Preliminary observations on the potential for long-term storage of fresh sweetpotatoes under tropical conditions

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ABSTRACT

Long-term storage of sweetpotato offers the potential for off-season marketing and improved incomes for farmers because seasonal price variations are high. This paper summarises some preliminary observations from experiments carried out to investigate the effect of a number of storage variables on market value.

Storage trials were carried out in the 2000 season at LZARDI Ukiriguru in Tanzania. Five different treatments were assessed: effect of cultivar (SPN/0, Polista and Sinia B); level of root damage; lining with dried grass; ventilation; and store design (pits or clamps). An incomplete randomised block design was used that involved 36 different stores. Ten consumer panellists assessed stored roots for their value.

It was found that the estimated economic value varied at harvest, with SPN/0 having a slightly higher price than Polista and Sinia B. Prior to storage there was no difference in value between damaged roots and undamaged roots. Stores have so far been assessed up to eight weeks. The estimated values decreased during storage. Damage had the greatest effect on quality, reflected in significantly lower estimated values over time. The best storage results were obtained using pits without a grass lining. Non-ventilated stores were slightly better than stores with extra ventilation, but this effect was not significant. The stores will be further assessed at 12 and 18 weeks. Additional assessments made during the trials included sensory properties of stored roots, external physiological variables (sprouting, shrivelling and weight loss), and sugar composition. These will be analysed with respect to the environmental conditions in the stores (temperature, RH and gas composition) to give a better understanding for the basis of the observations.

Introduction

In many places in the tropics, sweetpotatoes are consumed or marketed immediately after harvesting because their shelf-life can be as short as one week (Rees *et al.* 1998; Thomson *et al.* 1996; Jana 1982). In-ground storage (delayed harvest) is often not possible due to infestation by sweetpotato weevils (*Cylas* spp.). This means that the markets are subjected to seasonal gluts and shortages.

Both producers and consumers could benefit if storage enabled sweetpotato to be available for a longer period of time (Hall *et al.* 1998). This would contribute to food security and increase household incomes if roots are sold over a longer period of time when prices are higher.

In temperate areas, long-term storage of fresh roots is successfully practised. For example, in the United States sweetpotatoes can be stored for up to one year (Picha 1986). In some cooler areas of the tropics, fresh storage is also practised. In the highlands in south west of Tanzania sweetpotatoes are traditionally stored in pits (T. Ngendello, personal communication). In warmer regions, fresh storage is also feasible and has been demonstrated in Uganda, where in one trial sweetpotatoes were stored for up to 4 months (Devereau 1994). Some of the trails, however, failed for reasons that were not clear.

Features that most stores have in common are lining with dry plant material such as dried grass (NRI/NARO 1996), bamboo (Gooding and Campbell 1964), ash (Woolfe 1992) or sand (Sandifolo *et al.* 1998). The function of these materials is however not clear. Ventilation systems have been recommended, although closing stores with grass and soil could be beneficial in raising relative humidity (Woolfe 1992). The choice of cultivar can affect the storage success, because sweetpotato cultivars differ significantly in storability (Van Oirschot 2000; Rees *et al.* 1998).

This research aims to identify and understand the relationship between store design and successful storage. The factors tested included: cultivar, ventilation, lining with dried grass, store design (pit or clamp) and the effect of damage to the roots. This preliminary report gives an indication of the results from first two months of storage in trials started earlier in 2000.

Materials and Methods

Three sweetpotato cultivars, Polista, Sinia B and SPN/0 were planted on 1.5 ha in three blocks in December 1999 at LZARDI Ukiriguru, Mwanza, Tanzania. The roots were harvested in late May/early June 2000. The roots for the trials were selected and consisted of good roots with minimal damage and damaged roots with breaks and skinning injury. Roots showing *Cylas* spp. weevil infestation were discarded. Damaged roots were subjected to a standardised damage treatment by rolling a sack of roots 10 times This simulated damage that occurs during handling and transport of roots (Tomlins *et al.* 2000)

Experimental design

The experiment was set up as a randomised incomplete block design of 36 stores each with a unique combination of factors. The following treatments were included:

- **cultivar:** three cultivars were used: Polista, Sinia B and SPN/0;
- **damage:** half of the stores contained roots with the standardised damage treatment;
- **ventilation:** extra ventilation pipes were provided in half of the stores;
- **lining**: half of the stores were lined with dried grass; and

  store type: two types of stores were built - pits and clamps.

In order to protect the stores from rain and sun, a roofing structure was built for each of the blocks using locally available material. These measured 4 m x 12 m.

Monitoring of storage conditions

Temperature and relative humidity were measured using a probe (Hanna Instruments, Portugal), which was inserted in the store, and Tiny Talk data loggers (Gemini, Chichester, UK). Gas samples were taken in duplicate from each store via gas tubes

Tygon 3603 (BDH), 3 mm). Gas measurements were made using a CO_2 meter and an O_2 meter (Anagas CD 98 and Oxycheck 2, David Bishop Ltd, UK).

