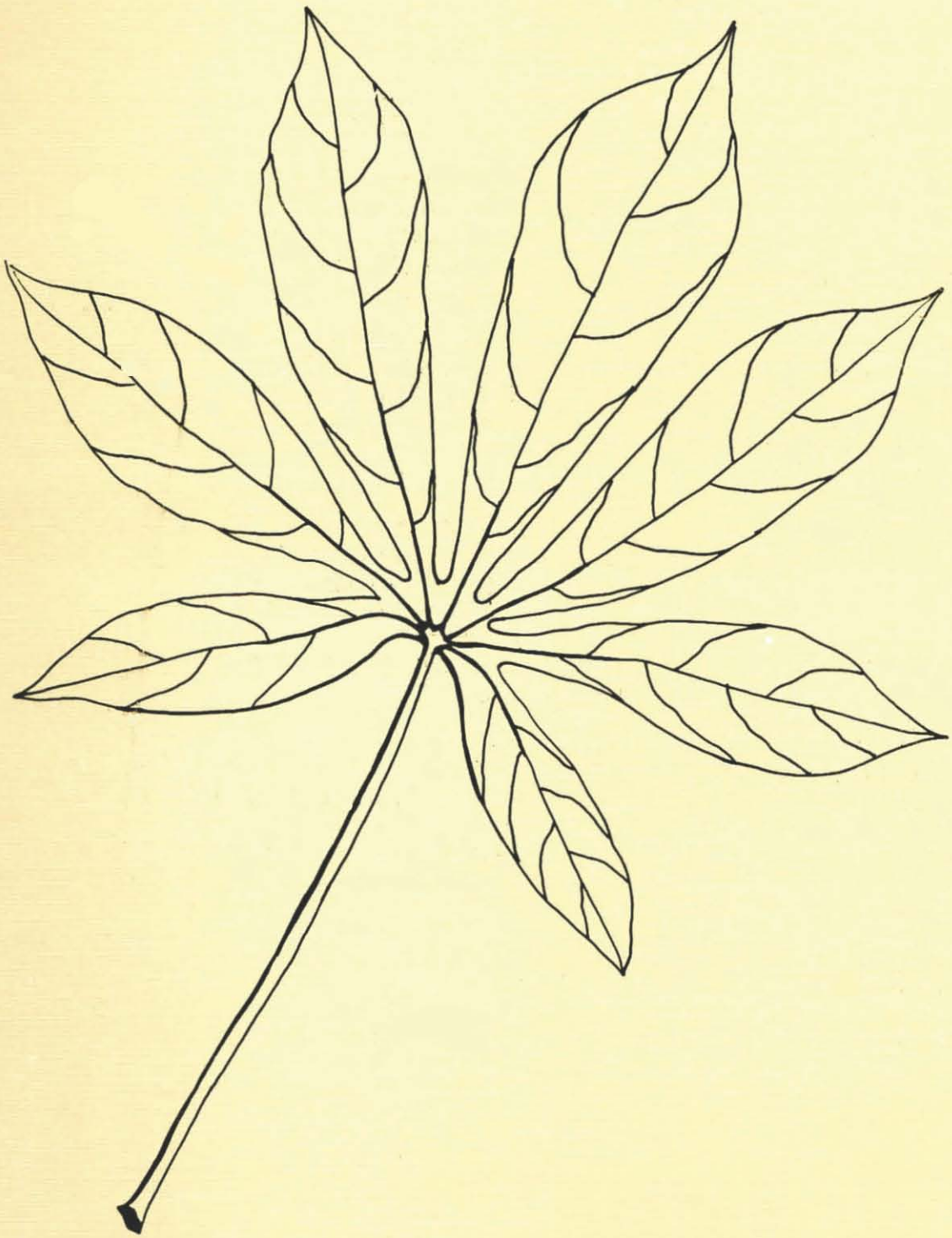
COSCA
Collaborative Study of Cassava in Africa
Working Paper No. 7

