R2375(S)

Losses in sweet potato quality at harvest and during the post-harvest handling in the Mwanza Region of Tanzania

K. I. Tomlins[1], G. T. Ndunguru[2] and E. Rwiza[3]

February 1998

Project A0500

Tanzania Food and Nutrition Centre[2]
PO Box 977
Dar es Salaam
Tanzania

ARI-Ukiriguru[3]
Box 1433
Mwanza
Tanzania

Natural Resources Institute
The University of Greenwich

CONTENTS

ACRONYMS AND ABBREVIATIONS

DFID	Department for International Development
g	Acceleration
Kg	Kilogram
NRI	Natural Resources Institute
TFNC	Tanzania Food and Nutrition Centre
TShs (/=)	Tanzanian Shillings US$ 1 = 660/= approx. UK£ 1 = 1,015/= approx.

ACKNOWLEDGEMENTS

The authors 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. Special thanks are given to Mr M Mkungu, Agricultural Extension worker, for assisting with the sourcing and procurement of sweet potatoes from the farmers in the Kahunda Division, Serengerema District. Also, thanks to Mr J 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 (DFID). DFID cannot accept responsibility for any of the information provided or views expressed. [R6508; Crop Post-Harvest Programme.]

SUMMARY

A preliminary survey of the sweet potato marketing chain, from the farm to the market, indicated that substantial loses in quality can occur at all stages. Sacks, containing between 107 and 114 kg of sweet potatoes took between 16 and 23 hours to reach the market. After leaving the farm, they were transported by bicycle, trolley, canoe, ship and light commercial vehicle. Assessment of the sweet potatoes, immediately after harvesting, indicated that approximately 20% to 35% of the sweet potatoes had minor cuts, 14% to 28% had breaks, 19% to 60% had signs of minor skinning, 13% to 59% had skin weevil and 1% to 4% burrowing weevil damage. After transport from the farm to the market, the level of damage in freshly harvested sweet potatoes increased such that 100% of the sweet potatoes had skinning damage, most severely, and 38% to 56% had breaks. Transport had little impact on the proportion of sweet potatoes with cuts or weevil damage. Shrivelled sweet potatoes were less susceptible to damage. The presence of rots, however, led to the sweet potatoes receiving a nominal market value.

Handling of the sacks was monitored by visual observations and by shock, temperature and humidity measurements recorded by an 'electronic sweet potato', designed and assembled at NRI, which was inserted into the centre of the sacks. The most severe handling (shocks above 20 g) occurred during loading and unloading from the ship, at the customs station of the port and at the markets and appeared to be associated with the occurrence of major breaks. The temperature (22°C to 34°C) in the sacks was optimum for curing although the very high humidity (greater than 95%) might lead to the occurrence of rots. Further studies will investigate seasonal variations along with other methods of transport to suggest practical and economic recommendations on improved transport and handling practices and direct future research.

INTRODUCTION

Sweet potato is an important staple food crop in several areas of Tanzania. It is increasingly being marketed providing an important source of income for rural producers and providing an important source of food to the rapidly expanding urban population. Previous work (Thomson *et al,* 1997) has identified important quality characteristics which can be divided into variety, size and damage categories. The study found that both traders and customers placed lower valuations on damaged sweet potatoes than undamaged ones. Weevil attack lead to the greatest reduction in value, with average discounts of about 30 to 40% for surface attack and 50% for deeper attack. Smaller but significant discounts of 10 to 30% occur if a sweet potato is shrivelled, cut or broken. Sweet potatoes with evidence of rots have no value. It was suggested that the priority suggested was to reduce the number of weevil damaged sweet potatoes entering the market, in particular the burrowing weevil. A second priority was to reduce breaks, cuts and shrivelling.

Little has been published on the influence of post harvest handling of sweet potatoes and quality. Recent work on losses during storage of sweet potatoes (Rees *et al,* 1997) in Tanzania suggested that cultivars differed in their rate of perishability, rotting was related to the degree of weight loss during the first week of storage, sweet potatoes with a high dry matter might deteriorate more rapidly and the effect of damage (cuts) on deterioration did not vary with cultivar. Mechanical injuries sustained by retailing in bulk in New York supermarkets produced approximately 5% of unsaleable sweet potatoes through *Rhizopus* soft rot decay and moisture loss (Woolfe 1992). Studies in North Carolina, USA have suggested that the optimum weight of sweet potatoes in shipping cartons should not exceed 18 kg to reduce skinning, cut and break damage (Estes *et al,* 1989). Sweet potato skinning injury can be reduced by pre-harvest canopy removal (Bonte and Wright 1993). A linear relationship between reduction in skinning damage and length of time the canopy was removed prior to harvest was reported; it was reduced by 62% if the canopy was removed ten days before harvest. Weight loss in sweet potatoes can be used to predict the level of skinning injury during harvest and subsequent handling (Strikeleather and Harrell 1990).

This study uses a novel low cost 'electronic sweet potato' comprising three commercially available lightweight and compact dataloggers (shock, temperature and humidity). Previous studies have utilised 'electronic potatoes' to study the effect of mechanised systems (transport on conveyors, mechanical harvesters, packaging) on the post harvest handling of Irish potatoes where 20% to 25% losses have been reported (Kempen 1991). These electronic potatoes, however, only utilised shock or pressure sensors. Work has suggested that damage to potatoes increases when potatoes are stored at the low temperatures, and could be reduced by cushioning the surface, on which the tubers were dropped, with foam (Mathew and Hyde 1997). The number of times a potato was dropped onto a conveyor correlated more with damage than the strength or severity or the drop (Leppack 1996, Molema *et al,* 1997). Studies in the Czech Republic have showed that loss in moisture and increases in tuber weight increase the resistance to damage (Cmunt 1997).

The aim of this study was to survey the current methods of post-harvest handling of sweet potatoes and identify stages that influence quality. This will assist in directing future research on sweet potato quality.

MATERIALS AND METHODS

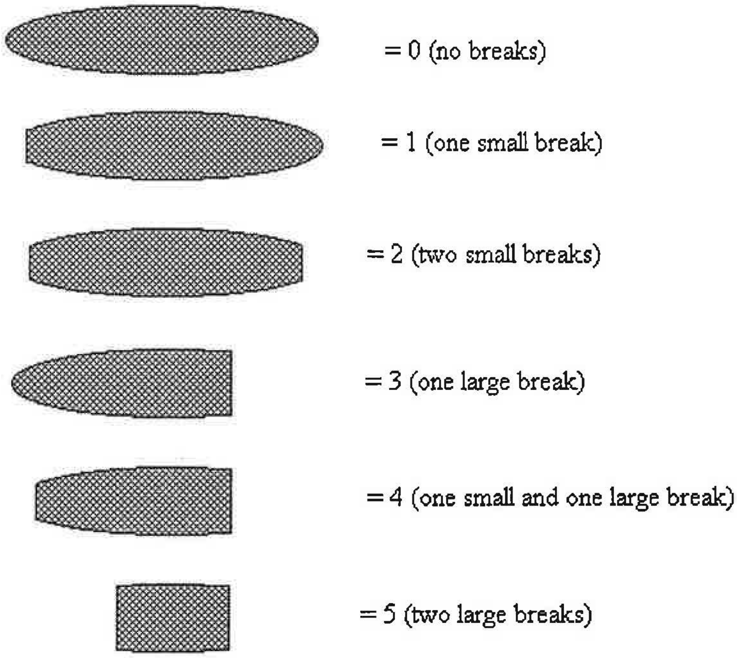
Quality assessment

Post harvest quality, at the farmers field and at varying stages in the transport chain, were assessed using a method as reported by Thomson *et al,* 1997. A total of 40 sweet potatoes were selected at random and assessed for breaks, cuts, shrivelling, skin weevil, burrowing (African sweet potato) weevil, bruising and rotting using the scoring system in Table 1 and Figure 1:

Figure 1: Scoring system for damage in sweet potatoes

Damage description	Scoring system
Cuts	0 = none, 1 = minor, 2 = major
Shrivelling	0 to 5 (0 = none, 5 = severe)
Skin weevil	0 to 5 (0 = none, 5 = severe)
Burrowing weevil	0 or 1 (0 = none, 1 = present)
Bruising	0 to 5 (0 = none, 5 = severe)
Rotting	0 to 5 (0 = none, 5 = severe)

Figure 1: Scoring system for breaks in sweet potatoes:



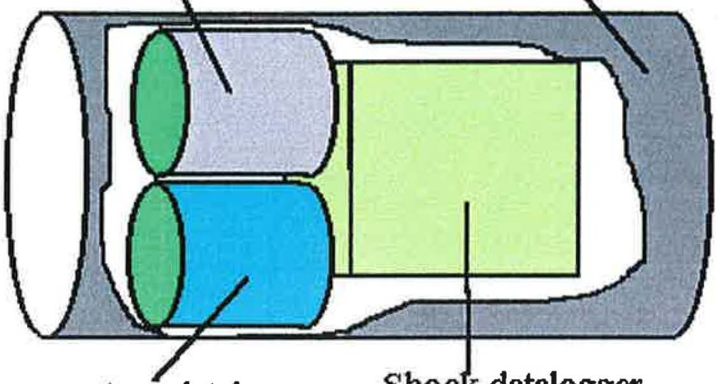
Sampling of sweet potatoes in the marketing chain

Sweet potatoes were assessed at the farmers field, at the lake shore (2 to 5 hours), at the customs station at Mwanza port (16 to 18 hours) and at the markets in Mwanza (18 to 21 hours). Where control sacks remained at the farm, they were assessed at 4, 18 and 19 hours.

Evaluation of the temperature, humidity and shock using an 'electronic sweet potato'

The temperature, humidity and motion of the sacks were recorded by means of an 'electronic sweet potato' (figure 2) comprising a ventilated tubular plastic pipe (16 cm long and 6.5 cm diameter) fitted with temperature (-20 to 75°C +/- 1°C), humidity (0% to 90% +/- 5%) and shock (0 to 50 g +/1 10%) dataloggers (RS Components, UK). The temperature and humidity dataloggers were set to record every 10 minutes while the shock datalogger recorded the maximum acceleration (g) at either 30 s or 1 minute intervals.