Estimated market value

The quality of the roots was assessed at 0, 2, 4 and 8 weeks of storage. Twenty randomly selected roots were taken from each store and divided into two heaps. Ten consumer panellists then estimated the value of the roots, in relation to standard heaps, consisting of roots bought on the market that day. All heaps of roots were weighed, and thus the price per kg was calculated for each heap of roots. At the start of the experiment the quality of the roots of the three cultivars (damaged and not damaged) were assessed.

Statistical analyses were carried out using Genstat (Rothamsted, UK). Due to the incomplete design, the significance levels were calculated using type II and type III sums of squares.

Results and Discussion

Before storage the choice of cultivar had a significant effect on the estimated market value of the roots ($P = 0.009$, Table 1). SPN/0 had the highest value per kg and was between 60 and 50 TSh/kg (exchange rate: 1$ = 775 TSh in June 2000). This observation is in agreement with the findings of Rwiza *et al.* (2000) who found that the consumers have a preference for the cultivar SPN/0. Sinia B was valued lowest per kg. At this stage the effect of damage was not significant ($P = 0.056$).

During storage the estimated market value declined for all roots (Figure 1). The decrease in value was greater for the damaged roots than for those that were undamaged. The damaged roots were valued at 35.8, 25.9 and 20.9 TSh/kg at 2, 4 and 8 weeks of storage respectively, while the undamaged roots were valued at 51.3, 43.8 and 31.2. TSh/kg after the same periods of storage. There were many incidences of rotting among the damaged roots. This indicated that the damage was too severe for wound healing to take place. The results here demonstrated that selecting for undamaged roots is the most important factor in successful storage.

There was an overall trend that roots kept in pits were valued higher than those stored in clamps (Figure 2). This difference was significant after eight weeks where the estimated market value for roots from clamps was one third lower than of pit-stored roots. This is in contrast to the findings of Devereau (1994) who reported that failures were more common in pits. The reasons for these differences have yet to be investigated, but it is possible that they may be due to greater temperature fluctuations or more evaporation in the clamps.

The presence of grass lining had a significant negative effect upon root quality (8 weeks; $P < 0.05$). No lining gave an estimated value of 29.7 TSh/kg while presence of lining an estimated value of 21.5 TSh/kg (Figure 2). This is in contrast to previous reports of the beneficial effects linings have on storage (Woolfe 1992; NRI/NARO 1996).

Although adequate ventilation is crucial for storage of all fresh produce (Wills *et al.* 1998), the results here suggest that the extra ventilation provided by extra pipes did not have a beneficial effect on the quality of the roots (Figure 2). Possibly sufficient ventilation was provided by the metal pipe that was used for the recording the relative humidity and temperature. Alternatively, sufficient air exchange may take place through the covering layer of soil and dried grass. This may be affected by the soil type.

Future analysis of the trials will include the sensory quality, weight loss, sugar content and dry matter content of roots, as well as measurements of physiological characteristics (sprouting, shrivelling and rotting). The environmental conditions in the stores have also been monitored in the trials and will be used to give a better understanding for the basis of the observations made. Other factors that have not been included in this study but that are likely to be of importance include: store size; soil type; location of stores within the farm and curing the roots before storage.

Conclusions

The preliminary observations presented in this paper indicate that long term storage of sweetpotatoes is feasible under tropical conditions. The value of the roots may however decrease substantially during storage. The most important factor to be taken into account for successful storage is to select only the undamaged roots. The trends observed so far indicated that pit stores are better than clamp stores, and that use of a grass lining did not have any beneficial effects. Further analyses that are planned will help to gain understanding these effects.

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Table 1. Significance levels of the factors affecting the estimated market value of stored sweet potato.

	Roots stored for 0 weeks	Roots stored for 2 weeks	Roots stored for 4 weeks	Roots stored for 8 weeks
Cultivar	0.009	0.246	0.6056	0.0168
Damage	0.056	0.0001	0.0012	0.0023
Store type	(NA)	0.3293	0.0673	0.0019
Lining	(NA)	0.1947	0.0605	0.0208
Ventilation	(NA)	0.9637	0.6335	0.1266

NA: Not applicable.