7

COSCA Phase I Processing Component

Natural Resources Institute
Chatham, United Kingdom



COSCA: PROJECT AGENCIES AND COLLABORATORS

Executive Agency
International Institute of Tropical Agriculture, (IITA, Ibadan)

Collaborating Agencies
Centro International de Agricultura Tropical (CIAT), Cali, Colombia
Natural Resources Institute (NRI), London
International Child Health Unit, (ICHU), Uppsala, Sweden
National agricultural research systems (NARS), of Burundi, Cameroon, Congo, Côte d'Ivoire, Ghana, Kenya, Malawi, Nigeria, Rwanda, Tanzania, Uganda, Zaire, and Zambia

Primary Funding Agency
The Rockefeller Foundation

Steering Committee
D. Spencer, IITA, (Chairman)
S. Hahn, IITA
R. Best, CIAT
R. Barker, IITA, Board of Trustees
T. Tshibaka, IFPRI
J. Lynam, The Rockefeller Foundation
T. Philips, University of Guelph
J. Strauss, Michigan State University
M. Dahniya, University of Sierra Leone
F. Nweke, IITA (Secretary)

Project Leader
F. Nweke

National Research Coordinators
K. Ngoran, Côte d'Ivoire
C. N'dri, Côte d'Ivoire
B. Konassi, Côte d'Ivoire
I. Quattara, Côte d'Ivoire
R. Al-Hassan (Ms), Ghana
S. Asuming-Brempong, Ghana
A. Kissiedu, Ghana
A. Cudjoe, Ghana
I. Bondzie, Ghana
A. Abubaker, Kenya
R. Sauti, Malawi
M. Chibwambo (Ms), Malawi
E. Nkhonje, Malawi
G. Thaulo, Malawi
B. Ugwu, Nigeria
O. Ajobo, Nigeria
C. Asinobi (Ms), Nigeria
A. Nwosu (Ms), Nigeria
M. Ibedu, Nigeria
J. Njoku, Nigeria
O. Essien, Nigeria
B. Rwenyagira, Tanzania
E. Ruzika, Tanzania
A. Makbel, Tanzania
G. Otim-Nape, Uganda
A. Bua, Uganda
H. Masembe-Kajubi, Uganda
Y. Baguma, Uganda
B. Bukaka, Zaire
N. Kalombi, Zaire
D. Lutete, Zaire
A. Sumani, Zambia

IITA Scientists
D. Spencer, Agricultural Economist, Resource and Crop Management Program (RCMP)
F. Nweke, Agricultural Economist (RCMP)
S. Jagtap, Agroclimatologist (RCMP)
S. Hahn, Breeder, Root, Tuber and Plantain Improvement Program, (TRIPP)
J. Otoo, (TRIPP)
W. Jeon, Postharvest technologist (TRIPP)
M. Bokanga, Biochemist, (TRIPP)

Non-IITA Scientists
S. Carter, (CIAT)
N. Poulter, Food Processing Technologist, (NRI)
A. Westby, Biochemist (NRI)
J. Gillings, Economist (NRI)
J. Lynam, Agricultural Economist, (The Rockefeller Foundation)
S. Romanoff, Anthropologist (The Rockefeller Foundation)

Consultants
E. Okorji, University of Nigeria, Nsukka
C. Asadu, University of Nigeria, Nsukka
W. Jones, Stanford University, USA
L. Fresco, University of Wageningen, Netherlands
M. Akoroda, University of Ibadan, Ibadan

Data Base Manager
S. Folayan, IITA

Administrative Assistant
J. Ojetade, IITA

COSCA

Collaborative Study of Cassava in Africa

COSCA Phase I Processing Component

Natural Resources Institute
Chatham, United Kingdom

COSCA Working Paper No. 7, 1992
A report from Phase I of the Collaborative Study of Cassava in Africa (COSCA)

