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EFFECTS OF THE INTRODUCTION OF STORAGE TECHNOLOGY ON THE URBAN FRESH CASSAVA MARKET OF COLOMBIA

(Effets de l'introduction de la technologie de stockage sur le marché des produits frais en Colombie)

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SUMMARY

The current status and structure of the urban cassava fresh root market in Colombia is summarized, the storage technology to be integrated into this market is described and the estimated benefits of this technology to small farmers and urban consumers are presented. A strategy for initiating commercialization of the storage is proposed.

RESUME

L'usage et la structure du marché du manioc frais en Colombie sont résumés, la technologie de stockage à intégrer à ce marché est décrite et le bénéfice de cette technologie pour les petits fermiers et les consommateurs urbains est présenté.

Une stratégie d'initiation à la commercialisation du stockage est proposée.

INTRODUCTION

Colombia is one of the major Latin American cassava producing countries, with a 1983 production of approximately 2.2 million tons (FAO, 1984). The great majority (68 per cent) of this is destined for consumption in fresh, unprocessed form by farmers and rural and urban populations, with the remainder principally used as an animal feed (fresh roots). Evidence suggests that of the roots produced for human consumption a large proportion, probably about 40 per cent, is not marketed but consumed on farm (CIAT, 1984).

The subsistence farmer relies on cassava to produce moderate, stable yields in often adverse climatic conditions or on marginal land. Cassava also has a very high yield potential in favourable edaphoclimatic conditions, suitable for producing a marketable crop (COCK, 1982). However, at present farmers have little incentive to increase yields or the area under cassava cultivation, and urban consumers are unable to take advantage of cassava's potential as a cheap calorie source, due to the severe marketing problems associated with the fresh root. These problems have become aparent and intensified during the last 30 years, when Colombia, along with other Latin American countries, has been transformed from a rural to an urban society (Table 1). Cassava has been unable to adapt to these changing conditions, unlike potatoes or rice which are now consumed in the major urban centres of country. Cassava has remained a foodstuff consumed principally by rural populations (Table 2). Currently, consumption per capita in the urban centres of Colombia is 16 kg/year, compared with 35 kg/year in rural areas. Furthermore, cassava consumption is declining in the major cities, suggesting that as urbanization continues absolute decreases in the volume of fresh cassava marketed can be expected (JANSSEN and WHEATLEY, 1985). This paper, by analysing in detail the present market structure of cassava in one region of the Colombia, the North Coast, will atempt to demonstrate that cassava's disadvantages are related to the rapid postharvest deterioration of the fresh root, which makes the crop inherently unsuited to efficient urban market conditions. A simple, cheap, medium term (2 weeks) storage technology is described and proposed as a means of eliminating this disadvantage, and a strategy for its adoption is proposed.

THE FRESH CASSAVA MARKET IN THE ATLANTIC COAST REGION OF COLOMBIA

As an example of how rapid postharvest deterioration of cassava can negatively affect the entire fresh root marketing process, from harvest through to final consumption, the results of a 1983 survey carried out in the North Coast region of Colombia, are presented. The survey was conducted by CIAT and the Integrated Rural Development Program of the Colombian Ministry of Agriculture, in relation to a cassava drying project undertaken in this area (CIAT, 1984b).

The fresh cassava market channels responsible for cassava sold in the major cities of the region, Barranquilla and Cartagena, are characterised by high number of intermediaries each handling a small volume of roots. Farmers sell their product to rural intermediaries who transport the roots to urban centres and sell to wholesalers. These then sell the roots directly to retailers, or often to another level of wholesaler who then sells to the retailer. The fragmentation of the marketing process into many traders handling

Table 1 (a). Latin America : Rural, Urban and total population, 1960 and 1981 (Janssen and Wheatley, 1985)

Latin America : Rural, Urban and Total Population, 1960 and 1981.

