, Mwanza town during June

Appendix 6: High season valuation of sweet potato (market 2)

Quality	Trader Number 1	2	3	4	5	Trader Average	%	Customer Number 1	2	3	4	5	Customer Average	%	Overall Average	%
Good	200	200	200	200	200	200.0	100.0	200	200	200	200	200	200.0	100.0	200.0	100.0
Shrivelled	160	140	100	100	80	116.0	58.0	100	150	140	170	100	132.0	66.0	124.0	62.0
Broken	180	190	150	150	130	160.0	80.0	90	130	130	150	60	112.0	56.0	136.0	68.0
Cut	170	160	160	80	150	144.0	72.0	70	120	120	160	120	118.0	59.0	131.0	65.5
Skin Weevils	190	170	170	180	180	178.0	89.0	150	140	150	180	180	160.0	80.0	169.0	84.5
Deep Weevils	150	150	70	50	100	104.0	52.0	50	110	100	140	150	110.0	55.0	107.0	53.5

Notes: Values are in TShs per heap. All heaps weighed around 1.4 kg and contained five Polista variety potatoes.
Data obtained in Kirumba market, Mwanza town during June 1997.

Appendix 7: Trader formation of sweet potato heaps of various damage types

	Trader 1				Trader 2				Trader 3				Trader 4				Average		
Quality	No. pots	Weight grams	Price TShs	Price / kg	No. pots	Weight grams	Price TShs	Price / kg	No. pots	Weight grams	Price TShs	Price / kg	No. pots	Weight grams	Price TShs	Price / kg	No. pots	Price / kg	% of good
Good	5	1525	200	131.1	5	1400	200	142.9	5	1475	200	135.6	5	1400	200	142.9	5.00	138.1	100
Shrivelled	12	2000	200	100.0	8	1600	200	125.0	8	1750	200	114.3	7	1550	200	129.0	8.75	117.1	84
Breaks	9	2375	200	84.2	7	1925	200	103.9	7	2050	200	97.6	6	1600	200	125.0	7.25	102.7	74
Cuts	4	2350	200	85.1	4	1650	200	121.2	5	2350	200	85.1	4	1900	200	105.3	4.25	99.2	71
Surface weevil	4	2350	200	85.1	5	2275	200	87.9	4	2875	200	69.6	4	2100	200	95.2	4.25	84.5	61
Boring weevil	5	1600	100	62.5	9	2125	100	47.1	7	1875	100	53.3	5	1200	100	83.3	6.50	61.6	44

Notes: Prices refer to price per heap of Polista variety potatoes.
Data obtained in Kirumba market, Mwanza town during June 1997.

Appendix 8: Sample characteristics of sweet potato heaps using in the statistical analysis
(based on location, selling price and variety)

Analysis by location						
	Low season		High season		Total	
Market	Number	%	Number	%	Number	%
Central	46	25	38	27	84	26
Mwaloni	58	32	39	27	97	30
Kirumba	19	10	21	15	40	12
Zimbabwe	61	33	45	31	106	32
Total	184	100	143	100	327	100

Analysis by heap selling price						
	Low season		High season		Total	
Price	Number	%	Number	%	Number	%
100/=	57	31	25	17	82	25
200/=	107	58	104	73	211	65
300/=	20	11	14	10	34	10
Total	184	100	143	100	327	100

Analysis by variety						
	Low season		High season		Total	
Variety	Number	%	Number	%	Number	%
Polista	86	47	79	55	165	50
Sinia	21	11	27	19	48	15
Njano	62	34	23	16	85	26
Mwezi Moja	4	2	0	0	4	1
Bilagara	11	6	14	10	25	8
Total	184	100	143	100	327	100