COSCA Working Paper No. 7

First printing 1992

Collaborative Study of Cassava in Africa
Resource and Crop Management Program
International Institute of Tropical Agriculture
P.M.B. 5320
Oyo Road
Ibadan, Nigeria

Produced for COSCA in cooperation with
African Book Builders Ltd.
26 Arigidi Street
Bodija Estate
Ibadan

CONTENTS

List of Tables

List of Figures

PREFACE

THE Collaborative Study of Cassava of Africa (COSCA) is an inter-institutional effort. The aim is to provide baseline information on cassava over a wide area. Such information is needed to improve the relevance and impact of agricultural research on the crop in Africa in order to realize the potential of cassava in increasing food production and the incomes of the people of Africa.

The COSCA working paper series is published informally by COSCA to disseminate its intermediate output. Publications in the series include methodologies for, as well as preliminary results of, the various components and phases of the COSCA surveys. The series is aimed at scientists and researchers working with national agricultural research systems in Africa (NARS), the international research community, policy makers, donors and members of international development agencies that are interested in cassava. As these papers are not in their final form, comments are welcome. Such comments should be addressed to the respective authors or to the COSCA project leader.

Individuals and institutions may receive single copies free of charge by writing to:

The Project Leader
Collaborative Study of Cassava in Africa
Resource and Crop Management Program
International Institute of Tropical Agriculture
P.M.B. 5320, Oyo Road
Ibadan, Nigeria

Results and Analysis

1. Introduction

The first phase of the Collaborative Study of Cassava in Africa (COSCA), involved the collection of village-level information from key informant groups in 233 villages across six African states.[1] This information has been assembled, using DBase III+, into a comprehensive database by COSCA staff based at the International Institute of Tropical Agriculture, Ibadan.

The phase I COSCA database is subdivided into four categories: production, marketing, consumption and processing. The Natural Resources Institute (NRI),[2] one of the participating organizations involved in COSCA, has the responsibility for analyzing aspects concerning processing.

The analysis of the first phase of COSCA is guided by a series of objectives and hypotheses set out in the first working paper.[3] The specific objective which relates to processing is "to quantitatively and qualitatively characterize the nature and distribution of cassava processing systems". This report interprets information contained in the phase I processing database to address this objective.

2. Phase I product definition

An observable characteristic of the phase I processing database is the use of a large number of different product names. Across the six countries, 147 different names (including spelling variations) are used to describe a total of 623 products. In most instances, these names refer to the same or similar types of products. This complicates the interpretation of information contained in the processing database.

In order to facilitate assessment of the information, there must be some means of identifying which products are synonymous or analogous, and defining their similarity.

This problem was foreseen by the designers of the first phase of COSCA. A solution was attempted through the use of 'product codes'. These codes were designed to allow products to be defined by a pre-specified code number. A list of sixty-two product codes was eventually drawn up, reducing the problem, but there were still too many categories of product to permit interpretation of the collected processing information. Further aggregation was necessary.

The next sections of this paper describe a system devised by the Natural Resources Institute to fit the various products encountered into unique aggregated categories, simplifying the interpretation of the data. These aggregated product categories were then used to analyze the information collected during phase I of COSCA, including the testing of various hypotheses.[4]

3. Developing discrete product categories

During the first phase of COSCA, general information was collected on the five major cassava products processed in each village. Detailed information covering the sequence of processing stages of the three most important processed products was collected, although not all survey villages had three different processed cassava products. This detailed information constitutes the database on which this report was written.

Processed products are identified in the processing database using two different fields: the local name and the product code. Using the product codes, there are, as explained earlier, 62 different product types, which is a large number for critical interpretation. The number of product types had to be reduced and combined into

---

[1] The six countries are: Côte d'Ivoire, Ghana, Nigeria (divided into East and West), Tanzania, Uganda and Zaire.

[2] Natural Resources Institute, Central Avenue, Chatham Maritime, Kent, United Kingdom, ME4 4TB

[3] F.I. Nweke, Cosca project description. COSCA Working Paper No.1. Resource and Crop Management Program, International Institute of Tropical Agriculture, Ibadan, Nigeria, 1988.

