Annals of Tropical Research 24(1):71-89

Effectiveness of cassava plastic storage technology and marketability of plastic-packed cassava roots

[1] Emma S. Data, [2] Editha G. Cagasan and [3] Joselito B. Layola

[1] Philippine Root Crop Research and Training Center (PhilRootcrops), Leyte State University (LSU), Visca, Baybay, Leyte; [2] Department of Development Communication, LSU, Visca, Baybay, Leyte; [3] Department of Economics and Agribusiness, LSU, Visca, Baybay, Leyte

ABSTRACT

Data, E. S. 2002. Effectiveness of cassava plastic storage technology and marketability of plastic-packed cassava roots. *Ann. Trop. Res.* 24(1):71-89.

This study was conducted to verify the effectiveness of plastic packaging and fungicide treatment in prolonging the shelf life of fresh cassava roots for marketing, determine the acceptability of the plastic-packed cassava among urban consumers, and determine the profitability of marketing plastic-packed cassava.

Results further showed that there is potential market for the plastic-packed cassava. Of the 1,911 packs delivered to the different market outlets, 1,769 packs (93%) were sold.

In the follow-up survey, it was found that the plastic-packed cassava was generally acceptable among the urban consumer-respondents. All of the 380 respondents revealed that they would like to continue buying the plastic-packed cassava. Among the reasons cited were: the roots remained fresh even if they were stocked for several days (36.8%); the roots tasted sweet and juicy when cooked (32.6%); and the price (P15.00/pack at 2 kg/pack) was just enough (18.7%).

Marketing plastic-packed cassava directly to consumers gave the highest return on investment (ROI) of 189%.

Keywords: plastic-packed cassava, shelf life, marketing

Correspondence: E.S. Data. *Present Address*: Philippine Root Crop Research and Training Center (Philrootcrops), Leyte State University, Visca, Baybay, Leyte, Philippines. *Telefax:* (053)335-2616 or 3932. *E-mail:* rootcrop@philwebinc.com. Website: www.philwebsoft.com/philrootcrops.

INTRODUCTION

Cassava is an inexpensive source of calorie. However, its consumption is limited to people living near the production sites. Although there are cassava consumers in urban areas, most farmers are discouraged to transport their cassava to urban markets because it is highly perishable. One day after harvest, cassava roots start to deteriorate. Among the common forms of deterioration are vascular streaking or the discoloration of the vascular bundles with accompanying acidity and unpalatability (Castagnino, 1943) and soft rots caused by fungal and bacterial infections (Majumber *et al*., 1956).

Several studies showed that cassava roots may be stored longer when they are packed in plastic bags and/or treated with fungicides (Averre, 1971; Lozano and Booth, 1974; Oudit, 1976). This storage technique has been reported to encourage natural wound healing, retard physical deterioration, keep the cassava roots fresh for two weeks and allow the packed roots to reach the market place long before deterioration starts (Averre, 1976).

Because it is simple and easy to follow, the cassava plastic storage technology had been adopted by people in other countries. It may also be used to increase the availability of cassava roots in the urban areas in the Philippines. However, there is still a need to verify the applicability of the technology under Philippine conditions.

This study was conducted to verify the effectiveness of plastic packaging and fungicide treatment in prolonging the shelf life of cassava roots under field and market conditions, determine the marketability and acceptability of the plastic-packed cassava urban consumers, and determine the profitability of marketing plastic-packed cassava.

METHODOLOGY

This study consisted of two components, namely: "Verification of the cassava plastic storage technology," and "Pilot marketing of plastic-packed cassava in selected urban areas in the Philippines."

Two urban areas - Cebu City and Tacloban City - were selected as the pilot sites based on the volume of cassava traded and the existing cassava marketing in the areas which needed improvement.

At the start of the project, formal and informal surveys were conducted to gather information that would serve as bases in the conduct of the technology verification and pilot marketing activites. For Tacloban, the respondents included 30 farmers, 30 cassava traders and 100 consumers. For Cebu City, the respondents included 60 farmers, 30 traders and 165 consumers.

Technology Verification Study

Three experiments were conducted to verify the technical feasibility of the cassava plastic storage technology [polyethylene (PE) bag packaging and fungicide treatment under Philippine conditions. Design of the plastic packaging for the fresh roots was based on the results of the baseline survey.