Figure 2: Electronic sweet potato



where: the logger housing (plastic pipe) was ventilated with a series of 8 mm holes

RESULTS AND DISCUSSION

A survey of traders in the markets at Mwanza (Mwaloni, Kirumba, Central and Zimbabwe) identified the following:

- sweet potatoes were obtained from the Kahunda Division of Sengerema District which could be reached by overnight ferry which visited once a week;
- the most common varieties on sale were polista, sinia and mzondwa;
- the methods of transport used comprised of bicycle, trolley, canoe, ship and commercial light vehicle;
- market traders usually purchase the sweet potatoes from the farmer before they were harvested. The trader would then be responsible for organising the labour and transport of the sweet potatoes to the market. On other occasions, the farmers harvest the sweet potatoes and sell to a trader or a trader would buy from several farmers during an open market day which was usually the day before the ship arrived;
- a sack of sweet potatoes (100 to 120 kg) costs between Tsh5,000 (main season) and Tsh16,000 (low season), the empty sack Tsh400, transport on the ferry Tsh1200 and government duty Tsh300. Other costs are labour to harvest the sweet potatoes, transport to the ferry, unloading from the ship and transport to the Mwanza markets.

Surveys

A total of three consignments of polista sweet potatoes were monitored which took between 16 and 23 hours to transport from the farm to the market. The short supply of sweet potatoes during the low season, restricted the design of the studies.

Survey 1

This comprised one sack of sweet potatoes, with some deterioration, which was transported to the market where the quality was assessed.

Survey 2
This comprised six sacks, three of which were transported to the market, the other three remaining on the farm to form controls. Single sacks were opened after 4, 18 and 18 hours which corresponded to the lake shore, customs at Mwanza port and the market in Mwanza.

Survey 3
This comprised six sacks, all of which were transported to the market. Sacks were assessed, in duplicate, at the lake shore, customs at Mwanza port and the market in Mwanza.

General observations regarding the handling of the sweet potatoes
Observations of the treatments received by the sweet potatoes at the farm, lake shore, on the ferry, customs station at the port and at the market are given below.

Farm
Sweet potatoes were usually harvested on the day or the day before they were shipped. On occasions, however, they might have been harvested several days earlier. Filling the sacks with sweet potatoes required skill and expertise. The farmers stuff as many sweet potatoes into each sack in order to attract buyers. This was observed to scrape the skin of the sweet potatoes (skinning). The sacks were overfilled and the sweet potatoes at the top were covered with sweet potato vines and carefully tied down with twine. The sacks weighed between 107 and 114 kg.

Lake shore.
The sacks were transported (0.5 to 6 miles) to the lake shore singly by bicycle or in bulk by trolley (up to 9 sacks). The sacks were gently loaded onto bicycles but could be handled roughly when loaded onto the trolley. The bicycles and trolleys were pushed by hand along dirt tracks.

When the sacks were unloaded at the lake shore, they could be dropped from a height as great as 1.5 m onto the sand or possibly onto other sacks of sweet potato. During the wait (4 hours) for the ship to arrive, it was noted that the sacks were sat and stood on by a number of people.

Transport by ferry
The ferry was capable of carrying several vehicles and took up to 10 hours to travel from Kahunda to Mwanza port. The sacks were roughly handled when loaded onto the ferry. They were rolled up a steep metal ramp into the hold of the ship. On arrival at Mwanza port, porters would carry the sacks on their shoulders and drop them onto a concrete surface or other sacks of sweet potato at the customs station.

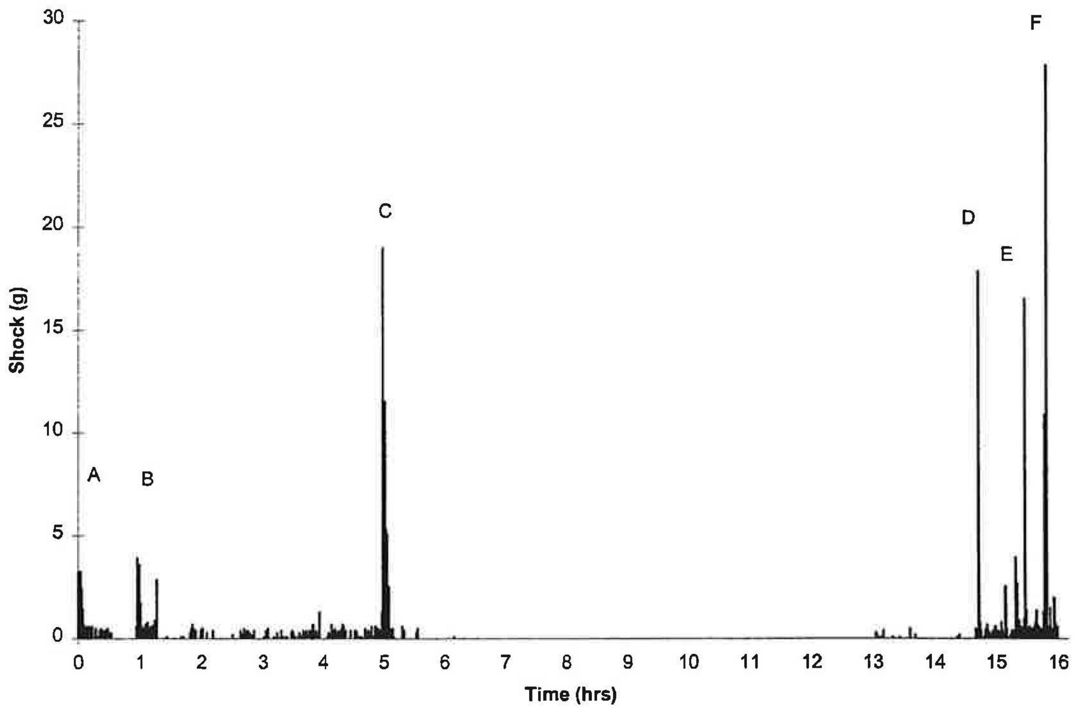
Customs station
At the customs station, the sacks were weighed and were roughly handled. Sacks could be dropped by up to 1.5 m, walked and stood on and piled on top of one another.

Market
The sacks were transported to market in Mwanza (2 miles) in the back of a light commercial vehicle. At the market, the sacks were carried on the shoulders of a porter who would drop the sack from shoulder height onto the ground.

Shock, temperature and humidity dataloggers (electronic sweet potato)

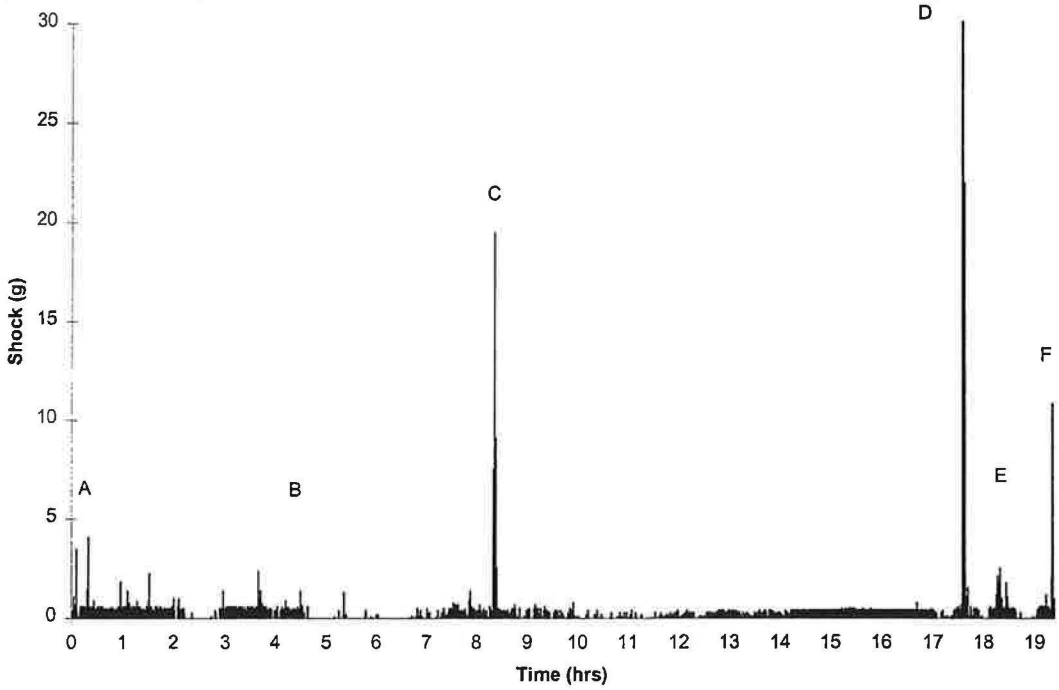
Shock datalogger
The shock profiles for surveys 1 to 3 are shown in Figures 3 to 6. The stages at which the sacks were observed to be subjected to large shocks correspond to the locations on the figures marked A (loading onto a bicycle or trolley at the farm), B (unloading at the beach), C (loading on the ferry), D (unloading from the ferry), E (handling at the customs station) and F (handling at the market). The largest shocks consistently occurred at Mwanza port (unloading from the ship and handling at customs) and at the market by the traders. Loading the sacks onto the ferry from the lake shore was also an area where the sack could receive large shocks (up to 20 g) although this was more variable. The sacks were either carried, then dropped or rolled along the ground. A further area of handling occurred when the sacks were loading onto the trolley at the farm (survey 3). Transport from the farm to the lake shore (between points A and B) resulted in a large number of minor shocks.

Figure 3: Survey 1 - Shock profile (1 minute resolution) of a sack of sweet potatoes when transported from the farm to the market (5 to 6 February 1998).



