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Effect of damage on market value and shelf-life of sweetpotato in urban markets of Tanzania

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Abstract *Sweetpotato is an important staple crop in Tanzania, grown mainly for home consumption, but marketing is becoming increasingly important. The short shelf life is a major constraint for marketing. This study assessed damage when the roots arrive at market and established which forms of damage affect the shelf life. Breakages, cuts, infestation by weevils* (Cylas spp.)*, rotting and superficial damage were assessed. Between 41 and 93% of roots arriving at urban markets were damaged, corresponding to a loss in economic value of 11 to 36%. Damaged roots had a shorter shelf life due to increased fresh weight loss and rotting. For six samplings during the low season the damage reduced shelf life by 13 to 46%.*

Keywords: sweetpotato, handling, damage, shelf life, weight loss.

Introduction

Sweetpotato is an important crop in East Africa, where its short growing season allows it to be grown between long dry seasons. In Tanzania, it is produced in many areas of the country. Production is generally on a small scale, and primarily for home consumption (Kapinga et al. 1995). There is increased interest in marketing and several surveys of this have been undertaken (Kapinga et al. 1997; Thomson et al. 1997; Ndunguru et al. 1998; Tomlins et al. 2000). In several areas such as those surrounding Dar es Salaam and Mwanza, production is focused primarily on marketing in the urban centres. Thus, in addition to its role as a food crop, sweetpotato has great potential as a source of income. Given its low need for inputs, and as it is usually regarded as a women's crop (Kapinga et al. 1995), it is likely to be especially valuable in helping the less-privileged sectors of the community. The short shelf life of fresh sweetpotatoes (7-10 days) is a major limitation to marketing (Kapinga et al. 1995), and is exacerbated by poor handling during transport and storage in the markets.

This paper describes a study carried out in 1996 and 1997 to assess the extent and types of damage for sweetpotatoes when they arrive at market and its economic implications, and to establish which are the most serious forms of damage affecting the shelf life.

Materials and methods

Observations were made in Dar es Salaam, Morogoro and Mwanza, and also on Ukerewe Island, a sweetpotato supply area, during months of peak and low supply.

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For each urban centre, samples of wholesale sweetpotatoes were collected twice in each of the high and low seasons of sweetpotato supply (Table 1). For each sampling, three sacks of roots were bought as they arrived at the market, prior to any form of sorting by traders (for Mwanza, high season 1, only two sacks were bought). Each sack was treated as a separate replicate throughout the experiment. The roots of each sack were sorted into: undamaged, roots with superficial damage (scuffing) only and roots with more serious damage. The last category was further classified as broken, cut, weevil (*Cylas* spp.) infested or rotting. Many roots suffered from more than one form of damage, but each was classified on the most obvious form. When this was doubtful classification was in the order: rotting, *Cylas* infested, broken, cut (determined by the seriousness of the damage in economic terms). The weight of roots in each class was recorded for each sack.

Table 1. Markets and sampling seasons

Location	Season	Time of sampling	Markets sampled	Main supply area (distance and means of transport)	Main cultivar
Dar es Salaam	High 1	Late June 1996	Tandale	Gairo (350 km by road)	Kasimama
	High 2	Late August 1996		Bagamoyo (75 km by road)	Kasimama
				Kigambone (< 50 km by sea)	Kanada
	Low 1	January 1997		Zanzibar (100 km by sea)	Name unknown
	Low 2	April 1997		Zanzibar (100 km by sea)	Name unknown
Morogoro	High 1	June 1996	Central (2 sacks) Saba saba (1 sack)	Gairo (150 km by road)	Kasimama
	High 2	July 1996		Gairo (150 km by road)	Kasimama
	Low 1	November 1996		Ifakara (250 km by road)	Chanzuru
	Low 2	December 1996		Ifakara (250 km by road)	Chanzuru
Mwanza	High 1	April 1996	Kirumba	Lake Victoria Islands (100 km by boat)	Sinia B
	High 2	May 1996		Various (by boat and road)	Mixed
	Low 1	February 1997		Various (by boat and road)	Mixed
	Low 2	March 1997		Various (by boat and road)	Mixed
Ukerewe Island		April 1996	Ukerewe Central, Ukerewe Soko Mshenzi	Local supplies Transported short distances by various means	Sinia B

For each damage category, 15 roots were selected from each sack, and placed into separate sacks (clean polypropylene fertilizer bags) for storage. For any categories with fewer that 15 roots, as many as possible were included. During storage, the sacks were kept open (rolled down to half height), in a well-ventilated room. The extent of root deterioration was assessed weekly in terms of rotting and loss of fresh weight.