[4] Nweke, 1988.

broader categories to facilitate interpretation. The starting point for this procedure was the work of Peter Ay[5] who defined a small number of broad but discrete categories for processed cassava products.

Using Ay's definition of the essential processing stages required for each product category, DBase III+ programs were developed to assign each product to one of eight different product categories: cooked fresh roots, roasted granules, steamed granules, flours/dried chips, fermented pastes, sedimented starches, leaves, and drinks.

Separate programs for each product category worked by comparing the stages used in processing each product with the essential processing steps defined by Ay. For example, the fermented paste program searched for any product which was fermented then pounded or milled, then boiled.

After running these initial programs, it became obvious that, due to extensive variations in processing techniques, Ay's simple essential processing steps would not suffice to accurately categorize the large numbers of different products. For example, roasted granules (*gari*), and steamed granules (*attieke*) were being defined as flours by the computer program since the two products shared the essential processing stages of fermenting and drying. In addition, ostensibly different (though similar) processing stages such as milling and pounding, or steaming and boiling were often being used interchangeably. As a further complication, some enumerators had included the food preparation stage[6] in the processing stage, with the result that flours and roasted granules were, in some cases, being categorized as fermented pastes as a result of the food preparation stage of adding boiling water to these products.

This problem was solved by using less equivocal definitions for each product type, plus the addition of "excluding" or "negative" conditions. These conditions stipulated that some products could be defined by processing stages which could not be used. Thus, to ensure, for example, that a *fermented paste* does not appear as a *roasted granule,* the paste is defined as being fermented, grated and pounded but not roasted. A list of definitions of product types appears in appendix 1.

4. Examining basic product-type patterns

Applying the revised product-type definitions to the phase I database, it is possible to categorize 602 of 623[7] recorded products. It is not possible to classify the remaining 21 products largely due to omitted processing steps, and possibly due to the esoteric nature of some of the products. Table 1 shows the distribution of the product types across the six COSCA countries.

Flours constitute the largest category of products, with 45 per cent of the total, followed by cooked roots (17 per cent), and fermented pastes (12 per cent). Côte d'Ivoire accounts for 94 per cent of steamed granules and 79 per cent of sedimented starches. The production of drinks is limited to Uganda. Cassava leaves were only enumerated as a processed product in four instances, although the consumption database indicates that they were consumed in 132 of the 233 villages surveyed.

Table 2 shows the distribution of first ranked products only. It is apparent that the most important product in COSCA villages in Eastern Nigeria, Tanzania and Zaire is flours, while in Uganda the preference is for cooked roots.[8] In Ghana and Western Nigeria, roasted granules (*gari*) is the most important product, while cooked roots and steamed granules vie for the position of the most important product in Côte d'Ivoire.

---

[5] P. Ay, Essential processing steps and their variations. Working draft, COSCA, Resource and Crop Management Program, International Institute of Tropical Agriculture, Ibadan, 1990.

[6] Food preparation stages are those stages used in preparing a processed product for immediate consumption (such as mixing gari with boiling water).

[7] There were 623 products described in the database instead of 699 because some villages did not record a second or third ranked product. The three most important products in each village were used for this analysis

[8] There was some confusion during the field administration of the Phase I questionnaire which resulted in some countries choosing not to record products which could be described as cooked fresh roots.

Table 1. Product type by country — first three ranked products

Product	Côte d'Ivoire	Ghana	Western Nigeria	Eastern Nigeria	Tanzania	Uganda	Zaire	Total	Per cent
Cooked roots	35	20		11	9	33		108	17
Roasted granules	7	19	18	24				68	11
Steamed granules	30	1					1	32	5
Flours/dry pieces	21	27	17	35	61	52	66	279	45
Fermented pastes	4	10	19	21	1		20	75	12
Leaves					1	3	2	6	1
Beers						6		6	1
Sedimented starch	22		3	3				28	4
Unclassified		5	4	4	2	2	4	21	3
							Total	623	100

Note: The figures in the columns indicate the number of times a particular product type was ranked in the first three most important in the 233 villages surveyed.