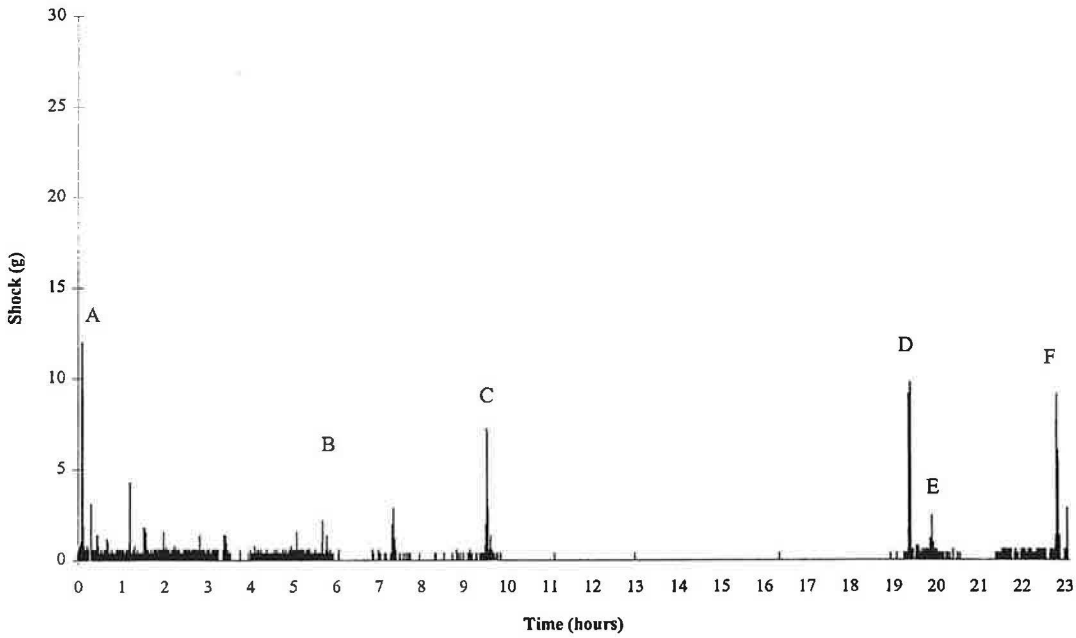
Where A = loading onto bicycle, B = unloading onto sandy beach on shore of Lake Victoria, C = loading onto the ferry, D = unloading from ferry at Mwanza port, E = handling at port customs and loading onto a light commercial vehicle, F = transport to market and unloading

Figure 4: Survey 2 - Shock profile (30 second resolution) of a sack of sweet potatoes transported from the farm to the market (12 to 13 February).



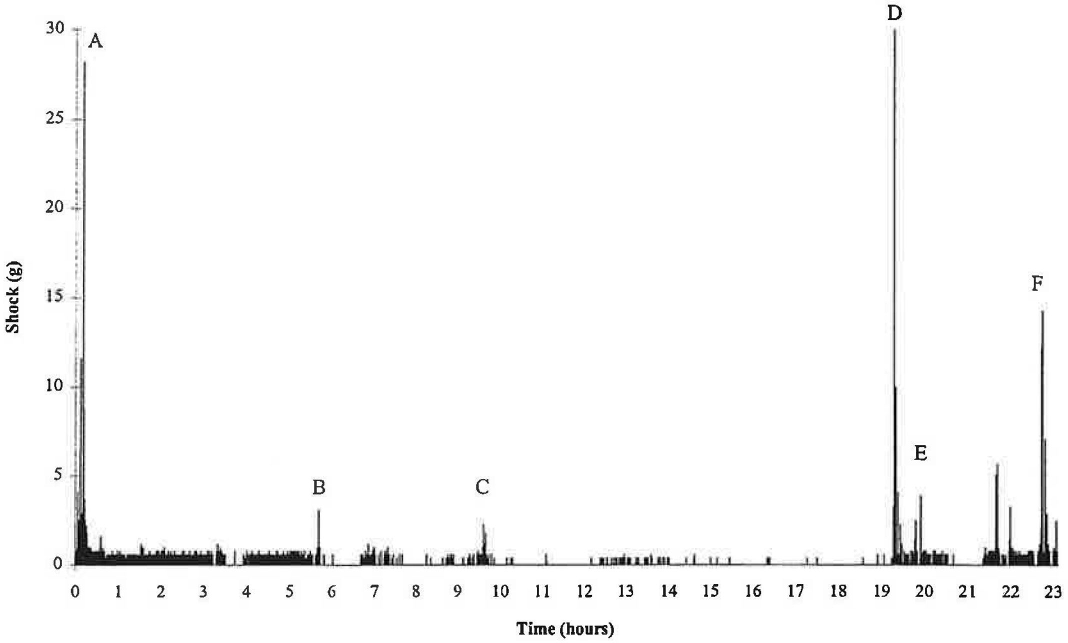
Where A = loading onto a trolley, B = unloading onto sandy beach on shore of Lake Victoria, C = loading onto the ferry, D = unloading from ferry at Mwanza port, E = handling at port customs and loading onto a light commercial vehicle, F = transport to market and unloading

Figure 5: Survey 3 - Shock profile (30 second resolution) of sack 1 (19 to 20 February 1998).



Where A = loading onto a trolley, B = unloading onto sandy beach on shore of Lake Victoria, C = loading onto the ferry, D = unloading from ferry at Mwanza port, E = handling at port customs and loading onto a light commercial vehicle, F = transport to market and unloading

Figure 6: Survey 3 - Shock profile (30 second resolution) of sack 2 (19 to 20 February 1998).

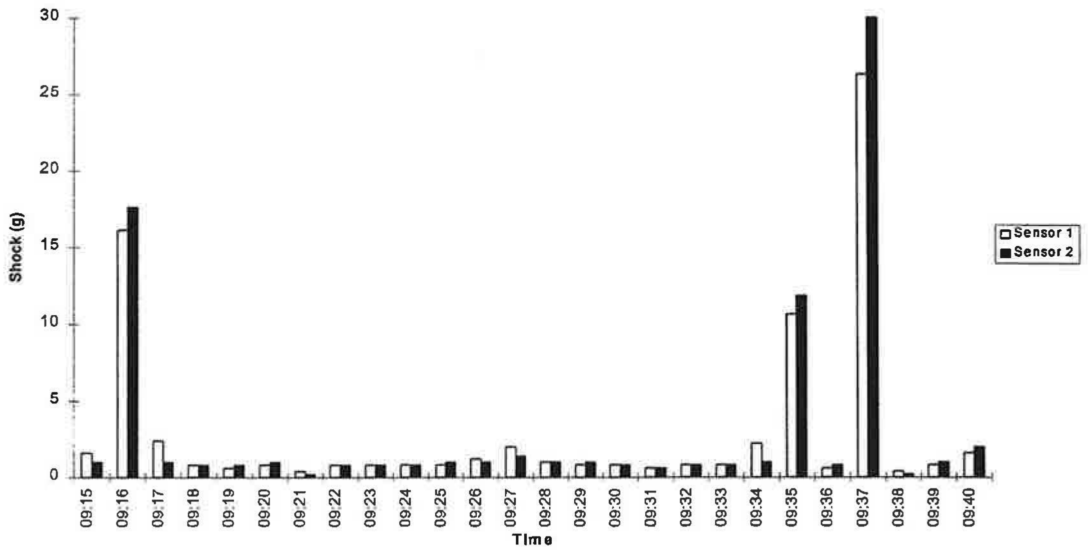


Where A = loading onto a trolley, B = unloading onto sandy beach on shore of Lake Victoria, C = loading onto the ferry, D = unloading from ferry at Mwanza port, E = handling at port customs and loading onto a light commercial vehicle, F = transport to market and unloading

Comparison of shock dataloggers.

The tinytag shock dataloggers contains a single piezo electric sensor that monitors in one axis only. Two shock dataloggers, positioned at different axes, were placed at the centre of a sack that was transported to the market Figure 7 indicates that the dataloggers gave similar results. It was noted, however, that on some occasions, the dataloggers did differ. It is thought that these shocks might not have been within the sensitivity range of 2 to 20 ms.

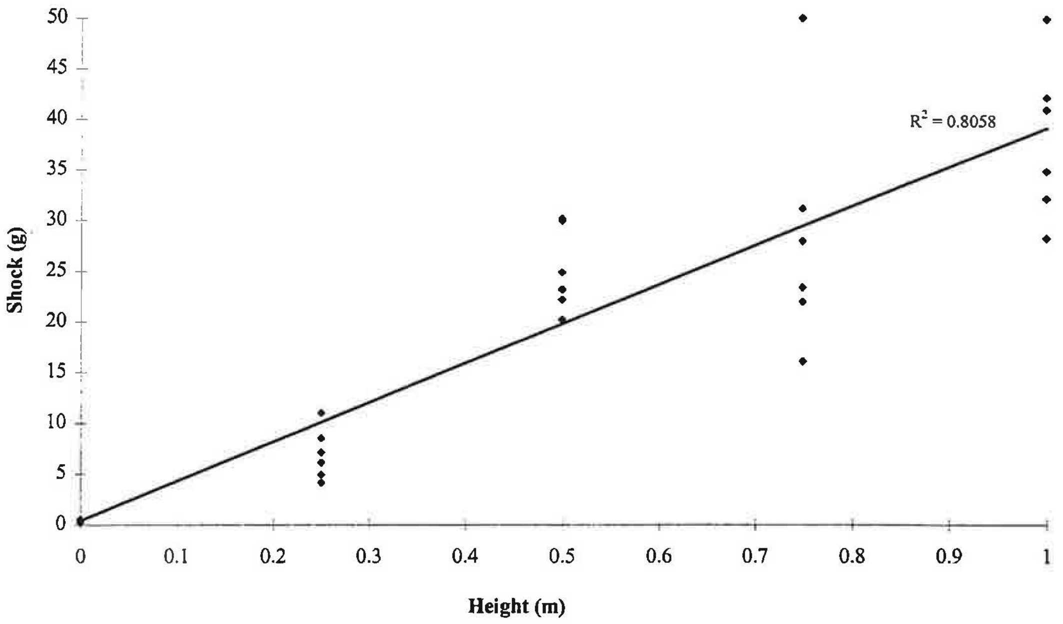
Figure 7: Comparison of shock dataloggers positioned at different planes within a sack of sweet potatoes.



