Comparative Assessment of Indigenous Methods of Sweet Potato Preservation among Smallholder Farmers: Case of Grass, Ash and Soil based Approaches in Zimbabwe

EDWARD MUTANDWA AND CHRISTOPHER TAFARA GADZIRAYI

Abstract: Lack of suitable storage facilities among smallholder farmers continues to expose farmers to intermittent food shocks. Farmers are thus making use of locally available preservation methods, derived from indigenous knowledge systems (IKS), to improve storability of sweet potatoes. However, not much is known about their efficacy in maintaining the quality of the stored crop. Thus the broad objective of this research was to assess the effectiveness of using soil, ash and grass as means of preserving sweet potato variety Mozambican White. The three mediums were tested over a period of 5 months and each treatment had two replicates. Three kilogram of soil, two kilogram ash and one kilogram grass were used for the analysis and the quantities were informed by local smallholder farmers. The experiment was conducted at ambient room temperature. Two parameters were monitored, the rate of discoloration of tubers and weight change over time. The results indicate that if quality of the stored crop and weight variation of tubers is considered, then use of soil banks is the most effective. However, weights of tubers for ash and grass were not statistically different from the soil treatment but some tubers were discolored. If farmers are to get the best results, a combination of the above techniques, particularly ash and soil, is recommended.

BACKGROUND AND PROBLEM

The bulk of developing countries in Africa are ensnared in abject poverty with individual households living on less than $1 dollar per day.[1] In addition, the HIV/AIDS pandemic has also ravaged social and economic systems of developing countries, thus compromising long-term economic development. Contemporary anecdotes reveal that at least 35 million people were infected by HIV/AIDS in Southern Africa in 2003. By the end of 2004, related estimates showed that 37.8 million people were infected by the scourge.[2] Thus it is not surprising that the gap between the rich and poor countries has been escalating over the last few years.

Although agriculture remains a key strategy to revitalizing the livelihoods of the rural poor, bottlenecks of major inputs such as fertilizers, chemicals and other synthetic inputs required for enhanced productivity remain a challenge for farmers and on household decision

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making vis-à-vis crop enterprise choice. Smallholder production trend indicate a shift in production patterns from the conventional crops such as cotton, maize and tobacco to other "unorthodox" crops which are less demanding in terms of input usage and labor requirements.[3] Crop enterprises such as indigenous vegetables and sweet potatoes are increasingly becoming an important option for the achievement of household food security in Southern Africa, including countries such as Zimbabwe. However, one of the major issues exposing farmers to chronic and transitory food shocks (particularly in the off-season), is postharvest loss. Studies indicate that postharvest loss due to pest and disease attack can account for as much as 40-60% of crop output.[4] Given that chemical-based systems of crop preservation are expensive for most farmers, least-cost preservation strategies need to be identified and there is not much literature on the efficacy of the various indigenous strategies to preservation.

In Zimbabwe, sweet potatoes are becoming an important component of the diet for both urban and rural households. For urban households, this has been necessitated by the escalating costs of bread and other starch-based foods such as Irish potatoes. Thus the integration of sweet potatoes should be considered as a rational coping strategy adopted by households to ensure food security. Sweet potato is an annual plant that thrives well under warm equatorial and tropical regions with hot summers. Taubenhouse (1989) noted that every buyer, grower, and storer of sweet potatoes has his own practices, theories, and beliefs about storing sweetpotatoes.[5] Therefore there is no universal method of managing postharvest losses. Postharvest losses are often identified as one of the key snags to the achievement of food security in Sub-saharan Africa.

