Performance of High-Yielding Cassava Varieties in Terms of Quantity of Gari per Unit of Labor in Nigeria

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Key words: Cassava - Yield - Gari - Labor - Adoption

Summary

This paper compares the quantities of gari produced per unit of labor from high-yielding and local varieties of cassava in Nigeria. Gari is a cassava-based granule obtained by roasting fermented cassava paste. It is widely consumed in Nigeria and many other West African countries. The results of the study show that, although high-yielding cassava varieties are superior to local varieties in terms of fresh roots per unit area, the difference in terms of gari (kg) per unit labor (person-day) between the two is not significant. This is due to high labor requirements for transportation and processing activities incurred by high-yielding varieties. The study further indicates a negative relationship between the adoption of high-yielding cassava varieties and distance to fields, the use of headload/backload as transportation means, and lack of processing machines in the village. This means that farmers are less likely to adopt high-yielding varieties of cassava where transportation and processing activities of cassava are carried out manually.

Résumé

Performance des variétés de manioc à haut rendement en termes de gari produit par unité de travail au Nigeria

La présente étude compare les quantités de gari produites par unité de travail entre les variétés de manioc à haut rendement et les variétés locales. Le gari est un produit granulé obtenu par rôtissage de la pâte fermentée de manioc. Il est largement consommé au Nigéria et dans la plupart des pays de l'Afrique de l'Ouest. Les résultats de l'étude montrent que, malgré la supériorité en rendement de manioc frais des variétés améliorées sur les variétés locales, la différence en termes de gari produit par unité de travail (homme-jour) entre les deux variétés de manioc n'est pas significative. Ceci est essentiellement dû au fait que le transport des racines fraîches de manioc ainsi que leur transformation en gari exigent relativement plus de travail pour les variétés améliorées que pour les variétés locales. En outre, l'étude indique l'existence d'une relation négative entre l'adoption des variétés améliorées de manioc avec la distance au champ, l'utilisation de la tête ou du dos comme moyen de transport des récoltes et l'absence de machine de transformation de manioc dans le village. Ceci voudrait dire que les chances d'adoption des variétés de manioc à haut rendement sont très maigres là où le transport du manioc frais ainsi que sa transformation se font essentiellement à la main.

Introduction

Cassava is a major staple in Nigeria where it ranks second in importance after yam. In order to increase the production output of cassava in Nigeria, high-yielding varieties have been developed and released by the National Root Crops Research Institute (NRCRI) and by the International Institute of Tropical Agriculture (IITA). Their performance is generally determined in terms of quantity of fresh roots produced per unit area. However, in Africa, labor is often more constraining than land because farm operations are manually performed. As a consequence, labor input in crop production is higher in Africa than in most developing regions (6). Moreover, in the particular case of Nigeria, most of the cassava produced is used in processed forms such as gari, lafun, fufu, abacha, etc. Cassava processing is intensive in the use of labor (4) since roots are manually processed with traditional techniques. This means that processing labor per unit weight is constant, irrespective of the quantity processed. Consequently, as yield per unit area increases, processing labor per unit area also increases. In addition, harvested crops including cassava are still mostly transported by headload and backload. The objective of this study is to quantitatively measure the effect of the increase in cassava yield on labor productivity at the processing level and examine the implications in terms of the adoption of improved varieties. The processed cassava product chosen is gari which is a granule widely consumed in Nigeria.