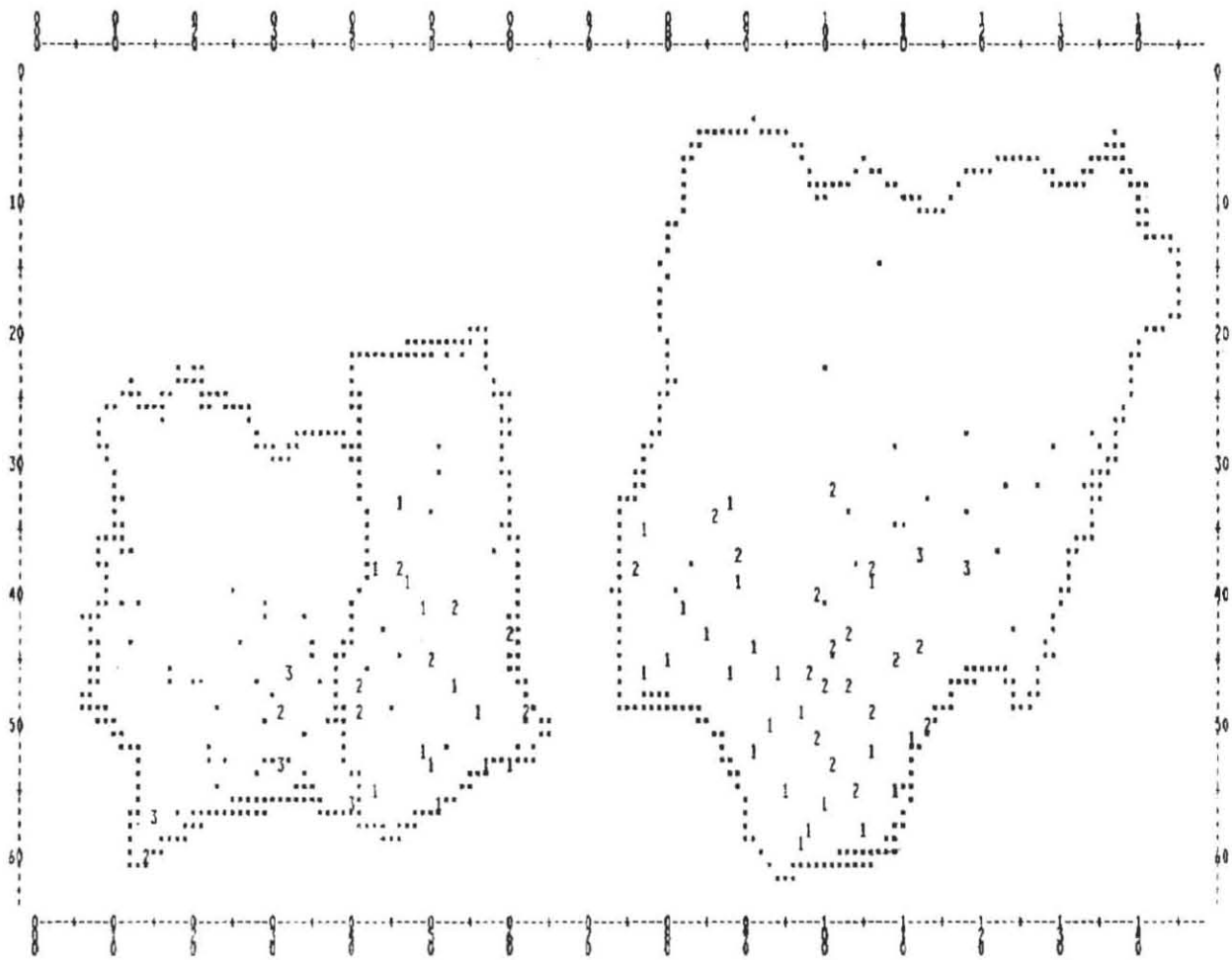
Table 2. Product type by country — first ranked products