	Rural Population	Urban Population	Total Population
1960-absolute :	101.611.000	100.142.000	201.753.000
% :	50.4	49.6	100.0
1981-absolute :	114.067.000	235.139.000	349.206.000
% :	32.7	67.3	100.0
% growth :	0.55	4.15	2.65

Table 1 (b). Colombia : Rural, Urban and total population, 1960 and 1981
(Janssen and Wheatley, 1985)

Colombia	Rural Population	Urban Population	Total Population
1960-absolute :	8.957.000	8.256.000	17.213.000
% :	52.0	48.0	100.0
1981-absolute :	5.833.000	20.832.000	26.665.000
% :	21.9	78.1	100.0
% of growth :	1.5	4.5	2.1

Table 2. Consumption of fresh cassava in different Latin American countries ; total urban and rural consumption per head (kg/year)

	Rural	Urban	Total
Bolivia (72)	17.0	5.4	15.3
Brasil (75)	11.2	2.7	6.3
Colombia (70)	35.0	16.5	20.4
Cuba (76)	30.0	12.4	18.8
Dominican Republic (75)	42.3	20.0	33.1
Ecuador (74)	31.0	6.0	19.0
Paraguay (76)	180.0	35.0	110.1
Peru (76)	18.3	5.6	11.0
Venezuela (75)	27.4	5.0	9.8
Total	19.1	5.9	11.4

Year of estimation in parenthesis.

Source : Janssen and Wheatley, 1985.

small volumes of roots (Table 3) is due to the risk inherent in handling an extremely perishable product and the necessity of rapid transport of cassava from rural producers to final consumers. Traders limit the time required to hold the roots by handling small volumes and by buying only what they are certain they can sell. In order to avoid being left with unsold roots, most (71 per cent) or rural intermediaries arrange their daily sales, 40 to 50 sacks containing 50 kg of roots each, before harvesting the cassava. While providing security, this procedure also restricts the volumes traded and hence increases prices. Roots are usually harvested in the morning, transported ot the urban market during the afternoon or evening and sold to the wholesalers on the night of the same day. This is essential both because the wholesalers require the roots as soon as possible after harvest and also so that the transporters can avoid deterioration losses, which are minimal during the first day. Transport problems due to mechanical failure or road closure can endanger the entire shipment, however. The risk of deterioration thus dictates the speed at which the roots progress through the marketing chain. Roots are sold to urban retailers in the early hours of the morning following harvest, and are sold to consumers during that day. Wholesalers carry out no selection of the roots, since this would delay the sale to retailers. The margins taken by transporter, wholesaler and retailer are all large, with the retailer charging an enormous 70 per cent over his purchase price. Since the later marketing stages are most vulnerable to deterioration losses, these margins appear as justifiable given the risks involved. The great majority (70 per cent) of wholesalers and retailers said that deterioration was a problem for them. The volumes traded at these points in the chain are very small. Retailers typically sell only 50 kg a day in lots of 1.5 kg each. Roots unsold at the end of the day are commonly sold at a lower price as pigfeed. The retailer will tend to buy only sufficient cassava, or less than sufficient, to cover his expected demand. Thus, supply restriction could be operating here also.

Urban consumers are the group most likely to suffer from the effects of deterioration, coming as they do at the end of the marketing process. Roots will be between 1 and 2 days after harvest at the time of purchase, and deterioration could be visible at or soon after this time. Immediate preparation of the root is thus necessary. Consumers are therefore forced into making small, daily purchases of cassava rather than a more convenient bulk purchase once a week as is possible for potatoes or rice. Cassava is therefore more likely to be bought from expensive local shops than from the cheaper market places. Since the margins on fresh cassava are substantially higher than for potatoes or rice, cassava is a relatively expensive and inconvenient foodstuff in the urban situation. This conclusion was confirmed by a consumer survey, in which urban consumers were asked to rate cassava, potatoes, rice and plantains for several characteristics. The results (Table 4) show that cassava, although perceived as a tasty, easy to prepare food, is widely regarded as

Table 3. Characteristics of the different fresh cassava market agents in the North Coast of Colombia, 1983.

	Rural Traders	Wholesalers	Retailer
Size of purchase (kg)	800	750	68
Size of sale (kg)	750	100	1.55
Kg sold per week	9600	7340	320
No. days buying cassava per week	4.0	5.5	4.7
Number of purchases per week	25	83	211
Purchase price (pesos)	7.9	10.3	14.6
Selling price (pesos)	11.1	14.4	24.7
Margin (pesos)	3.2	4.6	10.1
Margin as % purchase price	41	45	69
% arranging purchase before hand	100	45	19
% selling cassava same day as purchase	19	76	75
% having problems with deterioration	31	70	66

Source, CIAT, 1984b.