Methodology

Sampling and collection of data

This paper is based on information collected in 65

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Table 1: Definition of climatic zones

climatic zone	mean temperature (°C)	daily mean range temperature (°C)	months of dry season (< 60 mm rain)
lowland humid	> 22	< 10	< 4
highland humid	< 22	< 10	< 4
sub-humid	> 22	> 10	4 - 6
non-humid	> 22	> 10	6 - 9

Source: Carter and Jones (1)

Nigerian villages as part of the Collaborative Study of Cassava in Africa (COSCA). Climate, population density and market infrastructure formed the bases for sampling. Following Carter and Jones (1), four climatic zones were defined from temperature and duration of dry periods within the growing season (Table 1). Information available on all-weather roads, railways, and navigable rivers was derived from the 1987 Michelin travel maps and used to create a market access infrastructure map of Africa. This map was divided into good and poor zones according to the density of the roads, railways, or navigable waterways. Population density from the United States Census Bureau (unpublished) was used to calculate population densities and create a population map of Africa. This was divided into high (50 or more persons / km2) and low (fewer than 50 persons / km2) demographic pressure zones. The three maps of climate, population density, and market access infrastructure were overlaid to create zones with homogeneous climatic, demographic, and market conditions. Each climate/population density/market zone with fewer than 10,000 ha of cassava was excluded as unrepresentative of cassava-growing areas. The remaining areas which formed the potential survey regions were divided into grids of cells of 12' latitude by 12' longitude to form the sample frame for site selection. Sixty-five grid cells were selected randomly and one village was selected randomly in each of the grid cells (Figure 1).

In each selected village, a list of farm households was compiled and grouped into large, medium and small units according to their size with the assistance of key informants. Farm households that cultivated 10 ha or more of all crops were excluded. One farm household was randomly selected from each stratum. A total of 195 farm households was selected. Information was taken at the field level on all cassava fields cultivated

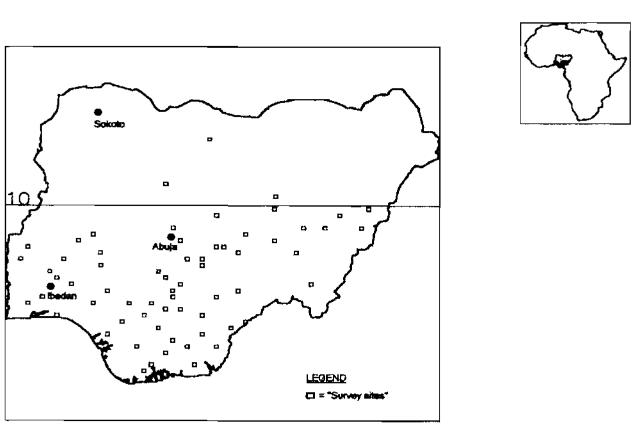

Fig. 1: Map of Nigeria, locations of survey sites

by each of the selected farm households. The information collected included, among others, cassava varieties (local or improved) planted in each field, crop area data, planting densities, distance from farmers' homesteads to their fields, presence of a cassava processing machine in the village, transportation means of cassava output from the fields, cassava fresh root yield and labor inputs. Improved varieties are here defined as bred varieties which have been released since the 1970's by the National Root Crops Institute (NRCRI), and by the International Institute of Tropical Agriculture (IITA) which has its headquarters at Ibadan in Nigeria. Field size was determined by measurement with compass, tape and ranging poles. Yield estimation was made for fields which were 9 months old and above, except when the farmer had harvested before that time. The estimation was based on a representative sample of 40 m2; if the field was small, a 20 m2 plot was used. There were one or two plots per field, depending on the size and heterogeneity of the field in terms of soil and toposequence. Cassava stands within the sample plot were counted, then harvested and fresh roots weighed. Field production labor information was based on estimates by the farmers; for each field the farmer was asked who (men, women, or children under 15 years of age) mostly performed each farm operation, i.e., land clearing, seedbed preparation, planting, weeding, and harvesting, and field-to-home transportation of cassava roots. The farmer was then asked how many men, women, or children would complete each of the farm operations in each field in one day. This survey was conducted in 1991-1992.