All treatments for each of the three experiments were laid out using three factor factorial in randomized complete block design (RCBD). Data were analyzed using analysis of variance (ANOVA), and means were compared using the Duncan's Mulitple Range Test (DMRT) for the first experiment and the Least Significant Difference (LSD) for the second and third experiments.

Effect of Verification on the Storage Performance of Cassava Roots Packed in PE Bags

This experiment was conducted at the PRCRTC Laboratory. PE bags measuring 30 x40 cm with a thickness of 0.003 mils were used as packaging material. Each bag was designed to contain 2 kg of cassava roots, the volume preferred by consumers per survey results. The bags were provided with different number of holes representing the treatments. Each hole had 2 mm diameter.

For root samples, freshly harvested cassava were trimmed, sorted, washed, dipped in 0.04% thiabendazole solution for 5 minutes (this concentration is very safe for humans), air dried, weighed, packed in PE bags previously prepared, then sealed.

The treatments, which were replicated three times included:

T1 - Unpacked casava (control)
T2 - Cassava roots packed in PE bags without holes
T3 - Cassava roots packed in PE bags with 8 holes
T4 - Cassava roots packed in PE bags with 16 holes
T5 - Cassava roots packed in PE bags with 24 holes

To gather data on the degree of root deterioration, three packs of cassava per treatment were taken daily for destructive sampling. The roots were cut cross-sectionally and degree of deterioration (vascular streaking and decay) was rated using following numerical scores as guide:

Score		Description
1	-	No sign of deterioration (vascular streaking or decay)
2	-	Less than 20% of the root surface area showed deterioration
3	-	21-40% of the root surface area showed deterioration
4	-	41-80% of the root surface area showed deterioration
5	-	Above 80% of the root surface area showed deterioration

Sensory evaluation of the boiled cassava roots was also conducted every other day starting from the fourth to the 14th day of storage. Fifteen panelists evaluated the samples based on the Hedonic rating scale.

Effect of Fungicide Treatment on the Storage Life of Cassava Roots Packed in PE Bags

This experiment was conducted at the farmer's field in Basey, Samar. "Makan," a native cassava variety provided by the farmer-cooperator, was used. The roots were carefully harvested, trimmed, sorted, washed, applied with 0.04% thiabendazole solution according to the identified treatment method, air dried, weighed, packed in PE bag with 16 holes, then sealed. Each pack contained 15 pieces of cassava roots.

The fungicide (thiabendazole solution) was prepared at the farmer's house by dissolving 0.04 gram of thiabendazole in a liter of water to get 0.04% concentration. It was explained to the farmer that cassava roots treated with such concentration of fungicide are safe for human consumption, firstly because the solution contains only a very small volume of the fungicide. Also, the fungicide treats only the peel of the cassava, which is removed when cassava roots are cooked or processed into food products.

The undamaged and damaged cassava roots were grouped separately and treated as follows:

A. Undamaged cassava roots
T1 - Unpacked and not treated with fungicide (control)
T2 - Packed in PE bag but not treated with fungicide
T3 - Dipped in thiabendazole solution then packed in PE bag
T4 - Sprayed with thiabendazole solution then packed in PE bag

B. Damaged cassava roots
T5 - Unpacked and not treated with fungicide
T6 - Packed in PE bag but not treated
T7 - Dipped in thiabendazole solution then packed in PE bag

Two sets of samples subjected to the above treatments were prepared. One set was placed inside the house, while the other was placed outside the house of the farmer-cooperator.

Effect of Transport Container on the Shelf Life of Cassava Roots Packed in PE Bags

Straw sacks and rattan baskets/crates were used as transport containers in this experiment. Preparation of root samples (cv. Makan) followed the same procedures as in the previous experiments except that the fungicide used was another brand (fungitox instead of thiabendazole).

The treatments in this experiment were:
T1 - Unpacked cassava roots placed in straw sacks
T2 - Cassava roots without fungicide treatment, packed in PE bags then placed in straw sacks
T3 - Cassava roots dipped in fungicide solution, packed in PE bags then placed in straw sacks
T4 - Unpacked cassava roots placed in plastic baskets/crates
T5 - Cassava roots without fungicide treatment, packed in PE bags then placed in rattan baskets/crates
T6 - Cassava roots dipped in fungicide solution, packed in PE bags then placed in rattan baskets/crates

The treated cassava roots were transported from the farmers field to Tacloban City market. Half of the treated roots were taken from the containers and displayed on the cemented roadside of the market area (as practiced by the cassava vendors), while the other half were left inside the roadside containers.