Relationship between acceleration (g) measured by the shock datalogger and the height that a sack was dropped

Figure 8 shows the relationship between the shock (g) recorded by the dataloggers and the height (m) that the sack (120 kg) was dropped onto firm dirt ground. This was achieved by lifting the sack using a simple pulley and rope. The curve indicates that the shock recorded by the datalogger increases with the height from which the sack was dropped. The scatter in the data is thought to be because of the difficulty in releasing the rope in a consistent manner and vibration of the sweet potatoes within the sack.

Figure 8: Relationship between shock (g) and height (m) for a sack (120 kg) of sweet potatoes.



<u>Temperature datalogger</u>

The temperature dataloggers were set to record at ten minute intervals. The temperatures within the sacks for surveys 1 to 3 are given in Figures 9 to 12.

Considering survey 1 (Figure 9), a total of four temperature dataloggers were buried in a sack; two in the centre, at the top and bottom. The temperature within the sack varied by up to 10°C and differed between the locations. The temperatures were similar in the centre and bottom where it steadily increased by between 3°C and 6°C for the first 6 to 7 hours after which it started to decline. The temperature at the top followed a different pattern with little change for the first 6 hours followed by a decline of 5°C. This decline might be caused by two effects; firstly, the front of the sack was facing the wind and secondly, the vines covering the top kept it cool.

For surveys 2 and 3 (Figures 10 and 11), the ambient temperatures on these particular days were lower as were the temperatures in the centre of the sacks. The change in temperature over time was similar with an increase for the first 5 to 15 hours, followed by a plateau and then a decline.

The ambient temperature, however, appears to have a large influence on the internal temperature in the sacks. These temperatures are within those considered suitable for curing (Woolfe 1992).

Figure 9: Survey 1 - Temperature in sack transported to market

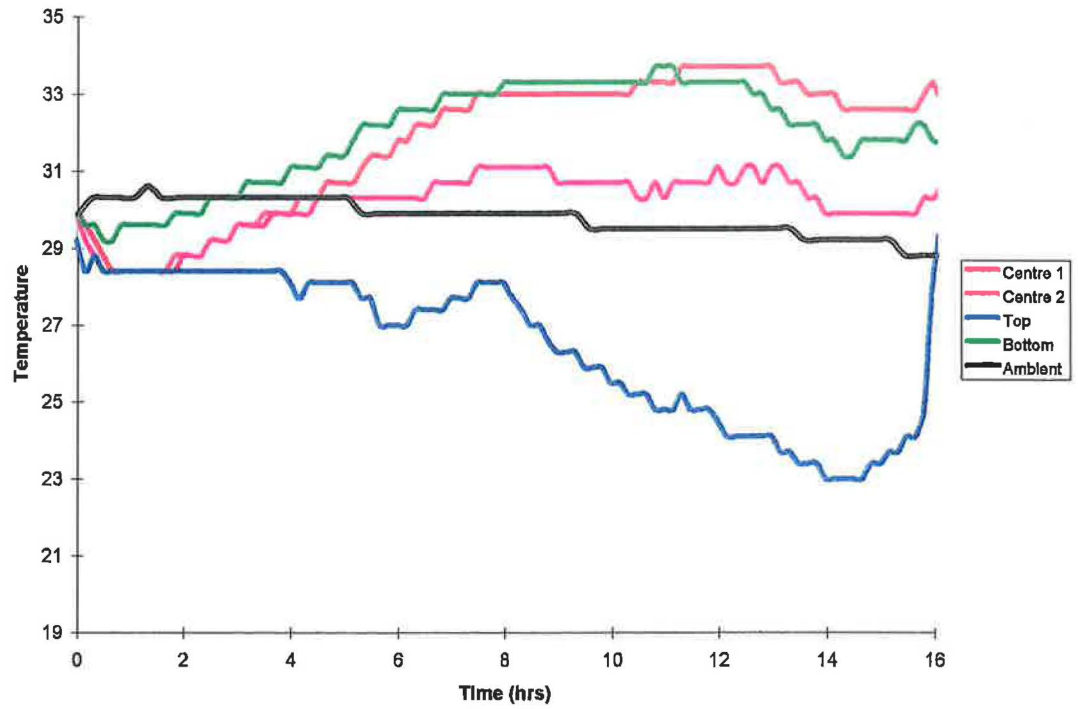


Figure 10: Survey 2 - Temperatures in transported and control sacks

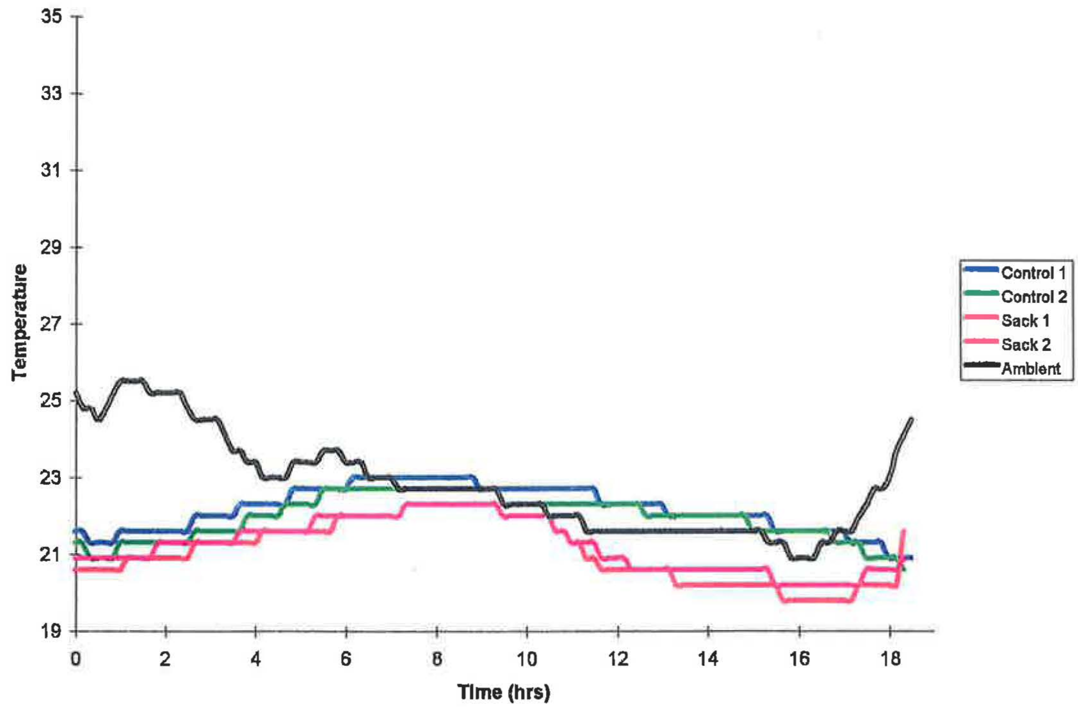
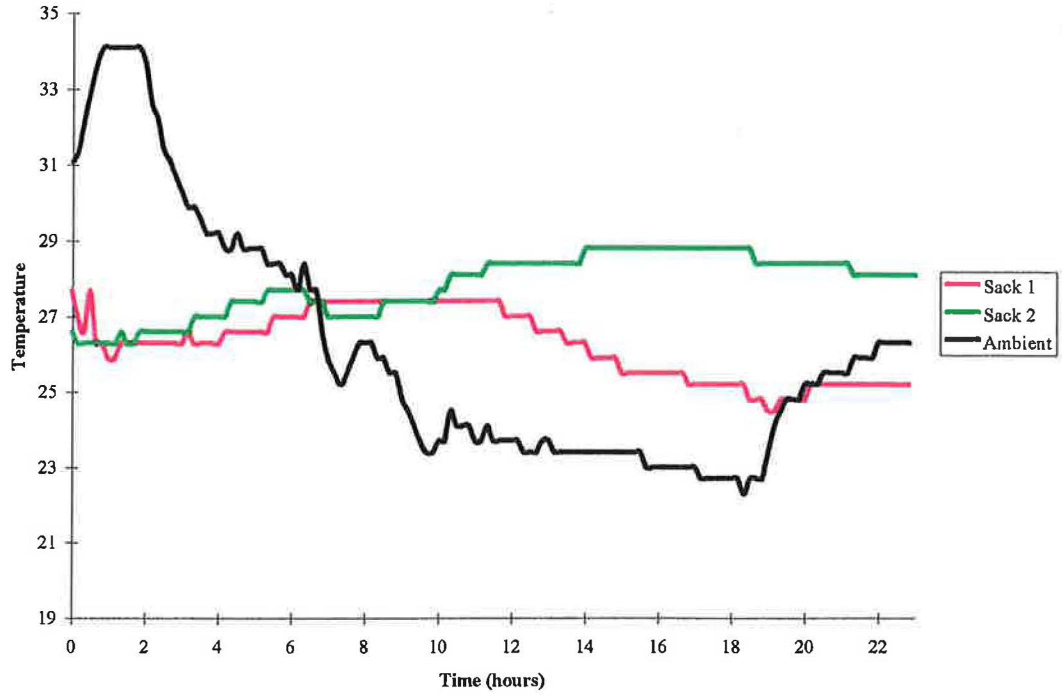


Figure 11: Survey 3 - Temperature during transportation (sack 1 and 2)



Humidity datalogger

The humidities recorded in surveys 1, 2 and 3 are given in Figures 12 to 14. In survey 1 (Figure 12), the humidity differed with location, the humidity being lowest at the top, which was exposed to the wind. In all three surveys, the humidity in the sack was higher than the ambient and rose to 95% or greater after 4 to 12 hours; this was greater than the humidity of 80 to 85% recommended for curing (Woolfe 1992). The high humidity might accelerate the formation of rots of which *Fusarium oxysporum* is associated with rough handling and is widespread in the tropics (Woolfe 1992).