Most smallholder farmers use methods that have been passed on from generation to generation through indigenous knowledge systems. Indigenous knowledge is perceived to be the knowledge that is unique to a given culture or society.[6] It creates the basis for local level decision-making in agriculture, health care, food preparation and preservation, education and natural resource management.[7] Indigenous knowledge is an important ingredient for development but is grossly under-utilized.[8]

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Although important, techniques of preserving crops derived from indigenous knowledge have only rarely been subjected to scientific enquiry. Thus there is a general paucity of information vis-à-vis their effectiveness in assisting households overcome short and long-term food shortages. An inventory of methods used in Africa to preserve sweetpotatoes shows that a number of methods, which include use of grass, ash and soil, are common. In Mali, Kone (1991) showed that sweetpotatoes could store up to 6 months in temperatures ranging from 12-14 degrees Celsius.[9]

Drawing from literature, this study investigates the storability of Mozambican White under room temperature whilst monitoring parameters such as turgidity and color changes using three preservation techniques viz. soil, ash and grass techniques. This study is premised on the

observation that local smallholder farmers in Zimbabwe use most preservation methods informally but not much is known about their efficacy from a scientific perspective. In addition, storage techniques based on IKS are grossly undervalued because farmers are now using chemical based methods but these are expensive in the country. These developments are linked to the volatile macro-economic environment that is besieging the country.

Objectives

The main objective of this study is to carry out a comparative assessment of the effectiveness of three techniques of preserving sweet potatoes - soil, ash and grass.

The specific objectives are:

1. To assess the effectiveness of soil, ash, and grass methods in terms of:

    i. The rate of water loss in tubers

    ii. The rate of discoloration

    iii. Weight change

2. To identify the most suitable storage facility to use for sweet potato storage among smallholder farmers.

LITERATURE REVIEW

Conceptual Framework

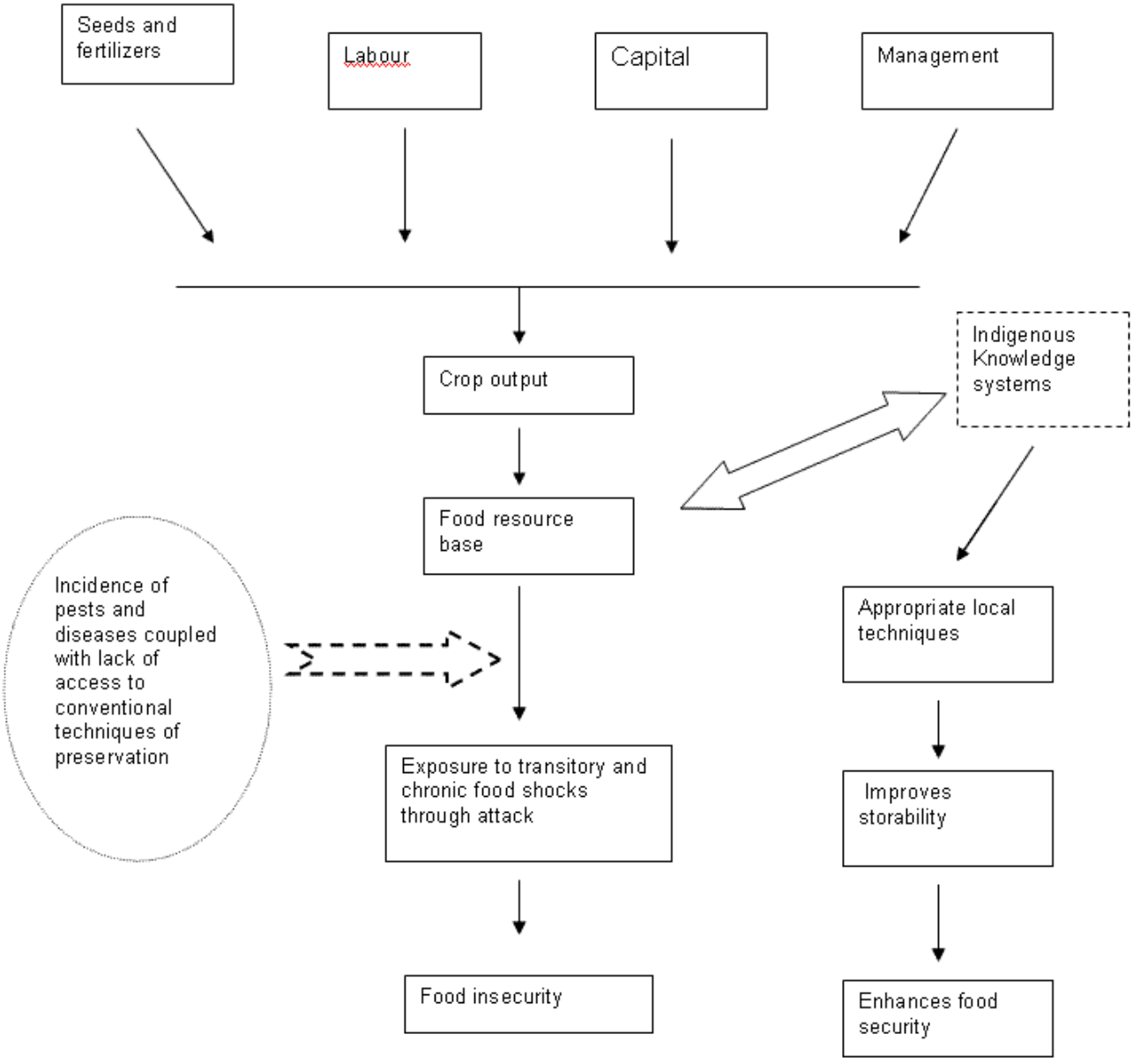


Fig 2.1 Contribution of Indigenous Knowledge Systems to Household food security

Fig 2.1 depicts the role and contribution of indigenous knowledge systems to household food security. The household typically combines the available inputs (land, labor, capital and managerial capacity) to produce crop outputs. This has the effect of increasing the food resource base. However, there are exogenous factors such as pests and diseases, which will lead to transitory (short term) as well as chronic (long term) food shocks resulting in food insecurity.

Lack of access to conventional processing and preservation techniques will also have the same effect on the food security status of the household. Another scenario would involve farmers also extracting appropriate local techniques from the indigenous knowledge systems (IKS). These local techniques are passed on and even improved over periods of time hence improving storability and leading to improved food security.

Social Context

In Zimbabwe, the smallholder sector consists mainly of poor farmers who comprise over 70% of the country's agricultural producers. This sector is also characterized by social and economic factors such as heavy reliance on family labor, a generally poor resource base, inadequate technologies, underdeveloped infrastructure, weak institutional support, and low production levels. These problems are further aggravated by the lack of an explicit policy framework guiding national programs on research and development of orphan crops like sweet potato. Orphan crops consist of a range of crops that do not enjoy formal agricultural policy support programs to enhance productivity and are therefore marginalized even though featuring prominently in the household food economy.[10] The agricultural policy framework (1995-2020) identifies its major crops to include maize, wheat, soyabeans, cotton and tobacco. Sweet potatoes are not explicitly noted as a recognized crop in the framework.[11]

When sweet potatoes are in season, they form a significant component of family diets for most families in Zimbabwe, particularly the urban and the rural poor. Despite this significance, the crop is still viewed as a "woman's crop" and does not feature prominently in the allocation of resources at family the level or national agricultural settings because of the partrilinear nature of the Zimbabwean society which undervalues the contribution of women to the household economy.

Agronomic requirements of sweet potatoes

Sweet potatoes (*Ipomoea Batatus*) are a tropical and sub-tropical plant that thrives in optimal conditions of between 20 to 25 degrees Celsius. In tropical zones, it can be grown in altitudes above 2500m.[12] At planting, it is important to grow the crop in moist soils to obtain good germination. The soils should ideally be moist for most of the production cycle of the crop, which ranges from 60-120 days. It does well in a wide variety of soils but the best are ferratic, brown humic, and calcimorphic soils.[13] The soils need to have good drainage properties. Sweet potatoes can be multiplied using tubers and stems however the most common method in Zimbabwe is the use of stems. In addition, planting is generally done by hand, putting the stem on a mound or ridge and covering it with earth using hoes. Most farmers in Zimbabwe do not use fertilizers for the crop.[14] Sweet potato productivity is stifled by the occurrence of diseases and pests. The most important diseases are the sweet potato virus complex (SPVD) and nematode infections.