Analysis of data

The unit for the analysis is the field, whose area is converted to hectare for comparison purpose. The fields are divided into two groups: (a) with local and (b) with improved varieties of cassava. The number of people (men, women or children) who would complete each farm operation in one day is equated to mandays, womandays or childdays of labor and converted to person-days by factors of one to one for mandays and womandays, and half to one for childdays; this is then converted to person-days per hectare by dividing by the area of the field. For both types of fields, the average of the amount of labor allocated to each farm task and total field production labor are computed. Field production labor comparison between the two types of fields is done using the Student t-test (3). Quantities of cassava output measured from representative plots are converted to quantities per hectare; the average for each type of field is computed and comparison also done with the t-test. The quantity of gari is computed for each type of field using the conversion rate of 20% from fresh roots to gari (4). Indices (local variety yield = 100%) of gari yield per unit area and per unit labor (production and processing labor) are computed.

Results and discussion

Root yield per unit area

Fresh root yield of the improved cassava varieties (19440 kg/ha) is 45% higher than the yield of local varieties (13410 kg/ha) (Table 2). In an independent sur-

Table 2: Cassava fresh root yield (kg/ha) and gari yield (kg/ha) of local and improved varieties of cassava

yield	local (n=105)	improved (n=35)
fresh roots	13410	19440
gari	2682	3888

vey, Nweke et al. (4) obtained 19600 kg/ha for the improved varieties and 11200 kg/ha for the local in the humid climate zone of Nigeria. IITA obtained averages of 21000 kg/ha in 1983, 23500 kg/ha in 1984, and 16000 kg/ha in 1985 in researcher-managed on-farm trials with the improved varieties in three locations within the humid zone of Nigeria (2). Improved varieties are more tolerant than local varieties to common diseases such as African cassava mosaic disease (ACMD) and cassava bacterial blight (CBB), and to pests such as cassava green mite (CGM) and the cassava mealybug (CMB). Gari yields are 3888 kg/ha for the improved varieties and 2682 kg/ha for local varieties (Table 2).

Labor input per unit area

Survey results show that the amount of labor allocated to land clearing operations is lower in fields with high-yielding varieties of cassava than with local varieties (Table 3). This is because high-yielding varieties are more widely adopted where market and demographic pressures on land are higher; in these areas, the fallow period is usually shortened which results in less dense vegetation to be cleared (7). Seedbed preparation labor and planting labor are higher for the improved varieties than for the local. It has been noticed that where improved varieties are adopted, farmers tend to plow their land more, use more manure and fertilizers, and adopt a higher planting density (5, 7). However, weeding labor is lower in fields planted with improved varieties of cassava than with local. Improved cassava varieties usually establish a low canopy that hinders the development of weeds through shading. Following the significant yield difference in favor of the improved varieties, labor requirements per unit area for harvesting and transportation are significantly higher for improved varieties than for local. As a result, total labor, including both field production and transportation labor, is higher (20%) for the improved varieties than for the local (Table 3).

Table 3: Field production and processing labor (person-days/ha) of local and improved varieties of cassava

operation	local (n=105)	improved (n=35)	sd sd	variation (% of local)
clearing	52a	46b	29	-12
seedbed	34a	48b	21	+41
planting	29a	35b	19	+21
weeding	42a	34b	24	-24
harvesting	53a	71b	37	+34
subtotal (1)	210a	234b	48	+11
transportation	79	114	43	+44
subtotal (2)	289	348	52	+20
processing (3)	268	389	—	+45
grand total (2)+(3)	557	737	—	+32

For each farm operation, means with the same letter are statistically the same (p=0.05)

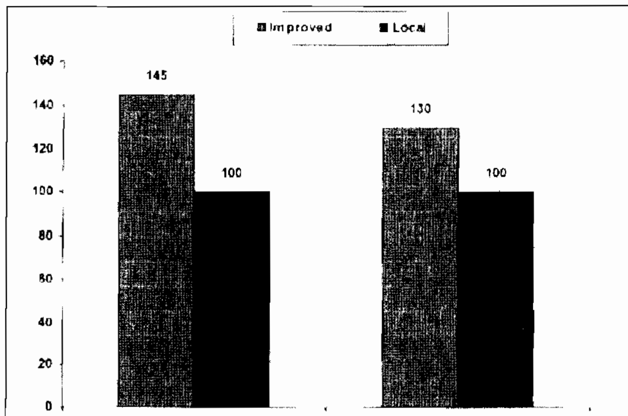

Fig 2 Indices of fresh root yield per unit area (local variety yield of 13410kg/ha = 100%) and per unit of labor (local variety of 64 kg/person-day = 100%)