Marketing Plastic-packed Cassava

Selection of cooperators. Three interested cassava farmers from Basey and Sta. Rita, Samar were chosen as farmer-cooperators to supply cassava roots for pilot marketing. These farmers were trained on the cassava plastic storage technology.

Contacting market outlets. Managers of supermarkets and owners of stores in public markets in Cebu City and tacloban City were contacted and briefed about the project. The supermarkets and stores with owners and managers who were interested to become cooperators of the pilot marketing activities were included as market outlets for the plastic-packed cassava.

Preparing the plastic-packed roots. This was done by the farmer-cooperators, at first under the supervision of the project staff, then later by the cooperators themselves.

Marketing. The plastic-packed cassava were delivered to the identified market outlets and displayed there for 14 days. After 14 days, the unsold roots were withdrawn by the project staff. Monitoring of the sales was done daily. Destructive sampling using one pack of cassava roots was also done to determine the degree of deterioration of the plastic-packed cassava roots.

Follow-up survey. The names and addresses of the buyers of the plastic-packed cassava were listed. Follow-up survey using prepared interview schedule was done to determine the acceptability of plastic-packed cassava roots among consumers.

RESULTS AND DISCUSSION

Baseline Survey Results

The cassava farmers, traders and consumers claimed to have experienced problem on the poor quality of cassava roots sold in the market. This problem was caused by the following:

a) Improper harvesting practices of the farmers which often resulted in the damage of many roots;

b) Use of sacks as containers in transporting the roots from the source to the market which exposed the roots to damage during loading and unloading; and

c) Traders' practice of displaying the roots on roadside which exposed the roots to high temperature (direct heat of the sun), or to rain, and consequently to damage.

It was also found that majority of the farmers, traders and consumers were not practicing any storage technique to prolong the shelf life of cassava. However all of the respondents expressed their desire to avail of the good quality cassava roots and were interested to try the cassava plastic storage technology. They specifically revealed that if the cassava sold in the market would be packed in plastic bags, they prefer a 2-kg pack.

Effectiveness of the Cassava Plastic Storage Technology

Ventilation Effect

On Degree of Deterioration

The roots packed in polyethylene (PE) bags regardless of th enumber of holes had significantlv lower degree of deterioration than the unpacked roots (Table 1). However, the degree of deterioration of the roots packed in PE bags was not significantly affected by the number of holes (ventilation). Generally, the degrees of deterioration in all of the plastic-packed roots were very low during the 14 days storage period. This was probably due to to the low mean temperature (26^0) and high mean relative humidity (85%) prevailing

Table 1. Degree of deterioration of cassava roots packed in PE bags with different numbers of holes[1]

Treatment	Days of storage 1	4	9	14	Mean
Unpacked roots (control)	1.8g-k	2.3d-f	2.8bc	2.3ef	2.6a
0 hole	1.2n-q	1.31i-q	1.4k-q	1.31-q	1.4b
8 holes	1.1pq	1.1pq	1.31-q	1.31-q	1.3b
16 holes	1.0q	1.1pq	1.1n-q	1.3k-q	1.2
24 holes		1.3m-q	1.6i-q	2.0f-h	1.4b
Mean	1.2d	1.4b-d	1.6a-d	1.8ab	

Table 2. General acceptability of the cassava roots packed in PE bags with varied holes[1]

Treatment	Days of storage 4	6	8	10	12	14	Mean
Unpacked roots (control)	6.87a	6.13ab	6.07b	5.73ab	6.80a	6.60a	6.37b
0 hole	6.53a	6.47a	6.13ab	5.73ab	6.80a	6.33ab	6.33b
8 holes	6.73a	6.47a	7.13a	6.53a	5.93ab	7.13a	6.65b
16 holes	7.07a	6.28ab	6.20ab	6.13ab	6.47a	6.53a	6.44ab
24 holes	7.20a	7.33a	6.47a	6.87a	6.60a	6.53a	6.83ab
Mean	6.88a	6.53ab	6.40ab	6.20b	6.52ab	6.63ab	