Product	Côte d'Ivoire	Ghana	Western Nigeria	Eastern Nigeria	Tanzania	Uganda	Zaire	Total	Per cent
Cooked roots	16	7			2	28		53	23
Roasted granules	1	12	14	8				35	15
Steamed granules	14						1	15	6
Flours/dry pieces	4	8	4	27	26	4	24	97	42
Fermented pastes	2	2		8	1		9	22	9
Leaves								0	0
Beers								0	0
Sedimented starch	3							3	1
Unclassified		1	3	1			2	7	3
							Total	232	100

Note: The figures in the columns indicate the number of villages where the products were ranked first in the 233 villages surveyed

Using the IDRISI[9] mapping package, it is possible to gain an insight into the geographical distribution of the various products. Maps 1, 2 and 3 suggest that roasted granules and fermented products are typically a first or second ranked product near the coast, but tend to decline in importance the further north one goes. The converse is generally true for flours. It is also notable that fermented pastes are the most important product in southern/central Nigeria.

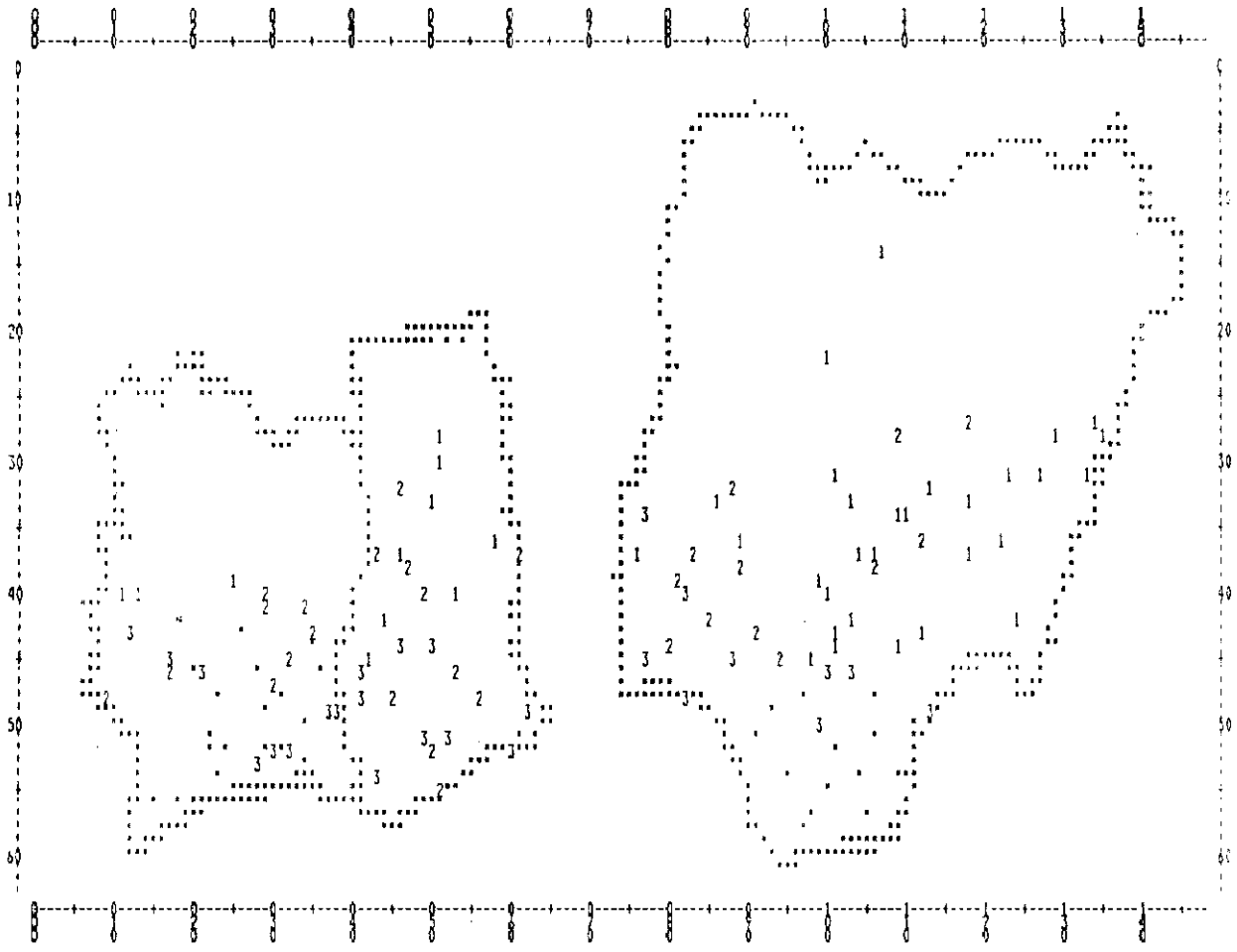
[9] A grid-based geographic analysis system produced by the graduate school of geography at Clark University, USA.