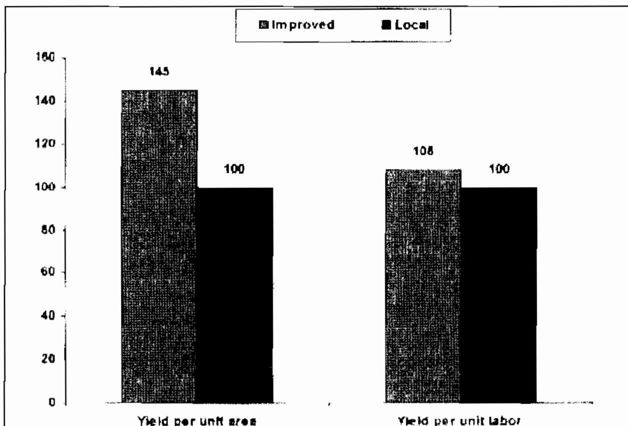

Fig 3 Indices of fresh root yield per unit area (local variety yield of 2682kg/ha = 100%) and per unit of labor (local variety of 4.8 kg/person-day = 100%)

Nweke et al. (4) estimated the labor input in the peeling and roasting activities in the making of gari as 20 womandays per ton of fresh roots. At yield rates given above (Table 3), the processing labor would be 389 person-days/ha for the improved and 268 person-days/ha for the local varieties, a difference of about 45%. The processing labor is proportionate to the fresh root yield per unit area because processing is carried out manually and labor input does not decline with quantity processed.

It is worth noting, from the foregoing that more labor is required to process cassava into gari than to produce cassava fresh roots.

Cassava yield per unit labor

On average, 83 kg of cassava root yield in fresh form are produced per person-day of labor with improved varieties and 64 kg with local varieties; this represents a difference of about 39% in favor of the improved varieties (Figure 2). Gari yield per person-day of labor is 5.3 kg for improved varieties and 4.8 kg for local; this represents a difference of only 8% in favor of improved varieties (Figure 3). This gap is substantially narrower than the gap in the gari yield as well as in fresh root yield per unit area. This is because transportation and processing labor requirements per unit area are substantially higher for the improved varieties than for the local. Transportation activity requires more than one third of field production labor requirements for the local varieties and almost half of field production labor requirements for the improved varieties. Transportation and processing labor requirements are, respectively, almost 45% higher for the improved varieties than for local cassava.

From the foregoing analysis, it can be hypothesized that the adoption of high-yielding varieties of cassava may be hindered where transportation and processing activities are manually carried out. This is tested by examining, using the logit model, the impact of distance to fields (LOCATE), transportation means (TRAMEAN), and the availability of a cassava processing machine in the village (CACINE) on the probability of adoption of improved varieties of cassava (VARYT). The explicit function which explains the likelihood of adoption of improved varieties is given as

VARYT = f (LOCATE, TRAMEAN, CACINE) where

VARYT = cultivation of improved variety of cassava in a field; VARYT = 1 if improved variety is planted in the field and 0 if not;

LOCATE= location of cassava fields in relation to farmers' homesteads; LOCATE = 1 if field is distant to farmers' homesteads and 0 if otherwise;

TRAMEAN = means of transportation of cassava output from the field; TRAMEAN = 1 if means of transportation is headload or backload and 0 if otherwise;

CACINE = availability of cassava processing machine in the village; CACINE = 1 if there is no cassava processing machine in the village and 0 if otherwise.