Rotting was scored on the extent observed on the external surface: 1 = 0%; 2 = 1-25%; 3 = 26-50%; 4 = 51-75%; and 5 = 76-100%. After each assessment, those roots that scored 4 or 5 were discarded. In subsequent weeks, the previously discarded roots were still included with a score of 5 when the overall mean score was calculated.

Fresh-weight loss was assessed by marking six random roots in each sack at the start of the trial and recording their weights weekly. Where roots were discarded due to rotting, only the remaining roots were considered when calculating the mean percentage weight loss.

Results and discussion

Table 1 summarizes the background information for the markets studied. For all three centres, the area from which sweetpotatoes are supplied varies by season. The distance of the supply area and the mode of transport are likely to affect the damage incurred by roots during transport. The main cultivars marketed also vary with the supply area (Table 1), and the characteristics of the cultivars are in Table 2.

Figure 1 summarizes the damage observed. In almost all cases, insect infestation was due to the larvae of sweetpotato weevils (*Cylas* spp.), which burrow deep into the root, and are a serious prblem worldwide (Chalfant et al. 1990; Sutherland 1986). Levels of damage were variable, but were generally high, with 44-67% seriously damaged roots and total damage of 49–93%. There was a clear seasonal effect in Morogoro, with more damage, mainly rotting, in the low season, but such clear seasonality was not observed in Dar es Salaam or Mwanza. The roots sampled from the rural market on Ukerewe Island showed the least damage.

In studies in Mwanza, Ndunguru et al. (1998) found that the decrease in market value for different forms of damage was: rotten 100%, *Cylas*-infested 55%, broken 25%, cut 28%, with

Table 2. Characteristics of sweetpotato cultivars included in this study

Cultivar name	Cultivar characteristics
Kasimama	Cream skin, cream flesh, moderate dry matter content Grown widely throughout East Africa (also known as SPN/0)
Kanada	Cream skin, yellow flesh, moderate dry matter content
Cultivars from Zanzibar Name unknown	Cream skin, cream flesh, low dry matter content
Chanzuru	Cream skin, white flesh, moderate dry matter content
Sinia B	Purple skin, yellow flesh, high dry matter content

no effect of superficial damage. From these values, we estimated that the loss in market value due to damage at each location was 11-36% (Table 3). In Dar es Salaam and Mwanza, the greatest loss in value was in breakages, while in Morogoro *Cylas* infestation and breakages were both important in the high season, rotting and *Cylas* infestation in the low season. The different forms of damage reflect the stage in the handling chain at which they originate, so the data obtained could indicate possible improvements in the system. *Cylas* infestation originates in the field, cuts are caused by hoes during harvesting, while breakages and superficial damage mostly result from post-harvest handling. Rotting is a secondary effect, as any form of damage makes a root more susceptible to pathogenic attack (Clark 1992).