Map 1: Rank for roasted granules—West Africa

IDRISI image : mapga

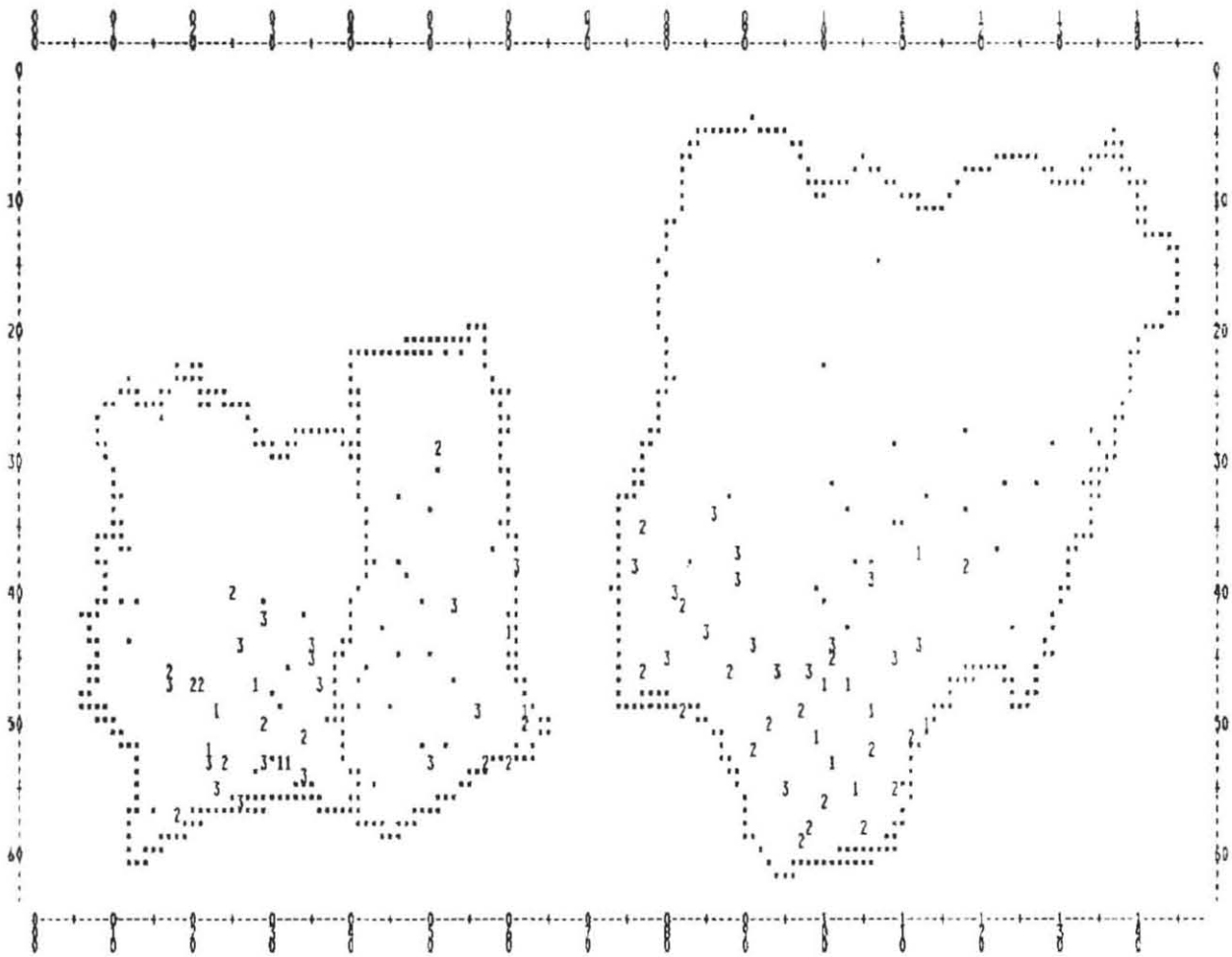
	0	8840	cells	=	92.70 %
111	11	34	cells	=	0.36 %
222	12	27	cells	=	0.28 %
333	13	6	cells	=	0.06 %
***	94	629	cells	=	6.60 %