Table 4. Responses of rural and urban consumers to different observations on cassava, potato and rice. % of people interviewed in agreement with statement

The most important values are underlined

	Cassava			Potato			Rice		
	Urban	Rural	Mean	Urban	Rural	Mean	Urban	Rural	Mean
1. This products are 'tusty'	70	64	<u>67</u>	77	55	<u>66</u>	57	53	<u>55</u>
2. This products are easy to prepare	73	81	<u>77</u>	66	64	<u>65</u>	66	65	<u>66</u>
3. If these were cheaper I would buy more	38	38	<u>38</u>	50	33	42	31	31	<u>31</u>
4. Buying these products is risky because of their quality	81	71	<u>76</u>	17	9	<u>13</u>	3	3	<u>3</u>
5. These producs are bought and consumed on the same day	83	92	<u>88</u>	57	61	<u>59</u>	48	74	<u>61</u>
6. These products are always available	61	75	<u>68</u>	71	78	<u>74</u>	88	94	<u>91</u>
7. These products are cheap at present	25	<u>62</u>	44	50	36	43	16	19	17
8. These products are necessary in meals	<u>48</u>	<u>75</u>	62	65	42	53	77	82	80

Source : CIAT, 1984b.

difficult to store, wasteful and inconvenient compared with the other staples. There is, therefore, an inherent appreciation of the crop, which is frustrated by its poor quality, related to the deterioration problem.

Rural consumers are not affected by deterioration to the same extent as urban consumers : they are closer to the source of supply, both in distance and time, and are less likely to suffer losses or inconvenience as a result. Deterioration therefore is the most likely explanation for the more marked rural-urban consumption differences, of cassava compared to those of other staples (Table 5), and also is the cause of the high prices found in cities as compared with rural areas (Table 6), again contrasting with the situation of the other foodstuffs. In any case, rural consumers can avoid cassava deterioration by delayed harvesting.

A solution to the deterioration problem would remove the major constraint on consumer acceptance of cassava, as well as reducing risk and losses during the marketing process. This should allow cassava to compete on a more advantagous level with other foodstuffs currently increasing in consumption in urban areas at the expense of cassava, as well as allowing a more rational, efficient marketing process to develop.

CASSAVA DETERIORATION AND ROOT STORAGE TECHNOLOGY

The mechanisms of cassava postharvest deterioration have been intensively studied recently, and are now well understood. Recent reviews (RICKARD and COURSEY, 1981 ; WHEATLEY, 1982), conclude that initial loss of acceptability is due to a physiological deterioration (BOOTH, 1976) in which complex phenolic changes, associated with wound reactions and mediated by oxygen (MARRIOTT et al, 1978) terminate in the formation of blue-black leucoanthocyanin pigments (RICKARD, 1982). Subsequently, a secondary microbial deterioration (rotting) can occur (BOOTH, 1976 ; NOON and BOOTH, 1977). Physiological deterioration, which involves enzymic reactions, can be prevented by the exclusion of oxygen, by freezing or by encouraging natural wound headling processes (curing) (BOOTH, 1976). The latter alternative, in which a protective barrier of suberised cells is laid down over damaged areas, thus preventing oxygen entry into the root tissues, is the only practical storage strategy for incorporation into current marketing channels in Colombia. Freezing, parrafin coating or reburial, examples of the other alternatives, are all either to expensive, involve use of technology or are irrelevent to the marketing situation. Roots cure when stored for four to five days at a temperature in excress of 30°C and a relative humidity of 85 per cent or more. BOOTH (1976) described a system of packing roots into wooden boxes along with a moistened packing material (coir

Table 5. Consumption of various carbohydrate sources in the North Coast Region of Colombia (kg/capita)

	CASSAVA	POTATO	PLANTAIN	YAM	RICE
A. By place of consumption					
Metropolitan capitals	30.5	36.6	64.4	30.5	69.4
Regional capitals	53.5	35.0	76.6	30.8	71.4
Rural areas	82.9	24.2	67.8	41.9	66.9
On-farm consumers	170.4	8.9	79.0	85.7	68.7
B. By income group					
High income	54.3	40.5	86.7	42.3	67.7
Medium income	54.3	25.8	76.5	40.2	70.5
Medium/low income	59.5	35.0	61.0	34.4	62.6
Low income	54.5	22.7	59.9	31.2	72.0

Source : CIAT, 1984b

Table 6. Price (Col. $/kg) of cassava and other products in the North Cost of Colombia, 1983.