Figure 12: Survey 1 - Humidity in sack transported to market

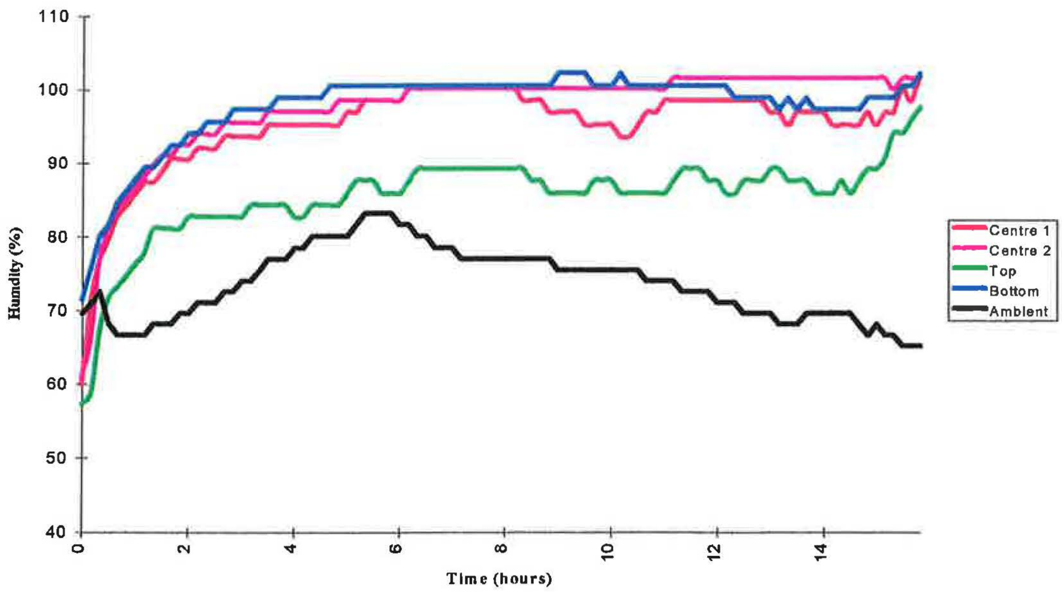


Figure 13: Survey 2 - Humidity in a sack on the farm and one being transported

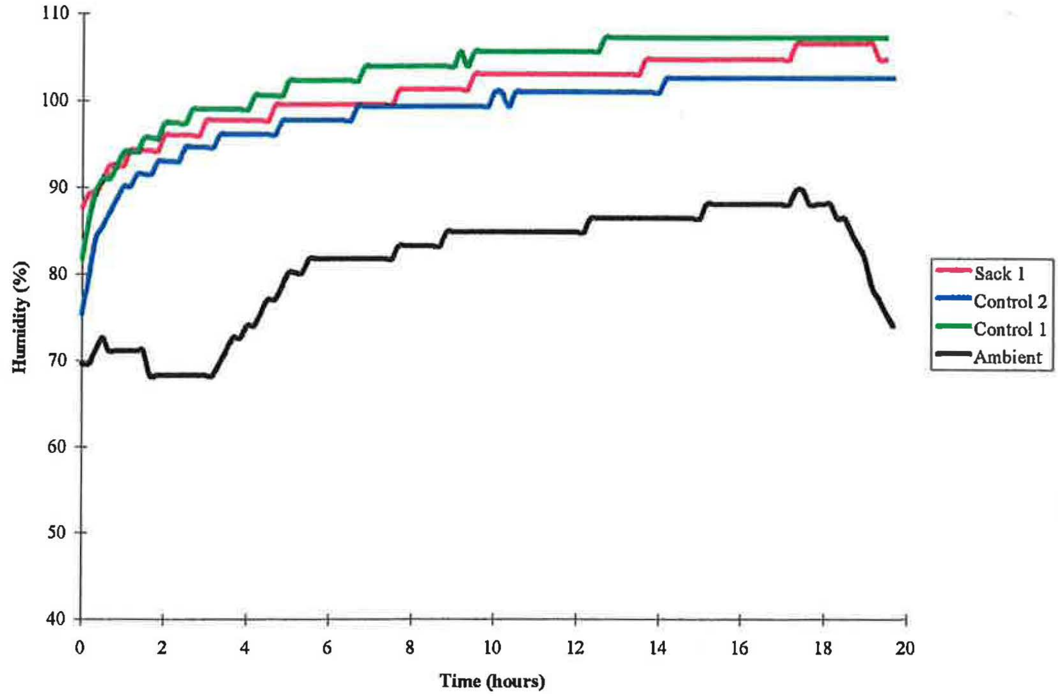
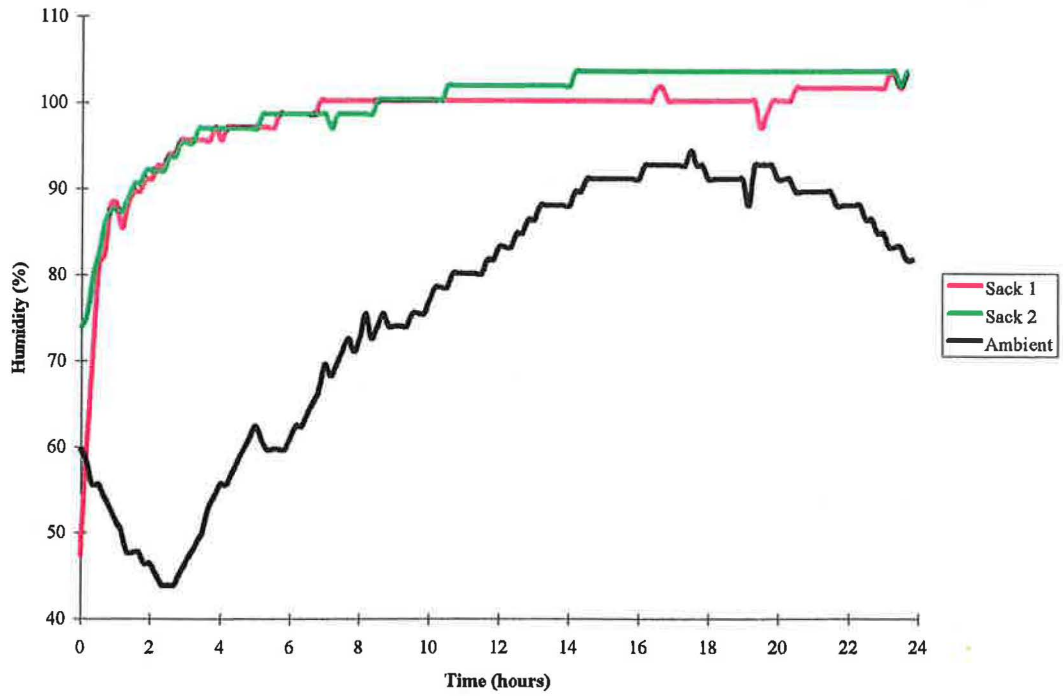


Figure 14: Survey 3 - Humidity in transported sacks



Weight loss during transport

Sacks weighed between 107 and 114 kg. The weight loss after transportation to the market was minimal (1%) and there was no evidence of shrivelling if they were transported when fresh.

Quality evaluation of the sweet potatoes

At harvest

At the farm, a total of 40 sweet potatoes were randomly selected and assessed for breaks, skinning, cuts, rots, shrivelling and weevil damage (skin and burrowing). The proportion of sweet potatoes with cuts varied between 20 and 35%, skin weevil 13% to 59% and burrowing weevil 1% to 4% (Table 1). Surveys 2 and 3 were almost entirely free of rots. Study 1, however, did have a high proportion of rots (estimated at 20%). Analysis showed that cuts and weevil damage did not vary during transport.

Table 1: Defects at harvest

Type of damage	Survey 1	Survey 2	Survey 3
Breaks			
minor	13%	24%	20%
major	3%	4%	5%
Skinning	-		
minor	-	19%	53%
major		0%	6%
Cuts	35%	26%	20%
Skin weevil	59%	13%	26%
Burrowing weevil	2%	1%	4%
Rots	20%	2%	0%

Effect of transport on the proportion of broken sweet potatoes

The per cent broken sweet potatoes at different stages in the marketing chain are given in Figures 15 to 19 for surveys 1 to 3. Minor breaks comprised the sum total of sweet potatoes which received a score of 0, 1 or 2 and major breaks comprised the sum of scores 3 to 5.

In survey 1 (Figure 15), the proportion of broken sweet potatoes was small and had not significantly increased as a result of being transported to the market. This is probably because the sweet potatoes were already in poor condition when purchased, many showing signs of shrivelling.

In survey 2, half the consignment remained on the farm to assess the effect of storage in the sack on quality (Figure 16), and the other half was transported (Figure 17). Of the sacks remaining on the farm, the proportion of broken sweet potatoes did not appear to change. The apparent decline in breaks is thought to be caused by sampling error. When transported, however, the proportion of broken sweet potatoes did not increase until they reached the market where 26% of the sweet potatoes had minor breaks and 30% major breaks. At the customs station, there was some indication that the proportion of broken sweet potatoes transported in the sack had also increased, relative to those remaining on the farm.

Survey 3 shows that the handling varied from sack to sack, as shown by the shock datalogger (Figures 5 and 6). Sack 2, received the greatest shocks as indicated by the shock datalogger and at the market had the greatest number of major breaks (25%), compared to sack 1 (8%). The variation in handling from sack to sack also means that it is more difficult to interpret the sweet potatoes that were evaluated at the lake shore and customs since they were not the same sack.