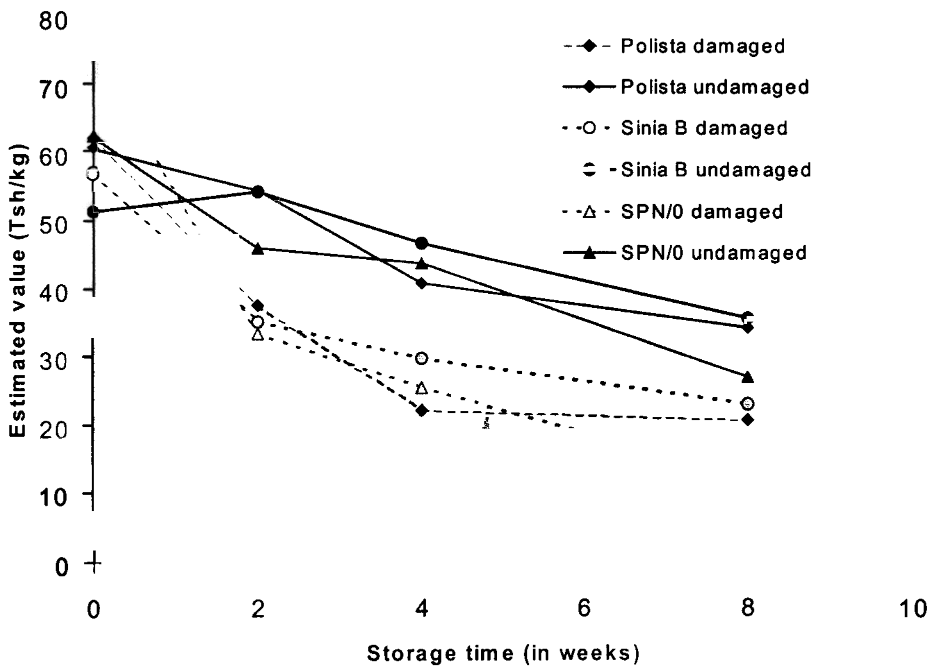

Figure 1. The effect of storage time, cultivar and damage on the estimated market value of sweetpotato roots assessed by ten panellists. The data were collected from six stores per time point and two heaps per store.

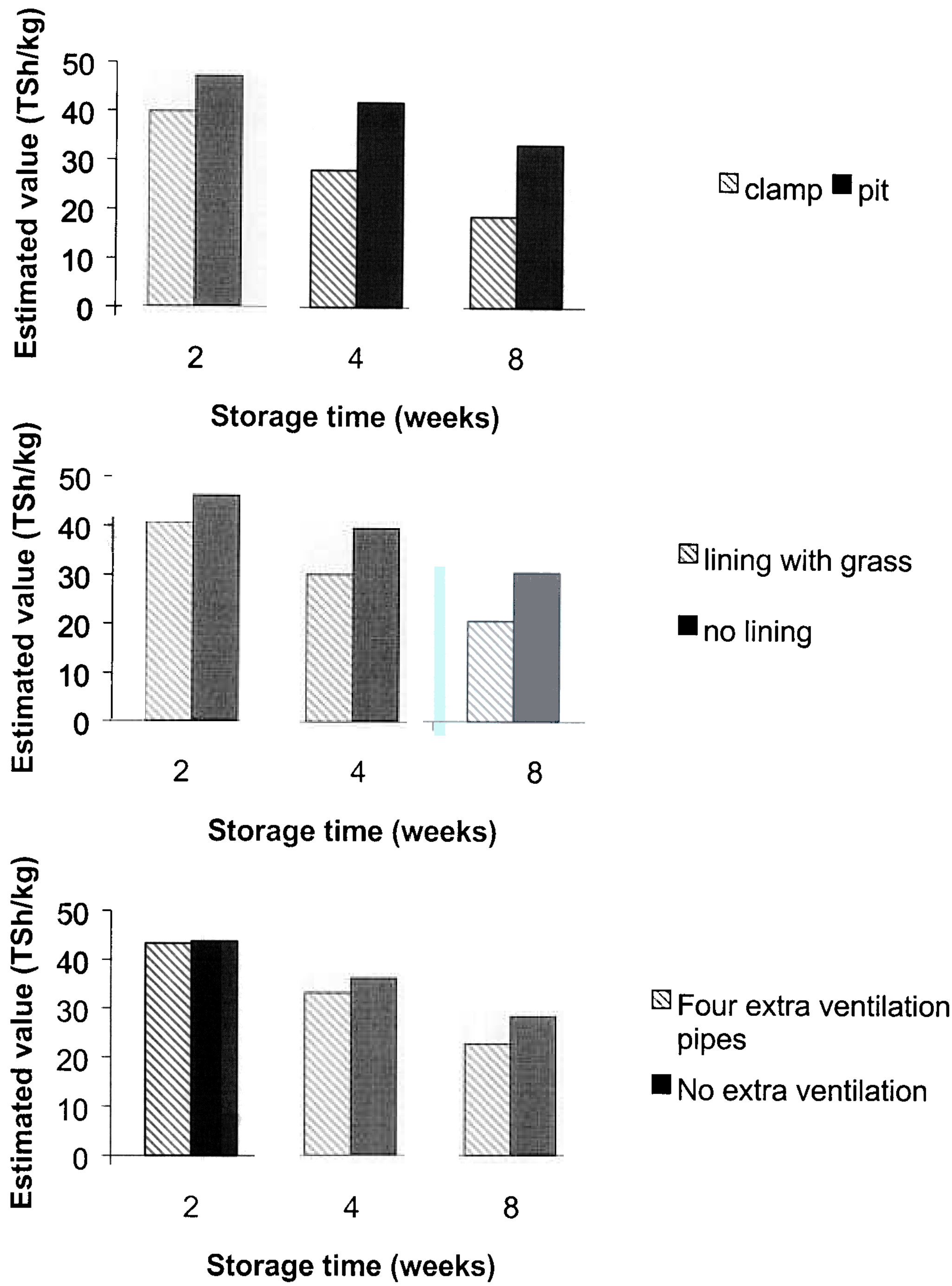

Figure 2. The effect of store design, lining with extra grass and extra ventilation pipes upon on the estimated market value of stored sweetpotatoes.