SWEET POTATO PRESERVATION METHODS

Soil based technique

This method involves digging of pits at a certain level of inclination (sloped areas). This is done to facilitate the complete drainage of the pits which avoids accumulation of moisture which would in turn lead to rotting or germination of tubers.

Ash based technique

This approach involves mixing ash powder with sweet potatoes. The ash will act as an absorbent to moisture and has a repelling effect on pests. Ash has alkaline properties, which are not conducive to development of diseases.

Grass based Technique

In this technique, dry grass is used to create dry and cool conditions within the storage area. This avoids the development of fungal diseases that normally thrive under humid and warm conditions.

Studies on the effectiveness of preservation techniques of sweet potatoes

Although sweetpotatoes are increasing in importance worldwide, there seems to be a relative dearth and paucity of information on the efficacy of local indigenous techniques of preserving the crop. Kone (1991) argued that sweet potatoes could be stored successfully in soil or ash for about 6 months.[15] However, it is critical to ensure that the stored crop does not have any bruises as this only aids infection and rotting.[16] Anochili (1984) investigated the impact of using ash on sweet potato storability and was of the opinion that the ash technique is effective.[17]

Indigenous Knowledge Systems (IKS)

Most of the existing methods on sweet potato preservation are based on indigenous knowledge. This is so because the orthodox approaches based on chemicals are relatively expensive. Thus one can argue that sweet potato preservation in Zimbabwe is predicated on indigenous knowledge. Berkes (1999) perceived indigenous knowledge as the local knowledge held by indigenous people and is unique to a given society. This knowledge is used to distinguish the knowledge developed by a given community from international knowledge bases or scientific knowledge. Warren's study indicates that IK refers to technical insight or wisdom gained and developed by people in a particular locality, through years of careful observation and experimentation with the natural phenomena around them.[18] Within this context, IK refers to the inventory of locally available techniques used to preserve sweet potatoes and these have to be derived from the community and have a direct bearing in their everyday lives.

RESEARCH METHODOLOGY

Overview of the Storage mediums used for analysis

The broad objective of this study was to comparatively assess the effectiveness of three techniques used by local communities to preserve sweet potatoes. The research used soil obtained from local gardens in Mashonaland East Province (Hwedza District) where farmers typically stored their sweet potato harvest. These soils ranged from loams to sandy loamy soils. Farmers chose areas with such soil types as they have relatively lower water holding capacity when compared to clays and this reduces the likelihood of rotting due to moist conditions.

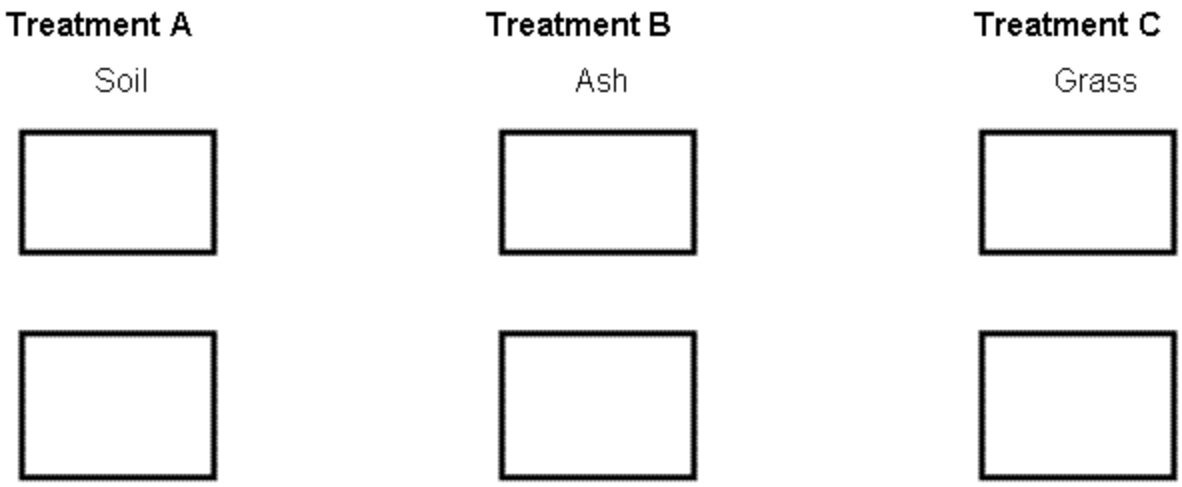
It was important to ensure that the soil was dry and free from observable external foreign materials such as sticks. Grass for thatch method was collected also from the local area, taking note of the aforementioned issues. Ash was prepared using wood from local tree species. The sweet potato variety used is Mozambican White, which was chosen because of its availability on the local market at the time of conducting the research.