Figure 15: Survey 1 - Broken sweet potatoes (%) when transported from the farm to the market.

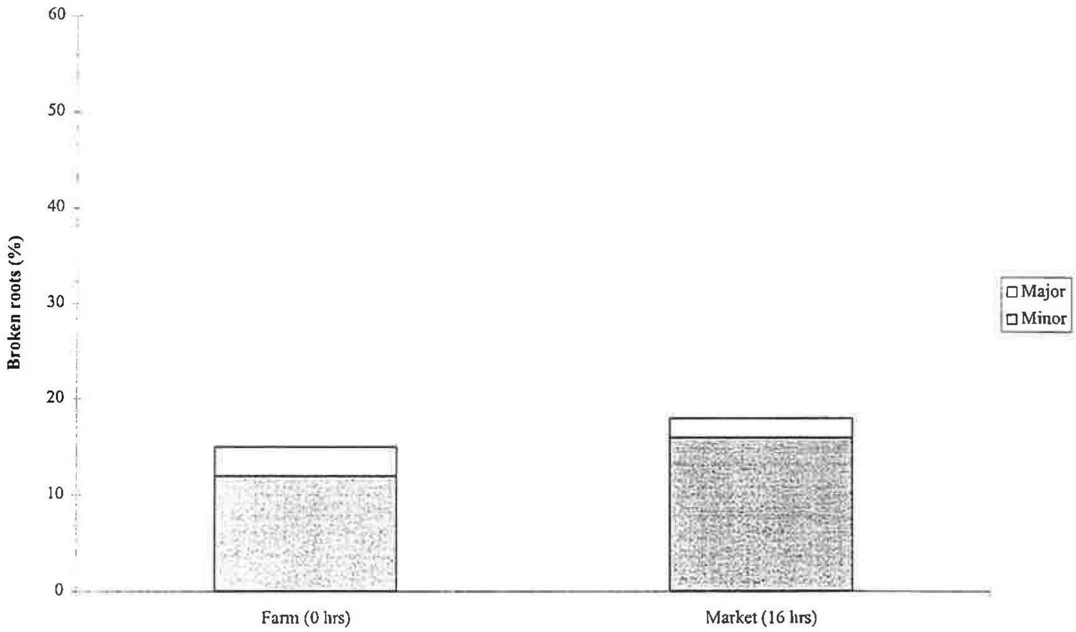


Figure 16: Survey 2 - broken sweet potatoes (%) when left on the farm for 0, 8, 18 and 19 hours.

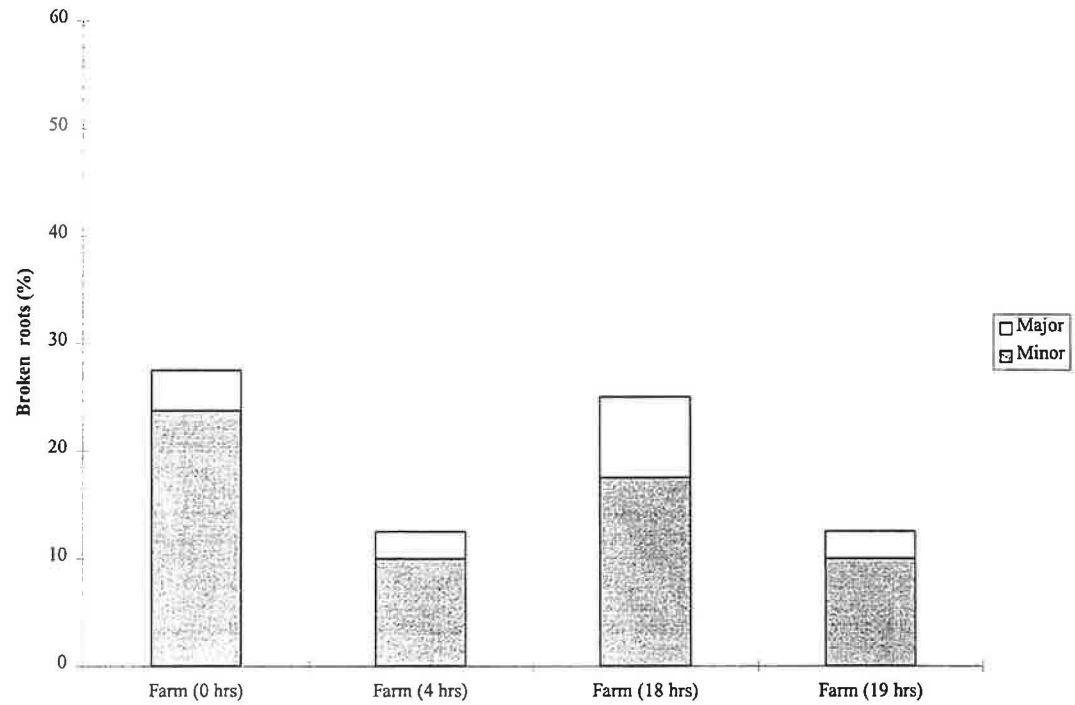


Figure 17: Survey 2 - broken sweet potatoes (%) when transported to the market.

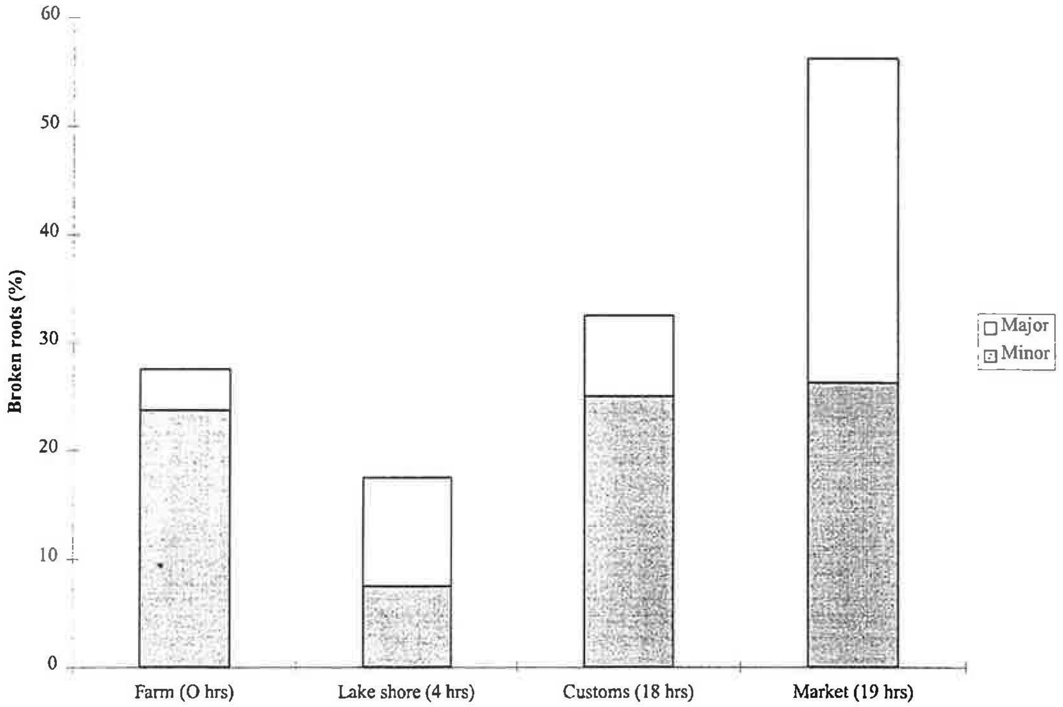


Figure 18: Survey 3 - broken sweet potatoes (%) in sack 1 when transported to the market.

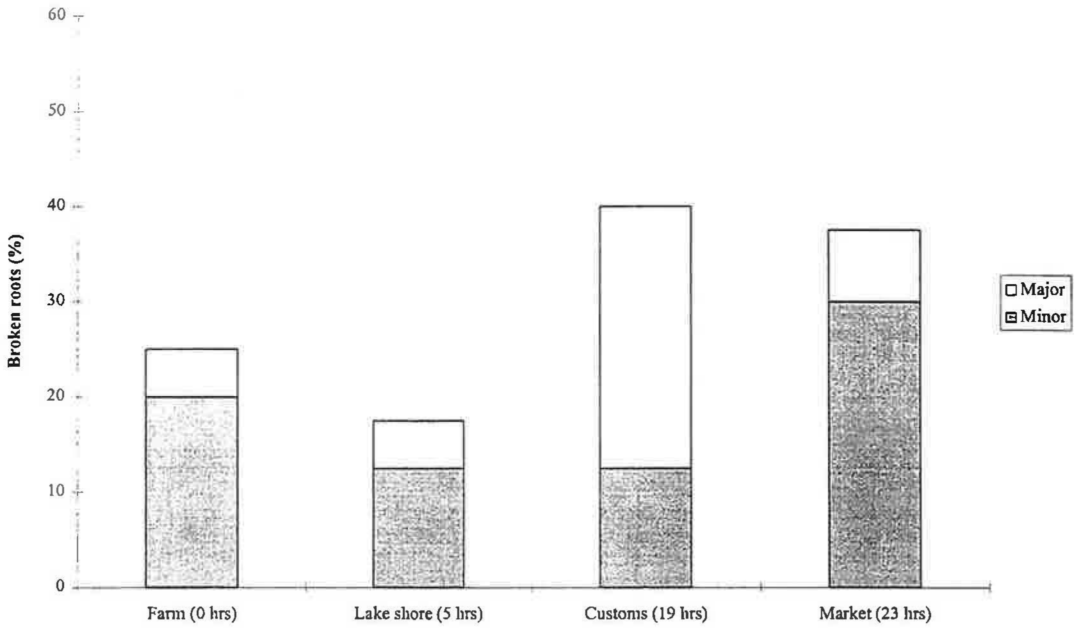
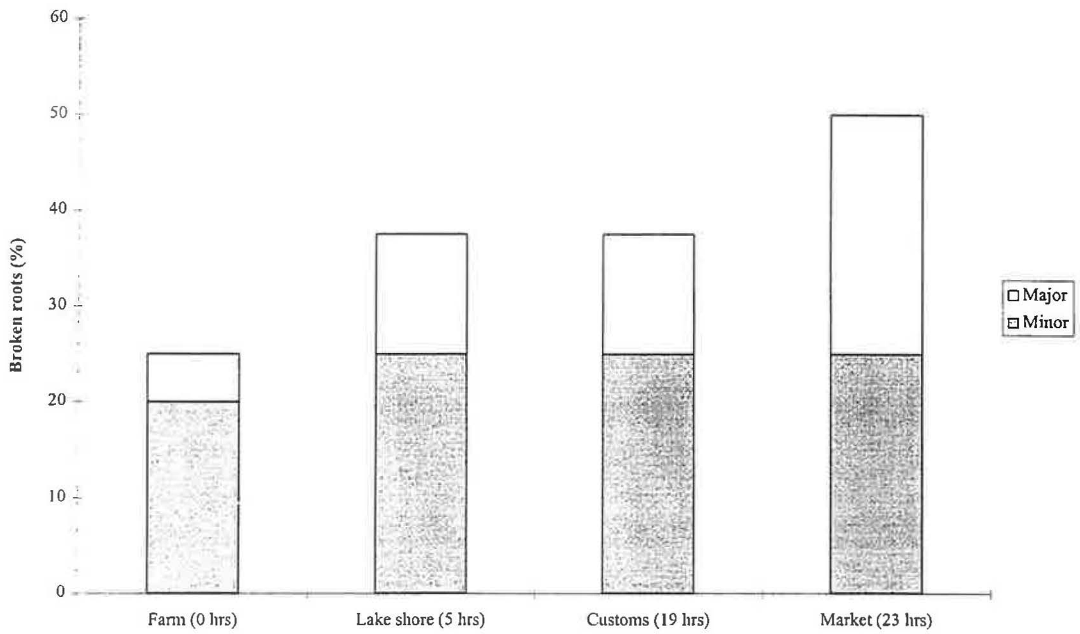