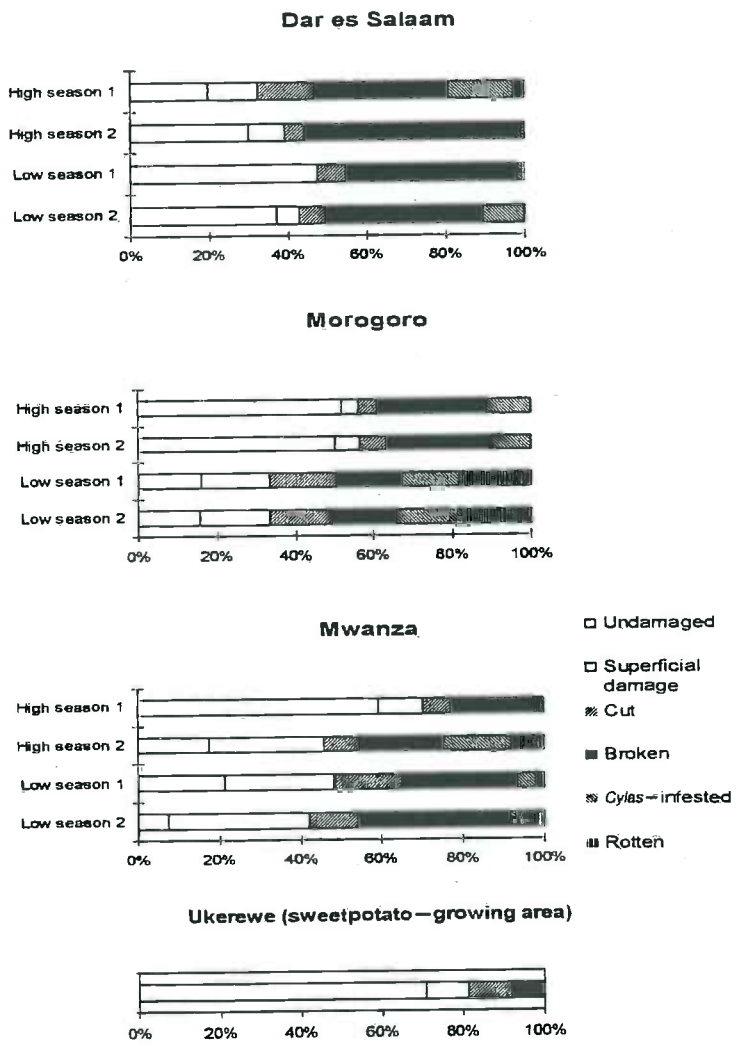

Figure 1. Levels and types of damage to marketed sweetpotato.

The average sack weights in kg were (high season 1, high season 2, low season 1, low season2) Dar es Salaam: 85, 79, 66, 80; Morogoro: 62, 62, 27, 29; Mwanza: n.d., 107, 86, 94.

		Standard deviation of % damage levels for three sacks					
		Serious damage				Superficial damage	Undamaged
Location	Season	Rotten	*Cylas* infested	Broken	Cut		
Dar es Salaam	High 1	2.9	9.1	0.6	4.9	0.0	11.9
	High 2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	Low 1	0.4	0.7	2.2	0.6	n.d.	2.9
	Low 2	0.5	2.6	1.1	1.7	0.3	1.2
Morogoro	High 1	0.0	3.2	6.4	2.3	0.6	2.3
	High 2	0.0	2.9	5.1	1.5	0.6	3.2
	Low 1	0.6	1.1	1.2	2.8	0.9	1.4
	Low 2	0.9	1.3	0.4	1.8	0.8	1.4
Mwanza	High 1	0.9	0.0	7.9	2.5	0.3	6.6
	High 2	3.5	7.2	10.0	5.5	4.6	10.0
	Low 1	2.9	4.7	6.5	7.4	6.3	7.1
	Low 2	2.1	1.5	12.3	2.2	10.9	4.0
Ukerewe Island		0.0	0.0	2.2	2.8	1.3	6.2

Figure 1. (contd).

Table 3. Loss in market value (%) due to damage (from data given by Ndunguru et al. 1998)

Season	Dar es Salaam	Morogoro	Mwanza	Ukerewe
High 1	25	15	25	
High 2	16	15	11	
Low 1	15	35	17	
Low 2	18	36	21	

5

The economic analysis suggests that, in Dar es Salaam and Mwanza, considerable benefit would be achieved by improving handling after harvest and during transport to prevent breakage of roots. Breakages were 20-37% in Mwanza and 35-55% in Dar es Salaam, where roots are often transported long distances by road, and this seems to be when most breakages occur. The lowest level of breakages was on Ukerewe Island, where roots were transported only short distances. However, cuts during harvesting are likely to increase the rate of breakage during transport. In Morogoro, rotting had serious economic effects on market value, as did infestation by sweetpotato weevil , the latter even at low levels as roots develop an unacceptable bitter taste. Farmers usually discard any roots with signs of *Cylas* infestation, but despite this, we observed more than 10% of infested roots in seven of the 11 sample sets.

The main forms of deterioration of sweetpotatoes under normal marketing conditions in Tanzania are weight loss and rotting (Rees et al. 1998), and the relative importance of these depends on storage temperature, humidity and growth conditions. In this study, roots were

stored in open sacks to simulate the conditions under which they would normally be stored during marketing or in the home after sale. Figure 2 shows the weight loss and rotting of roots classified as undamaged for all six samplings undertaken during the low season. The rates of deterioration do vary, but the weight loss was higher than anticipated, 10-17% over seven days, and 67% over 3 weeks in one case (Morogoro, low season 2). The rates of weight loss and rotting in this case are in Figure 3. Weight loss differed significantly among damage classes at 7 and 14 days, but not 21 days. Least significant differences indicate that the undamaged roots lose weight more slowly than the damaged roots of all classes, including superficial damage. For rotting, the undamaged roots had rotted less rapidly after 21 days but there was no significant difference after 7 or 14 days. Kushman (1975) and Strikeleather and Harrell (1990) showed that damage to sweetpotato results in increased rates of weight loss and rotting.