Materials Used

Boxes measuring 20x15x15 cm were used as materials for conducting the experiments. For each storage technique, two replicates were used making a total of six boxes for the experiment. Approximately three kg of soil was used for the soil technique and this quantity had to guarantee total coverage of the tubers. About two kg of ash and one kg of thatch grass was used for the other replicates used in the study. In each box 12 tubers were placed and subjected to the experimental conditions. These quantities were derived from local farmers in Zimbabwe.

Research Design

The methodological approach used was the pre- and post-test design. Within this context, the desired parameters were measured before commencement of the study and after a period of 5 months. The experiments were conducted at room temperature that is 24 degrees Celsius in an agricultural shed. The diagrammatic presentation of the experiment is presented below.



Sampling Procedure

A simple random sampling technique was used to select tubers from each treatment and replicate. The random sampling approach ensured that the parameters under observation were taken from representative universe of units from each replicate and experiment. Two parameters, namely weight changes due to water loss and color changes, were recorded for each treatment. Discoloration of tubers was observed using visual assessment. Any tuber whose surface area had at least twenty five percent deviation from inherent off-white colour was categorized as discoloured. The twenty five percent benchmark was based on local consumer grading systems in major open markets in Zimbabwe. Parameters were monitored monthly over five months.

Data Analysis

An analysis of variance table was set to investigate whether there were statistical differences in parameters under observation. A one way ANOVA table was set up to investigate whether there were differences in the grand means of weights of potatoes before and after the experiment and across experiments.

RESULTS AND DISCUSSIONS

Rate of Discoloration

Discoloration in this study was defined as the change of color of the sweet potato tuber of at least twenty five percent surface area. This is normally evidenced by the presence of lesions on the tubers. The number of discolored tubers was recorded for each treatment.

There were no discolored tubers in treatment A, in which soil was used. In treatment B, where ash was used, a total of 6 out of 12 tubers were discolored at the end of 5 months. In

treatment C, a total of 8 out of 12 tubers were found to be discolored. The results are depicted in Fig 4.1.

Fig 4.1 Rate of discoloration over time

According to the graph, the three treatments had no discolorations for the first 2 months. However, in ash the discolored tubers were observed in the 3rd month whilst in grass this was observed in the 4th month of the experiment. On the basis of ANOVA test ($p<0.05$) there was no statistical difference in the number of discolored sweet potato tubers at the end of five months (see Table 4.1).

Table 4.1 ANOVA results for number of discolored tubers across treatments

Source of Variation	**Sum of squares**	**DF**	**Mean square estimates**	**F value**	**Significance (5% level)**
Between groups	2.733	2	1.367	2.267	0.147
Within groups	7.267	12	0.606		
Total	10.00	14			

Water Loss in tubers

The rate of water loss in the tubers from each treatment was observed using the average weight of the tubers. An implicit assumption made was that the change in weight between two time periods was attributed mainly to water loss. The research also ensured that the size of the tubers across treatments were roughly of the same size. In addition, the variety used had been screened for infections i.e. cultured. Therefore, the incidence of internal infections, which could lead to changes in weight, was minimal across treatments. The data obtained is shown in the table below.