Table 3. Degree of deterioration of undamaged (healthy) cassava roots treated with fungicide (thiabendazole) and packed in PE bags [1]

Treatment	Days of storage 0	5	10	Mean
Unpacked roots (control)	1.0a	2.67b	3.60b	2.42b
Without fungicide but packed in PE bags	1.0a	1.40a	1.67a	1.36a
Dipped + PE	1.0a	1.57a	1.63a	1.40a
Sprayed + PE	1.0a	1.77a	1.57a	1.45a
Mean	1.0a	1.85b	2.12b	

in the storage room. Among the treatments, however, cassava roots packed in the PE bags with 16 holes had the lowest degree of deterioration in most of the daily observations made. Thus, PE bags with 16 holes were chosen as packaging material for the cassava roots for marketing.

On Sensory Quality

The general acceptability of the cassava roots was significantly affected by plastic packaging and the number of holes (ventilation) in the packaging material. The unpacked roots and the roots packed in PE nags without hole had significantly lower mean general acceptability scores than the roots packed in PE bags with holes regardless of the number of holes (Table 2). This result suggests that appropriate ventilation is important to maintain good sensory qualities of the plastic-packed roots.

Effect of Fungicide Treatment

On Undamaged Roots

Fungicide treatment did not significantly affect the degree of deterioration of undamaged cassava roots packed in PE bags (Table 3). During the 5th and 10th day of storage, PE-packed cassava, with or without fungicide treatment, had comparable degree of deterioration.Also, the method of fungicide application (dipping or spraying) did not significantly affect the degree of deterioration of the PE-packed cassava roots.

Plastic packaging, however, had significant effect on the degree of root deterioration (Table 3.)The plastic-packed roots regardless of fungicide application remained fit for human consumption even during the 10th day of storage as indicated by the deterioration ratings below the limit of 2. On the other hand, the unpacked cassava (control) had significantly higher degree of deterioration, which exceeded the limit of 2 even before the 5th day of storage.

Significant variations on the degree of deterioration with fungicide application were observed when the treated roots were placed outside the house (table 4). This could be because the cassava roots placed outside the house were more exposed to microbial contamination. The roots dipped in fungicide then packed in PE bags had the least degree of deterioration (1.3),

followed by the roots not treated with fungicide but packed in PE bags (1.4), then by the roots sprayed with fungicide then packed in PE bags (1.53). The unpacked roots had the highest degree of deterioration (2.67).

These results suggest that fungicide application might be necessary to prolong the shelf life of cassava roots under conditions where the roots become exposed to microbial contamination (i.e. outside the house). Results further suggest that if cassava roots have to be treated with fungicide, they should be dipped rather than sprayed with fungicide.

On Damaged Roots

During the early period of storage (i.e., first 5 days), fungicide treatment did not significantly affect the degree of deterioration of damaged roots packed in PE bags (Table 5). On the 10th day of storage, significant variations on the degree of deterioration were observed on the PE-packed roots treated with fungicide. The roots dipped in fungicide then packed in PE bags had the least degree of deterioration (1.7), while the unpacked roots had the highest degree of deterioration (3.83).

Of the fungicide application methods, dipping significantly prevented root deterioration even up to the 10th day of storage (Table 5). At this period, only the roots dipped in fungicide and packed in PE bags remained fit for human consumption as indicated by its deterioration rating of 1.7 (less than the limit of 2). The roots subjected to other treatments had ratings above 2, suggesting that they were not anymore fit for human consumption.

When the treated damaged roots were exposed to different conditions (i.e. inside and outside the house), a response different to that of the undamaged roots were observed. When the treated roots were placed outside the house, fungicide application did significantly affect the degree of root deterioration. PE-packed roots regardless of fungicide application had comparable degree of deterioration (Table 6). When the treated roots were placed inside the house, the degree of root deterioration significantly differed with fungicide application. The roots dipped in fungicide had the least degree of deterioration, while the unpacked roots had the highest degree of deterioration.