Tables 4 and 5 summarize the low season data for weight loss and rotting after 7 days for all six low season samplings. Undamaged roots lose weight more slowly than damaged, but there were no clear differences between the types of damage. Superficial damage has as signif-

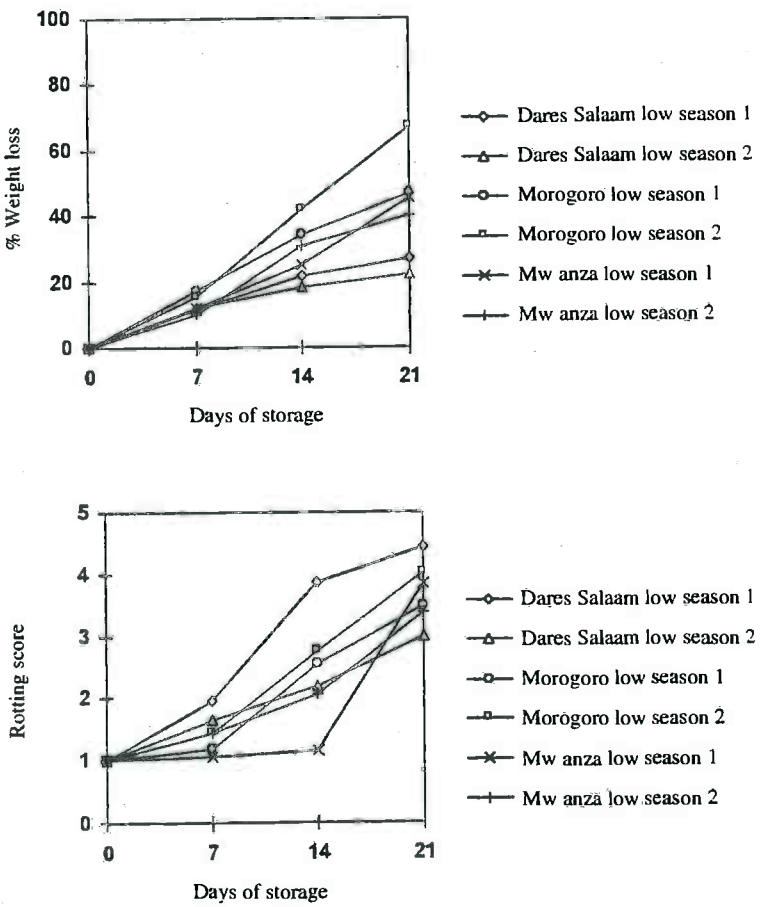

Figure 2. Rates of weight loss and rotting for undamaged roots.