Table 4.2 Percentage weight loss of tubers over 5 months

Time period (months)	**Treatment A** **Soil (grams)**	**Treatment B** **Ash**	**Treatments C** **Grass**
1	0.36	0.354	0.346
2	0.36	0.344	0.321
3	0.32	0.313	0.307
4	0.29	0.270	0.295
5	0.27	0.261	0.243
Grand Mean	**0.320**	**0.308**	**0.302**
Final % weight change per treatment	**25**	**26.2**	**29.8**

Fig 4.2 Weight variation of sweet potato tubers over time

The three treatments were tested statistically using one-way analysis of variance procedure (ANOVA).

The hypothesis being tested was that the three treatments are equally effective implying that the observed average weights of tubers are the same for the treatments.

The results of the ANOVA are shown below.

Table 4.3 Comparative assessment of mean weights of tubers for the three treatments

Source of variation	Sum of squares	DF	Mean Square Estimates	F value	Significance (5 %)
Between groups	8.005E-04	2	4.003E-04	0.246	0.786
Within groups	1.95E-02	12	1.628E-03		
Total	2.034E-02	14			

Since the observed significance value is greater than 0.05%, it implies that we do not reject the null hypothesis that the mean weights of the tubers are equal. Therefore, it can be argued statistically that the above three treatments soil, ash and grass are equally effective in terms of maintaining the turgid state of preserved tubers. The results of the study are consistent with

other studies such as Anochilli (1984) and Kone (1991) whose study was carried out in Mal.[19] They found out that ash and grass are effective means of preserving sweet potatoes, especially among resource constrained smallholder farmers.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The study attempted to provide a scientific analysis of preservation methods that have traditionally been used by smallholder farmers over generations. In this regard, the results showed that if both parameters state of the crop (color) and weight changes - are to be considered, then preservation in soil would be most recommended. This finding is consistent with Owen's study (1987) that highlights the importance of using soil banks as a means of preserving sweet potatoes.[20] However, in terms of maintaining the weight of the stored crop, all three can be considered by resource-constrained farmers in Zimbabwe. There is need also to research the issue of variation across different sweet potato varieties.

Recommendations

The socio-economic value of indigenous knowledge cannot be under estimated. The results of this study point to soil banks as the most effective in terms of maintaining the quality of the stored crop and reducing water loss. However, use of grass and ash are also valuable methods but could be associated with loss in quality judging by the incidence of discolored tubers. If the best results were to be obtained, it would be recommended to use a combination of these preservation methods. This is because ash has some repellent properties to vices such as pests. There is need for further investigation to identify the effectiveness of these techniques across other varieties of the sweet potatoes and also under varying conditions.

Notes:

1. UNDP, 2004, p. 16-18.
2. UNAIDS, 2004, p. 127.
3. AREX, 2004, p. 1-5.
4. Mariga, 2000, p. 16.
5. Tabenhouse, 1989, p. 8.
6. Warren, 1991, p. 8-9.
7. Warren, 1991, p. 23.
8. Flavier, et al, 1995, p. 5-6.
9. Kone, 1991, p. 7.
10. Mutimba, 1996, p. 4-7.
11. Zimbabwe Agricultural Policy Framework, 1995- 2020, P. 1-5.
12. Del Carpio, 1969.
13. Ramirez, 2005, p. 5-8.
14. AREX, 2004, p. 1-5.

15. Kone, 1991, p. 7.
16. Hand and Cockerham, 1921, p. 23.
17. Anochilli, 1984, p. 67.
18. Warren, 1991, p. 33.
19. Anochilli, 1984, p. 67, Kone, 1991, p. 7.
20. Owen, 1987, p. 16-23.

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