	Cassava	Potato	Plantain	Yam
Metropolitan Capital	39.5	29.8	24.0	39.1
Regional Capitals	23.5	29.6	16.0	33.6
Rural Areas	23.2	29.6	21.6	29.7

Source : CIAT, 1984b.

dust, sawdust, etc.). Although roots cure under these conditions and the system is used for some high value export markets, it is too costly and unsuited to the large volumes required in the urban under discussion.

The most promising system is that of packing roots into polyethylene bags (OUDIT, 1976 ; LOZANO et al., 1978) in which storage times in excess of two weeks have been achieved. The great advantages of this system are its simplicity and the low transport and labour requirements. However, the humid environment of the bag favours the development of microbial deterioration (especially of fungal origin). Therefore, a fungicide pre-treatment of the roots has to be included before packing to ensure that both physiological and microbial problems are prevented. Recently, work at CIAT (CIAT, 1982, 1983, 1984a) has shown that such a system using the fungicide thiabendazole (Mertect, a product with minimal toxicity problems (CIAT, 1984a) can give excellent storage of roots for a two week post harvest period with non-significant changes in quality. This method has been field tested on-farm and in a number of Colombian cassava production regions with excellent results (Table 7). Consumer acceptance sutdies demonstrate that stored and fresh roots of the same cultivar are indistinguishable in taste, texture and other characteristics, although a sweet taste may develop when stored in excess of two weeks (CIAT, 1985). The treatment and bag together cost US$0.02 per kilogram of roots.

The field tests have identified several important factors necessary for the success of storage ; namely that roots should be treated and packed within a few (2-3 hrs) of harvest ; that damage should be minimised (some root selection is advisable) and that storage conditions should allow some ventilation if the ambient temperatures are in excess of 30°C. The two week storage time made practical by this system is more than sufficient to accomodate both the marketing requirements (2-3 days) and consumer storage at home (7 days). Longer storage times are not necessary, given the weekly shopping frequency of most consumers and the stable cassava system should allow the urban cassava fresh market to overcome the constraints operating currently. The possible effects of this are discussed in the next section.

THE EFFECTS OF STORAGE TECHNOLOGY ADOPTION

A whole range of benefits can be expected to flow from the adoption of the storage technology described above. Marketing losses, and risks of losses will be much reduced, and hence the marketing margin should fall. In addition, an increase in cassava demand is envisaged due to the convenience of storable cassava. JANSSEN and WHEATLEY (1985) have estimated the likely range of price changes in Colombia as a result of storage introduction (Table 8). These show that the reduction in marketing margin from US$0.35 to US$0.23

Table 7. Results of storage experimennts in different regions of Colombia

Region	% acceptable roots after :			
	One week storage		Two week storage	
	+ Mertect	- Mertect	+ Mertect	- Mertect
Valle del Cauca (on-farm)	98	83	98	61
North Cost (on-farm)	99	92	95	77
Eastern Plains	100	73	97	18
Santander (on-farm)	99	1/	94	-
Popayan	70	92	64	86

1/ Control bags completely rotted.

Table 8. Effect of successful cassava-deterioration research in Colombia[1/]

	Price elasticity of supply 0.5		Price elasticity of supply 1.0	
	Margin decreases to		Margin decreases to	
	0.18	0.23	0.18	0.23
A. Expected benefits : (million US $/year)				
Willingness to pay (WNP) : 0	18.99	10.74	19.17	10.84
+ 10%	27.42	18.89	27.99	19.17
+ 20%	36.35	27.42	37.31	27.99
consumer benefits = 59.7%	consumer benefits = 74.8%			
producer benefits = 40.3%	producer benefits = 25.2%			
B. Projected consumption per capita (present consumption = 10 kg)				
(WNP) + 0	11.29	10.76	11.60	10.94
+ 10%	11.82	11.29	12.26	11.60
+ 20%	12.35	11.82	12.93	12.26
C. Projected prices at reatail level, WNP (present retail price = US$0.47)				
(WNP) + 0	0.40	0.43	0.38	0.42
+ 10%	0.42	0.45	0.39	0.43
+ 20%	0.44	0.47	0.41	0.44
D. Projected prices at farm level. (present farm price = US$ 0.17)				
(WNP) + 0	0.22	0.20	0.20	0.19
+ 10%	0.24	0.22	0.21	0.20
+ 20%	0.26	0.24	0.23	0.21

1/ Most reasonably to be expected values are underlined.

2/ US$.