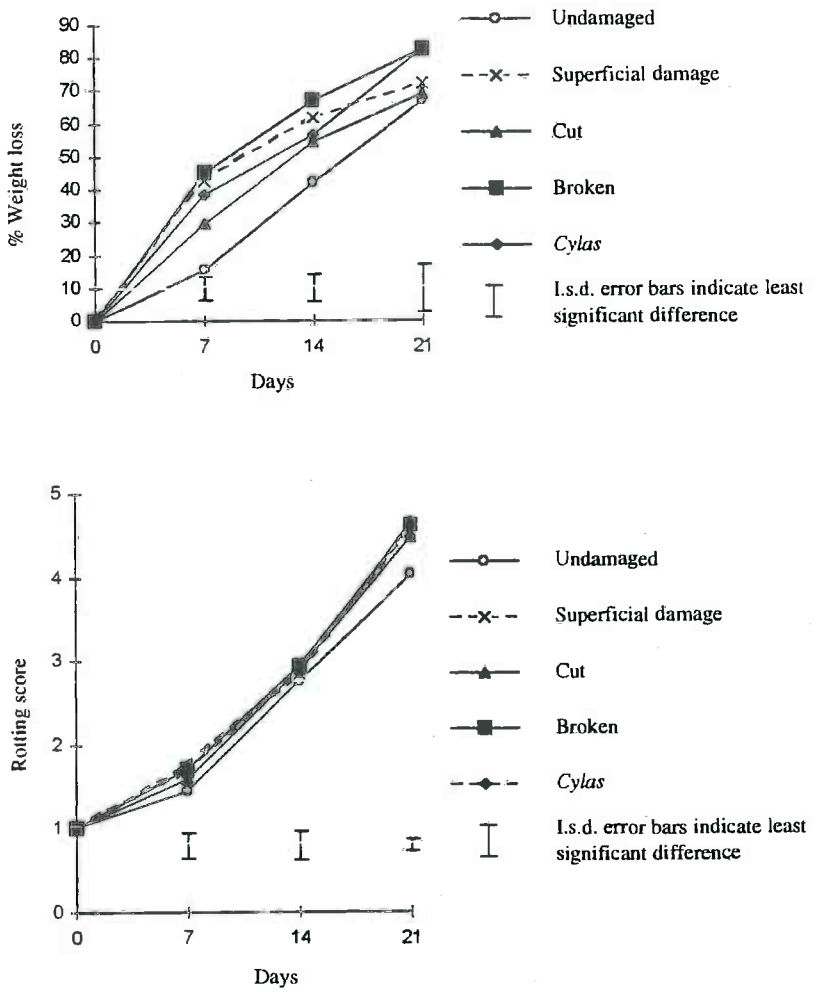

Figure 3. Rates of weight loss and rotting in Morogoro during low season 2.

icant an effect on shelf life as the other forms of damage. The data for rotting are generally consistent with those for weight loss, except that roots with only superficial damage do not rot significantly more quickly.

Roots may be considered unmarketable after a substantial weight loss. In Kenya, a weight loss of 20-30% results in loss in marketability (Q. van Oirschot, personal communication). Our data for seven days show that damage causes a 1.6-1.9-fold increase in rate of weight loss which indicates a decrease in shelf life to 53-62% compared to the undamaged roots (assuming a constant rate of weight loss). This information, together with the observation that 35-93% of roots were damaged, indicates that bad handling practices not only reduce the market value of roots, but also have a significant effect on root shelf life. Thus for the cases considered, damage caused a 13-46% reduction in shelf life.

Table 4. The effect of damage on weight loss

Sampling location	Season	% Weight loss during 7 days of storage				
		Undamaged	Superficial damage	Serious damage		
				Cut	Broken	*Cylas* damage
Dar es Salaam	Low 1	11.8	n.d.	16.5	17.6	18.8
	Low 2	12.2	14.3	15.0	13.4	13.1
Morogoro	Low 1	17.4	41.6	26.8	43.1	24.1
	Low 2	15.4	42.7	29.9	45.3	38.6
Mwanza	Low 1	12.2	14.6	12.3	14.5	10.6
	Low 2	10.0	15.1	19.8	19.3	15.6
Mean		13.2	25.6	20.0	25.6	20.1

Damage class effects***, sampling location/time effect***, interaction***
LSD (0.05) among damage means 5.
LSD (0.05) among damage within locations 10.9

Weight loss relative to that of undamaged roots

		Undamaged	Superficial damage	Serious damage		
				Cut	Broken	*Cylas* damage
Dar es Salaam	Low 1	1.0	n.d.	1.4	1.5	1.6
	Low 2	1.0	1.2	1.2	1.1	1.1
Morogoro	Low 1	1.0	2.4	1.6	2.5	1.4
	Low 2	1.0	2.9	2.0	3.0	2.6
Mwanza	Low 1	1.0	1.2	1.0	1.2	0.9
	Low 2	1.0	1.6	2.0	2.0	1.8
Mean		1.0	1.8	1.6	1.9	1.6

Damage class effects***, sampling location/time effect***, interaction**
LSD (0.05) among damage means 0.4
LSD (0.05) among damage within locations 0.9
**, ***significant to 1%, 0.1%.

Acknowledgement

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Table 5. The effect of damage on rotting

Sampling location	Season	Rotting score after 7 days of storage				
		Undamaged	Superficial damage	Serious damage		
				Cut	Broken	*Cylas* damage
Dar es Salaam	Low 1	1.95	n.d.	2.75	2.70	2.89
	Low 2	1.64	1.71	1.87	1.78	1.73
Morogoro	Low 1	1.18	1.49	1.51	1.56	1.24
	Low 2	1.44	1.67	1.60	1.71	1.74
Mwanza	Low 1	1.06	1.39	1.11	1.06	1.58
	Low 2	1.44	1.67	1.83	1.89	2.00
Mean		1.45	1.58	1.78	1.78	1.87

Damage class effects***, sampling location/time effect***, interaction**.
LSD (0.05) among damage means 0.20
LSD (0.05) among damage within locations 0.40
**, ***significant to 1%, 0.1%.n.d., no data.

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