Table 5. Degree of deterioration of damaged cassava, roots treated with fungicide (thiabendazole) and packed in PE bags [1]

Treatment	Days of storage			Mean
	0	5	10	
Unpacked (control)	1.0a	3.47b	3.83d	2.77b
W/o fungicide but in PE	1.0a	1.83a	2.00bc	2.61a
Dipped + PE	1.0a	1.80a	1.70a	1.50a
Sprayed + PE	1.0a	1.03a	2.13c	1.72a
Mean	1.0a	2.28b	2.41b	

[1] Means followed by common letters not significantly different at 5% level, LSD

Table 6. Degree of deterioration of damaged cassava roots treated with fungicide and packed in PE bags then exposed to different condiitons [1]

Treatment	Condition		Mean
	Inside the house	Outside the house	
Unpacked (control)	2.90c	2.57b	2.74b
W/o fungicide but in PE	1.67ab	1.50a	1.59a
Dipped + PE	1.56a	1.57a	1.57a
Sprayed + PE	1.86a	1.60a	1.73a
Mean	1.99a	1.81a	

[1] Means followed by common letters not significantly different at 5% level, LSD

Effect of Transport Container

Regardless of fungicide treatment, the degree of deterioration of the plastic-packed cassava significantly differed with the containers used to transport the roots to the market (Table 7). The plastic-packed roots placed in straw sacks. The plastic-packed roots placed in straw sacks had high degree of deterioration, which was comparable with that of the unpacked roots placed either in crates

Table 7. Degree of deterioration of cassava roots treated with fungicide (fungitox), packed in PE bags and transported using straw sacks and crates then stored for 10 days [1]

Treatment	Condition		Mean
	Inside the house	Outside the house	
Unpacked (control)	2.98b	2.88b	2.93a
W/o fungicide but in PE	2.27a	3.10b	2.69a
W/ fungicide +PE	2.17a	2.88b	2.53a
Mean	2.47a	2.95a	

[1] Means followed by common letters not significantly different at 5% level, LSD

or straw sacks. These results indicate that straw sacks are not good transport containers for the plastic-packed roots, especially when the packed roots are exposed to sun and rain during marketing. This could be attributed to the high temperature and relative humidity in the sacks, which cause rapid growth of fungi and bacteria on the root tissues resulting in faster root deterioration (Booth, 1976: Noon and Booth, 1977).

Marketability of Plastic-packed Cassava

Considering results of the technology verification study, the cassava roots for marketing were not treated with fungicide but they were packed in polyethylene bags with a thickness of 0.003 mils and with 16 holes (at 2 mm diameter/hole). Each pack contained 2 kg cassava roots.

The pilot marketing activities were limited by the problem on the scarcity of cassava during pilot marketing period (caused by the drought that damaged the farmers' cassava plants). However, the data gathered suggest that the plastic-packed cassava ha potential market among urban consumenrs in the pilot sites. Of the 1,911 packs delivered to the different market outlets, 1,769 packs were sold. The other 95 packs were withdrawn by the project staff for sampling purposes, while the 47 packs were discarded due to rat damage.

Acceptability of Plastic-packed Cassava Among Urban Consumers

Results of the follow-up survey conducted among the buyers of the plastic-packed cassava roots in Cebu City (264 respondents) and Tacloban City (116 respondents) revealed that the plastic-packed cassava roots were generally acceptable among the urban consumers as shown by the respondents' positive feedback on the commodity (Table 8).

Majority of the respondents (73.4%) considered the price of the plastic-packed cassava roots as just enough. Also, majority of the respondents (74.2%) said they did not observe any deterioration on the plastic-packed roots they bought. Moreover, more than half of the respondents (59.7%) liked the design of the plastic packaging and did not give any suggestion to improve it.

Many of the respondents had positive feedback on the quality of the plastic-packed roots. Almost half (48.2%) said the roots remained fresh even when stocked for several days, about one-third (34.5%) said the roots tasted sweet when cooked, more than one-tenth (12.1%) said the roots were juicy, and a few (5.5%) said the roots were soft to grind and, thus, good for processing into food product.

All of the 380 respondents expressed their desire to continue buying the plastic-packed cassava. Among the reasons cited were: the roots remained fresh even when stocked for several days (36.8%); the roots tasted sweet and juicy when cooked (32.6%); the price was enough (18.7%); the roots were good for snacks (12.9%); and the roots were good for processing into food products (6.1%).

Profitability of Marketing Plastic-packed Cassava

The profitability of marketing plastic-packed cassava was compared with those of other marketing schemes. This was done considering the weekly average sales and expenses of the three farmer-cooperators in Samar. Volume of cassava considered in the computations was 150 kg.