Table 4: Parameter estimates of explanatory variables of adoption of improved cassava varieties (VARYT)

variable	parameter estimate	standard error	Wald Chi-square	Pr > Chi-Square
intercept	-3.1599	0.4606	47.0627	0.0001
LOCATE	-1.7292	0.7271	5.6555	0.0174
TRAMEAN	-0.5526	0.3342	2.7329	0.0983
CACINE	-1.2027	0.4736	6.4490	0.0111
Statistics				
-2Log:	intercept only:	522.696		
	intercept & cov:	501.108		
	Chi2 for cov :	21.588		
	with DF:	3 (p=0.0001)		
	Percent of correct specification:	33.3		

The results of analysis (Table 4) show a negative and statistically significant relationship between distance to fields and cultivation of improved cassava varieties. This means that where fields are located far away from farmers' homesteads the adoption of high-yielding varieties of cassava is not likely to have much success because of the reasons given above. This will be particularly the case in areas of high demographic pressure resulting in land scarcity and the need to travel longer distances to and from fields (7). Tshiunza et al. (8) found that about 75% of cassava fields in sub-Saharan Africa are located far away from farmers' homesteads as a result of demographic and market pressures on land. Transportation by headload/backload bears a negative and statistically significant relationship with the likelihood of adoption of improved cassava varieties. This means that the lack of motorized vehicles for the transportation of cassava output from fields is likely to impede the adoption of high-yielding cassava varieties. Lack of cassava processing machine in the village has a negative and statistically significant relationship with the likelihood of cultivation of improved cassava varieties.

Conclusion

Cassava fresh root yield per unit area is significantly higher (45%) for the improved varieties than for the local. However, field production labor per unit area is also higher (11%) for the improved varieties. As a result, their advantage in terms of cassava root yield per unit labor is only 30%. When transportation and processing activities are taken into account, gari yield per person-day is only about 8% higher for the improved varieties. This is because field-to-home transportation activity and the processing of cassava into gari are highly labor-intensive, and the processing labor requirements per unit weight are constant. These results indicate that high-yielding cassava varieties do not have a significant advantage (kg of gari per person-day) over local varieties. As a result, the level of their adoption is negatively related with distance to fields, headload transportation means, and absence of a processing machine in the village. It is suggested that field-to-home transportation (of fresh roots) as well as processing activities be mechanized, especially in areas characterized by relative land scarcity.

Literature

1. Carter S.E. & Jones P.G., 1989. COSCA Site selection procedure. COSCA Working Paper No. 2, Collaborative Study of Cassava in Africa, International Institute of Tropical Agriculture, Ibadan, 19 p.
2. International Institute of Tropical Agriculture (IITA), 1986. Root and Tuber Improvement Program Annual Report for 1985, Ibadan, 115 p.
3. Mezei, L.M., 1990. Practical spreadsheet statistics and curve fitting for scientists and engineers, Prentice Hall, New Jersey, 311 p.
4. Nweke F.I., Ezumah H.C. & Spencer S.C., 1993. Farm level performance of improved cassava varieties in the humid forest zone of Nigeria. Journal of Farming Systems Research-Extension 3(2), 83 - 95.
5. Nweke F.I., Dixon A.G.O., Asiedu R. & Folayan S.A., 1994. Cassava varietal needs of farmers and potential for production growth in Africa. COSCA Working Paper No. 10, Collaborative Study of Cassava in Africa, International Institute of Tropical Agriculture, Ibadan, 239 p.
6. Tshibaka T.B., 1987. Food crop production in the Zairian basin: empirical evidence and policy issues. International Food Policy Research Institute, Washington, DC, 125 p.
7. Tshiunza M., 1996. Agricultural intensification and labor needs in the cassava-producing zones of sub-Saharan Africa, Ph.D. dissertation, Katholieke Universiteit Leuven, 159 p.
8. Tshiunza M., Nweke F.I. & Tollens E., 1997. Cassava field-to-home transportation labor needs. African Journal of Root and Tuber Crops 3(1), 43-45.

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