Figure 19: Survey 3 - broken sweet potatoes (%) in sack 2 when transported to the market.



Effect of transport on the proportion of skinned sweet potatoes

The effect of transport through the marketing chain on skinning is given in Figures 20 to 23 for surveys 2 and 3. Minor skinning refers to sweet potatoes with scores between 1 and 2 and major skinning refers to scores between 3 and 5.

Considering survey 1, skinning was only recorded when the sweet potatoes reached the market of which 21% were minor and 10% major.

For survey 2 (Figures 20 and 21), the sacks that remained undisturbed at the farm showed an increase in the proportion of sweet potatoes with minor skins from 19% to 58% and 0% to 30% for major skins after 19 hours when the transported sacks reached the market. In the sacks that were transported, the proportion of sweet potatoes with minor skins declined from 19% to 5% while those with major skinning increased from 0% to 95%. Hence, effect of stuffing the sweet potatoes into a sack causes about a third of them to show minor skinning damage and this will increase to 88% of the sweet potatoes after storage in a sack for 19 hours. Transporting the sacks, however, resulted in 95% of the sweet potatoes showing major skinning damage.

A similar trend to survey 2 was noted for survey 3 (Figures 22 and 23). There was not much variation from sack to sack even though the shock datalogger showed that one sack was handled more harshly than the other.

Figure 20: Survey 2 - skinned sweet potatoes (%) when left on the farm for 0, 8, 18 and 19 hours.

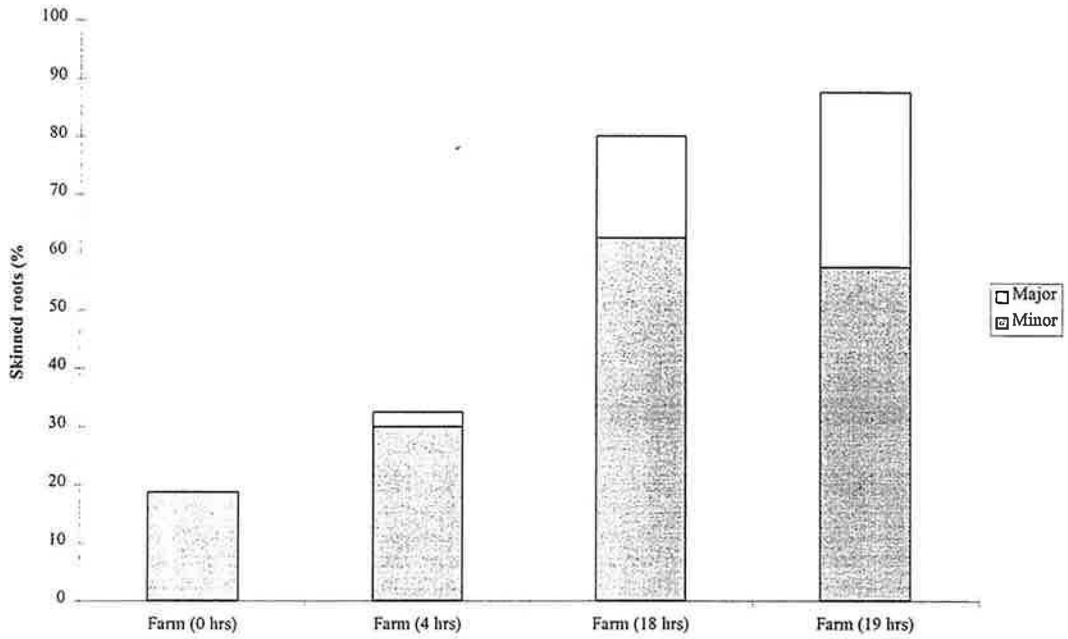


Figure 21: Survey 2 - skinned sweet potatoes (%) when transported to the market.

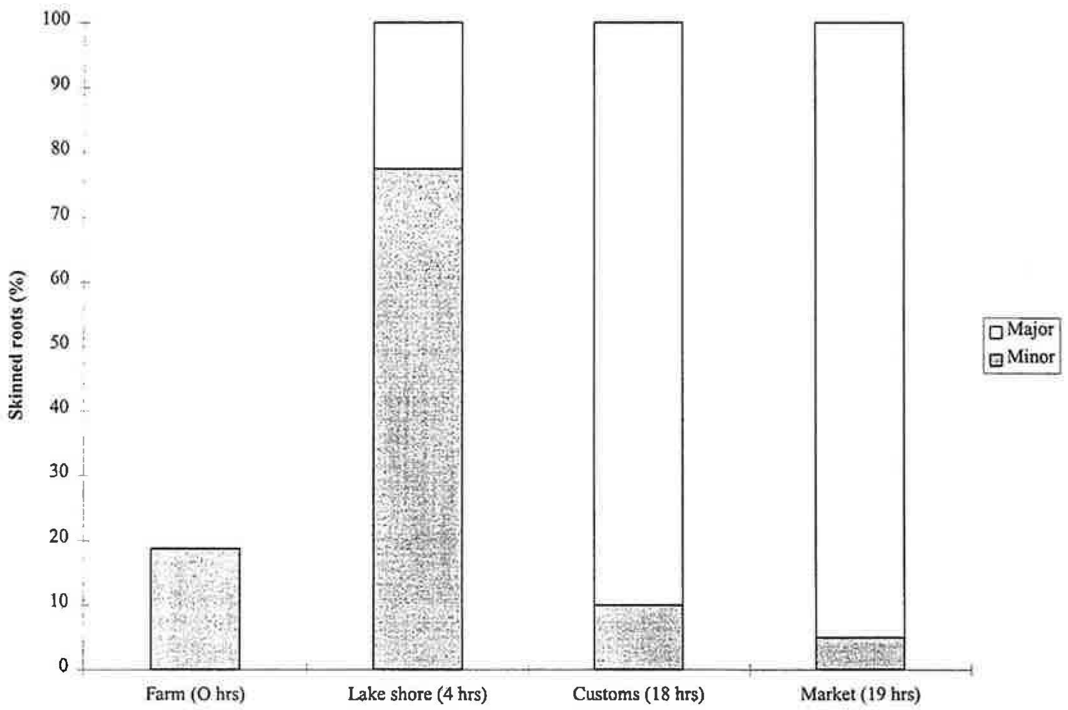


Figure 22: Survey 3 - skinned sweet potatoes (%) in sack 1 when transported to the market.