Before introducing the plastic packaging technology, the farmer-cooperators, as well as most of the other cassava farmers in the area, were

Table 8. Consumer-respondents' feedback on theplastic-packed cassava

Feedback	Frequency	Percentage
On price		
Enough	279	73.4
Expensive	231	8.2
Very cheap	70	18.4
	380	18.4
On degree of deterioration observed		
Vascular streaking	73	19.2
Decay	25	6.6
None	182	74.2
	380	100
On root quality*		
Fresh	183	48.2
Sweet	131	34.5
Juicy	46	12.1
Soft to grind	21	5.5
Over mature	12	3.2
Suggestions to improve packaging		
Liked the packaging as is/no comment	227	59.7
Make color more attractive	114	30.0
Have roots in smaller packs	37	9.7
Use thicker plastic	2	0.5
	380	100
Reasons to continue buying*		
Roots remained fresh	140	36.8
Roots are sweet and juicy	124	32.6
Price is enough	71	18.7
Good for snacks	49	12.9
Good for processing into food products	23	6.1

* Multiple response

practicing any or all of the following marketing schemes:

1. Selling cassava roots at the Tacloban public market by pile. The farmer-cooperators, or their wives, went to Tacloban at an average of three times a week, each time bringing an average of one sack cassava (50 kg/sack) to be sold at the market by pile.

2. Selling cassava roots to traders who went to their farms, or to their neighbors and friends. In this case, they sell cassava by can at P15.00-P40.00/can (about 15 kg/can) or by sack at P50.00-P120.00/sack (about 50 kg/sack).

After its introduction, the farmer-cooperators continued to practice the above cassava marketing schemes. In addition, they also delivered plastic-packed cassava to Tacloban City only once a week at an average of 75 packs per delivery (150 kg) per farmer. These plastic-packed cassava roots were delivered to the trader-cooperators at P10.00/pack and left there until the next delivery (the next week). The trader-cooperator also tried selling plastic-packed cassava directly to consumers at P15.oo/pack. He went to Tacloban market three times a week, each time bringing 25 packs cassava for sale to consumers.

Results of the net sales computation (Table 9) showed that marketing plastic-packed cassava (150 kg) directly to consumers gave the farmer-cooperator the highest weekly net sales of P903.12. It was followed by selling plastic-packed cassava through the trader-cooperators (P538.12/week). Selling unpacked cassava by can or sack gave the lowest net sales.

Aside from higher net sales, the other advantages of selling plastic-packed cassava as cited by the farmer-cooperators included the following:

1. The farmer-cooperators were able to save time when they sold plastic-packed cassava through the traders. Instead of going to Tacloban three days each week to sell cassava, they had to go only once a week. After delivery, they could go home immediately to do other things.

2. The plastic-packaging activity was able to give some people the chance to earn money by working as hired labor to wash and pack the cassava roots.

Results revealed that marketing plastic-packed cassava through traders (at P10.00/pack) gave farmers a return on investment (ROI) of 92%, while marketing plastic-packed cassava directly to consumers gave farmers an ROI

Table 9. Profitability of selling plastic-packed cassava vs. other marketing schemes

Items	A Seling plastic-packed cassava thru traders	B Seling plastic-packed cassava direct to consumers	C Selling by pile at the market	D Selling to traders /neighbors/friends
A. Volume sold per week	150 kg (75 packs at 1 delivery per week)	150 kg (25 packs per delivery at 3 deliveries per week)	150 kg (50 kg per delivery at 3 deliveries per week	150 kg (3 sacks)
B. Gross Sales	P750.00 (at P10.00/ pack)	P1125.00 (at P15.00/pack)	P600.00 (60 piles at 2.5 kg/pile x P10.00 /pile)	P150.00 (at min. farm gate price of P1.00/ kg)
C. Expenses				
Harvesting	P50.00	P50.00	P75.00	P50.00
Washing	P50.00	P50.00	-	-
Packing	P28.13	P28.13	-	-
Transportation	P50.00	P60.00	P45.00	-
Cost of packaging material	P33.75	P33.75	-	-
Total expenses	P211.88	P211.88	P120.00	P50.00
D. Net sales	P538.12	P903.12	P480.00	P100.00 (min. fgp) P310.00 (max. fgp)