Source : Janssen and Wheatley, 1985

per kilogram of roots (i.e. to the margin of potato plus treatment costs) would produce a fall in the consumer price of US$0.02/kg and an increase in the farm gate price of US$0.05/kg.

Consumers will obtain the advantages of a more convenient product of a more constant quality and with less waste than before, and this together with the favorable price changes, should produce an increase in per capita urban consumption of cassava. Contrary to conventional wisdom, cassava consumption will respond positively to price changes : the price elasticity has been estimated at -0.88 from a survey of 25.000 households made by DANE-DRI in Colombia (SANINT et al., 1984). Thus, consumption should increase by 2.4 kg year capita . The marketing process, removed from the constaints now operating on it, can become more efficient, with individual traders handling larger volumes, at lower margins than previously. A more streamlined, cost-conscious marketing system should allow any production improvements (lower costs per ton, higher yields, etc.) to fully benefit both farmer and consumer, rather than resulting in farm gate price colapses as at present. With this newfound stability, farmers will have an extra incentive to adopt yield improving production technology.

A STRATEGY FOR CASSAVA TECHNOLOGY ADOPTION

Storable cassava is a novel product, which neither consumers nor traders will have experience of handling. In order to achieve the adoption of storage into the present marketing structure of cassava a procedure permiting consumers, traders and retailers to observe and sample the new product before commiting themselves to make purchases will be necessary. Ideally, a strategy involving farmers, traders, retailers and consumers which progresses gradually from experiments, through market trials towards commercial use would provide opportunities for this, as well as for feedback on quality aspects during the increase in volumes treated. With the necessity of integrating consumers, intermediaries and farmers closely in order that each group is made aware of the advantages realised by the others, the following strategy is proposed for achieving the adoption of cassava storage technology.

1.- **Project area** : The area in which commercial use of cassava storage is sought should contain both a large urban centre where fresh cassava consumption is established, if declining, associated with an area producing high quality cassava for the fresh market. The urban centre should be large enough for deterioration losses to be significant (i.e. a market margins should be sufficient to bear the cost of the treatment.

2.- **Preliminary surveys** : an understanding of the cassava production areas, the fresh market structure and consumer consumption habits is essential before initiating storage trials, and will also serve as a baseline study for latter impact evaluation.

3.- **Initial on-farm storage trials** : storage technology should first be tested on farm, in order to identify and resolve any problems associated with the particular production area or cassava cultivars before proceding to marketing trials.

4.- **Consumer evaluation** : roots stored in the on-farm trials should be evaluated by consumer groups (panels) in selected "barrios" of the urban centre, in order to assess consumer reaction (with feedback to the on-farm trials) and to make consumers aware of the advantages of stored roots.

5.- **Marketing trials** : cassava roots should be transported through actual commercial marketing channels, and evaluate by traders and retailers, with feedback to the farmer as necessary.

6.- **Commercialization** : commercial trading and sale of stored cassava will start using interested traders and retailers operating in the "barrios" where consumer panels are located (i.e. where consumer awareness exists). With time, volumes of roots traded and areas of city coveres should expand.

7.- **Publicity** : once general sale of stored roots is envisaged, a publicity campaign should be initiated using all available media, in order to make the general consumer aware of the "new", storable cassava now being marketed.

8.- **Impact evaluation** : after a suitable period of time during which the volumes of stored roots being traded have been increasing, a new series of production, marketing and consumer surveys will permit the impact of the adoption of storage technology to be evaluated.

One further important aspect is the organization of the root treatment operations. Given that these must be completed within three hours of harvest, the involvement of farmers is inevitable. Either traders must treat and pack roots at the time of harvest on the farmer's land, where at present traders carry out the harvesting, or farmers will themselves handle these operations, delivering packed roots to the traders. Various issues are raized by this, such as the availability of credit to farmers and the formation of farmer organizations (associations or cooperatives). At this stage it is impossible to describe the optimal arrangement, which should become aparent during the initial marketing trials and may vary from region to region. However, as a result of the storage technology, the market channels should become less fragmented and more efficient and farmer involvement in marketing should increase.

The strategy presented here for storage technology adoption involves all stages of marketing from farmer to consumer, and requires an integrated operation including storage specialists, economists, nutritionists and even advertising experts. Given the unique nature of the crop and its post-harvest behaviour this relatively complex approach is required and justified by the dramatic benefits which should accrue to all groups involved.

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