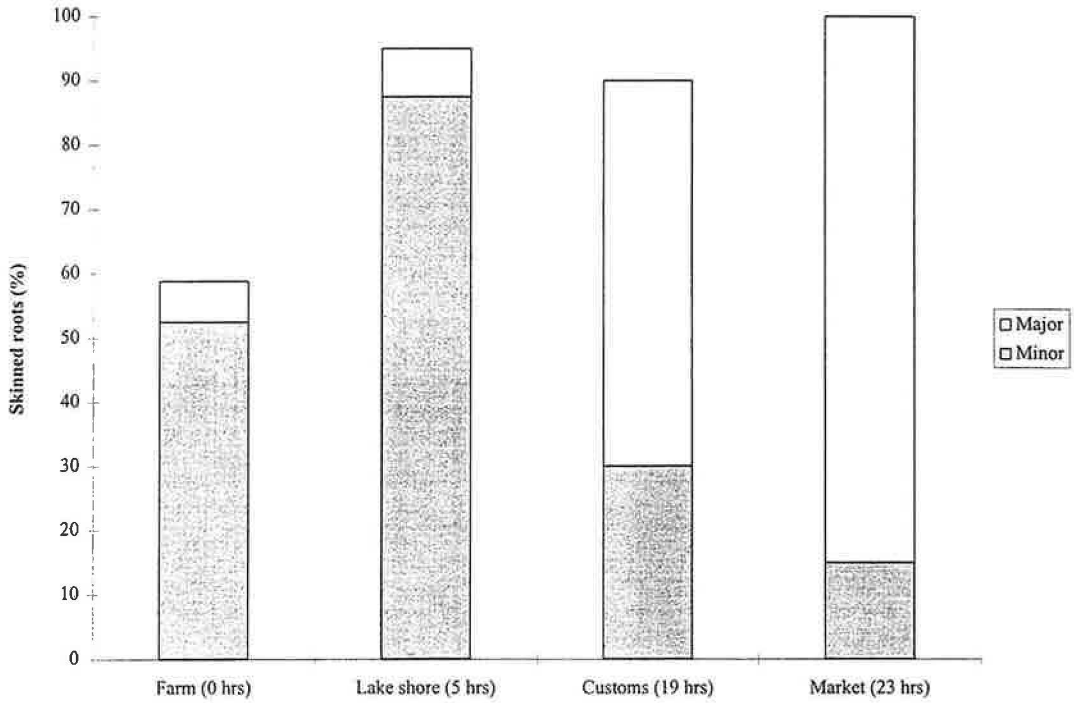
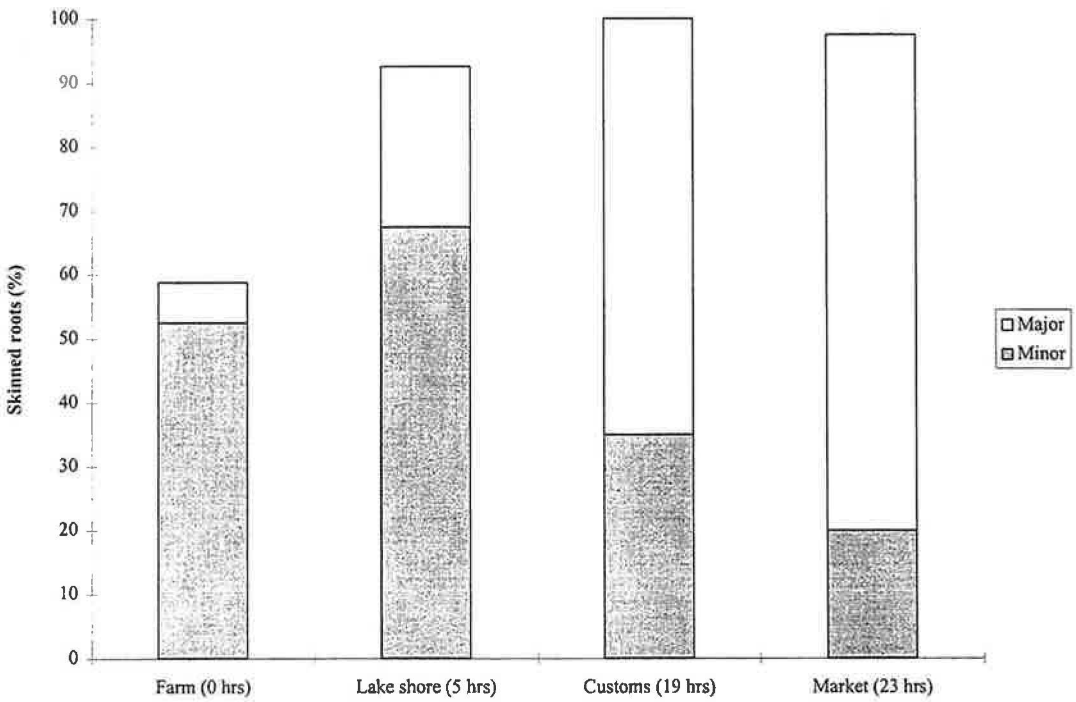


Figure 23: Survey 3 - skinned sweet potatoes (%) in sack 2 when transported to the market.



Shrivelling of sweet potatoes

Shrivelling, which occurs when sweet potatoes lose moisture, was observed in survey 1 only. The proportion of shrivelled sweet potatoes increased from 20% at the farm to 31% at the market. The loss in weight was not recorded.

Relationship between shock recorded by the datalogger and damage to the sweet potatoes.

Table 2 shows the number of times the sacks were dropped (as monitored by the shock dataloggers) and the degree of damage recorded at the market is reported.

Inspection of the results indicates that shrivelled sweet potatoes were less to susceptible to skinning and breaks. The sweet potatoes transported in survey 1, for example, were the only ones which showed signs of shrivelling. The recorded breaks and skinning were lower than the fresh sweet potatoes transported in surveys 2 and 3 even though the shock datalogger recorded that it had received a harsher treatment than sack A, survey 3. Shrivelled sweet potatoes have a softer skin and are more pliable than fresh sweet potatoes. It is thought that these reduced the occurrence of breaks and skinning. It should be noted, however, that the occurrence of rots meant that the sweet potatoes in survey 1 realised a nominal sale price at the market (Tsh5000 per sack compared to Tsh23,000 for sweet potatoes in premium condition).

Considering the fresh sweet potatoes transported in surveys 2 and 3, the shocks, particularly above 20 g appeared to be related to the occurrence of broken sweet potatoes (major breaks). The high incidence of skinning indicates that sweet potatoes are easily skinned.

Table 2: Number of times a sack is dropped (as monitored by a shock datalogger) and relationship with broken, skinned and shrivelled sweet potatoes detected on arrival at the market.

	Survey 1	**Survey 2**	**Survey 3**	
			Sack A	**Sack B**
Shock (g)	**Number of occurrences**			
2 to 10	17	16	21	26
11 to 20	4	2	1	3
21 to 30	1	10	0	2
31+	0	1	0	0
Broken sweet potatoes (%)	**Sweet potatoes (%)**			
Minor	16	26	30	25
Major	2	30	8	25
Skinned sweet potatoes (%)	**Sweet potatoes (%)**			
Minor	21	5	15	20
Major	10	95	85	78
Shrivelled sweet potatoes (%)	31	0	0	0

CONCLUSIONS

Significant damage occurred to the sweet potatoes when harvested and as a result of transport to the market. Losses caused by broken sweet potatoes (up to 56% in a sack) occurred as a result of harvesting practices and poor handling during transport. Those that occurred as a result of poor transport could be significantly reduced by improved handling during loading and unloading at the ferry, at the customs station and at the market. A major factor in the poor handling of the sacks is that they weighed almost 120 kg which are difficult to man handle. Dropping the sack from heights of 0.5 m or greater appeared to be associated with the occurrence of major breaks.

Losses caused by skinning occurred at a result of harvesting, storage in the sacks and transport. Those that occurred as a result of storage in sacks can only be reduced by altering the method of stuffing the sweet potatoes into the sacks and by reducing the weight of the sack. Losses from poor handling can be reduced by avoiding drops onto the ground or onto other sacks of sweet potatoes.

The high humidity and above ambient temperature might be a cause for concern if the sweet potatoes are left in the sacks for any length of time (several days).

Further work is required to quantify some of the causes of the losses more precisely and to carry out a similar survey during the main season (June to July).

RECOMMENDATIONS

A further study should be carried out during the main season (June to July 1998) to determine the influence of season and other methods of transport, for example, by road, on quality **(action: Dr Westby, Mr K Tomlins)**.

A plentiful supply of sweet potatoes would also enable controlled studies to be carried out in order to quantify, more precisely, the effect of handling on losses. These are as follows:

- effect of stuffing the sweet potatoes into the sack compared to loose packing
- influence of dropping of loosely and tightly packed sacks of different weights from varying heights
- influence of weight of a sack on skinning
- influence of age of the sweet potatoes on subsequent handling
- effect of dropping sacks onto differing surfaces (concrete, firm dirt ground, sand, bed of vines etc)
- effect of post harvest curing prior to transport

The impact of preharvest removal of the canopy on reducing damage caused by post harvest handling could also be investigated. Other factors that should be considered are impact on yield and weevil damage **(action: Dr Westby)**.

References

Bonte, D. R., and Wright, M. E. (1993) Image analysis quantifies reduction in sweet potato skinning injury by preharvest canopy removal, *HortScience*, **28,** 1201.

Cmunt, P. (1997) Resistance of potato tubers to mechanical damage with multiple stage harvesting, *Rostlinna Vyroba*, **43**, 131-136.

Estes, E. A., Wilson, L. G., and Bandelo, O. (1989) A performance evaluation of five sweet potato shipping containers, *J. Food Dist. Res.*, **20**, 29-38.

Kempen, P van. (1991) Use of protective materials to limit tuber damage, *Pomme de Terre Francaise*, **53**, 193-196.

Leppack, E. (1996) Procedures for measuring the pressure on potato tubers during sorting processes, *Kartoffelbau*, **47**, 338-341.

Mathew, R., and Hyde, G. M. (1997) Potato impact damage thresholds, *Transactions of the ASAE*, **40**, 705-709.

Molema, G. J., Verwijs, B. R., Berg, J. V van den., and Breteler, H. (1997) Effect of repetitive impacts on subcutaneous tissue discoloration in potato tubers, *Netherlands J. Agric. Sci.*, **45**, 185-200.

Rees, D., Kapinga, R., Rwiza, E., Mohammed, R., Van Oirschot, Q., Carey, E., and Westby, A. (1997) The potential for extending shelf-life of sweet potato in East Africa through cultivar selection, Proceedings of the 11th Triennial Symposium of the International Society for Tropical Root Crops, Trinidad, October 1997.

Strikeleather, L. F., and Harrell, K. P. (1990) Sweet potato damage as measured by weight loss, *American Soc. Agric. Eng.*, **90**, 11.

Thomson, M., Ndunguru, G. T., Waida, T. D. R., Rwiza, E., and Jeremiah, S. (1997) The relationship between quality and economic value of fresh sweet potato and dried cassava products in Mwanza, Tanzania, NRI Report (A0500)

Woolfe, J. A. (1992) Sweet potato an untapped food resource, Cambridge University Press, Cambridge, UK, ISBN 052140295, 643p.