Exchange rate: 1 US Dollar = P55.15

Table 10. Cost and return analysis of marketing plastic-packed cassava (1 year period; 48 deliveries)

Item	Cost
A. Cost	
Labor	P6,150.24
Transportation	2,400.00
Electricity	200.00
Water	48.00
Repair and maintenance of equipment	200.00
Inputs	
Cassava roots (P1.00/kg)	7,200.00
Printed packaging mat. at P.45/pc	1,620.00
Sacks at P7/sack, 24 sacks	168.00
Fixed costs	
Interest on capital investment	300.00
Depreciation cost of equipment	333.12
Tools	74.88
Total Production cost	P18,694.24
B. Returns	
B.1. Plastic-packed cassava delivered to traders	
Gross income (3,600 packs/year x P10.00/pack)	P36,000.00
Net income	17,305.76
Return per peso invested per year	0.92
Return of investment (ROI) per year	92%
B.2. Plastic-packed cassava sold directly to consumers	
Gross income (3,600 packs/year x P15.00/pack)	P54,000.00
Net income	35,305.00
Return per peso invested per year	1.89
ROI	189%

Exchange rate: 1 US Dollar = P55.15

of 189% (Table 10). Break-even price of the plastic-packed cassava was P5.65/pack at 2kg/pack.

CONCLUSION

Based on the results of this project, it can be concluded that:

1. Packing cassava roots in polyethylene bags with a thickness of 0.003 mils and with 16 holes (at 2m diam/hole) can prolong the shelf life of the roots up to 10 to 14 days under market conditions.
2. Fungicide treatment is not necessary if the plastic packed roots will be stored for not more than 14 days. If longer storage is desired, dipping undamaged roots in fungicide (thiabendazole or fingtox at 0.4% concentration) for 5 minutes is necessary.
3. Crate is a better transport container for the plastic-packed cassava roots than straw sacks.
4. Plastic-packed cassava roots (at 2 kg/pack) are generally acceptable among urban consumers.
5. Marketing plastic-packed cassava can give farmers higher profit than selling unpacked cassava by pile consumers, or by can/sack to traders and other buyers.

RECOMMENDATIONS

Marketing of the plastic-packed cassava is recommended not as a complete replacement but as another alternative of the marketing schemes curremtly practiced by the cassava farmers. In actual marketing, fungicide treatment is not anymore necessary because just the mere packing of undamaged roots in PE bags would prolong the shelf life of the roots up to 10 to 14 days under market conditions. It is recommended, however, that the interested technology taker should also see to it that there is continuous supply of plastic-packed cassava in the selected market outlets. If supermarkets are included as market outlets, there is a need for an information campaign to

promote the product since the consumers are not yet used to buying cassava in the supermarkets.

For further study, pilot marketing activities may be done in other cassava growing areas like Western Mindanao, Central Luzon and the National Capital Region.

REFERENCES

AVERRE, C. W. 1971. Effects of packaging on vascular streakin of fresh cassava roots. *Noticiero Tuberosas*, Bogota 14.

AVERRE, C. W. 1976. Vascular streaking of stored cassava roots. *Proceedingsof the First International Symposium on Tropical Root Crops*. Trinidad. pp. 31-35.

BOOTH, R. H. 1976. Storage of fresh cassava (*Manihot esculenta*). I. Postharvest Deterioration and Its Control. *Exp. Agric.* **12**(2): 103-111.

CASTAGNINO, G. A. 1943. Conservacion de la raiz de mandica. Campo (Argentina) 27:23.

LOZANO, J. C. and R. H. BOOTH. 1974. Diseases of cassava (*Manihot esculenta*). *PANS*, **20** (1). 30-54.

MAJUMBER, S. K., S. Y. PINGALE, M. SWAMINATHAN, and V. SUBRAMANYAM. 1956. Control of spoilage in fresh tapioca roots. *Food Sci*. **5**: 108-109.

NOON, R. A. and R. H. BOOTH. 1977. Nature of postharvest deterioration of cassava roots. *Transactions of British Mycological Society*. **69** (2):63-66.

OUDIT, D. D. 1976. Polyethylene bags keep cassava tubers fresh for several weeks at ambient temperature. *J. Agric. Soc.* **76**:63-66.