Map 2: Rank for flours and dried pieces

IDRISI image : mapflr

	0	8691	cells	=	92.59 %
111	11	41	cells	=	0.44 %
222	12	30	cells	=	0.32 %
333	13	26	cells	=	0.28 %
***	94	599	cells	=	6.38 %



Map 3: Rank for fermented pastes

```
IDRISI image : mappst

      0          8840  cells    =     92.70 %
111   11           15  cells    =      0.16 %
222   12           29  cells    =      0.30 %
333   13           30  cells    =      0.31 %
***   94          622  cells    =      6.52 %
```

Table 3 shows the distribution of product type by agro-ecological zone, as defined by Carter and Jones.[10] Products are concentrated in the lowland humid and lowland semi-hot zones because almost 90 per cent of the COSCA villages are themselves concentrated in these zones.[11] Only cooked fresh roots and flours are processed in lowland semi-arid and highland humid zones.

Table 3. Product type by agro-ecological zones — first three ranked products

Product	Low Humid (A)	Low Semi-Hot (C)	Low Continental (E)	Low Semi-Arid (G)	High Humid (J)	Total
Cooked roots	70	15	2	1	12	100
Roasted granules	31	35	1			67
Steamed granules	24	5	2			31
Flours/dry pieces	124	88	7	15	19	253
Fermented pastes	41	31	1			73
Sedimented starch	15	11	1			27
Total	303	183	14	16	29	545

Table 4 illustrates the statistically significant relationship between population density and product type. For the purposes of the survey, population densities were defined as *high* when the number of people per square kilometer was 50 or more. The number of villages in the high and low density bracket was 115 (54 per cent) and 98 (46 per cent) respectively.[12] The concentration of steamed granules and sedimented starches in low density areas reflects the predominance of these product types in Côte d'Ivoire.

Table 4. Product type by population density

Product	POPULATION DENSITY				Total
	High		Low		
	number	per cent	number	per cent	
Cooked roots	51	50	51	50	102
Roasted granules	51	76	16	24	67
Steamed granules	1	3	30	97	31
Flours/dry pieces	121	48	133	52	254
Fermented pastes	50	68	23	32	73
Sedimented starch	4	15	23	85	27
				Total	554

Note: Degrees of freedom 5; chi squared: 69.33

Table 5 illustrates a significant relationship between product type and the trend in cassava production (i.e. whether the production of cassava is said to be rising or falling). Cassava production was rising in 159 (70 per cent) out of the 233 villages and falling or static in 67. Roasted granules, fermented pastes and cooked roots are associated with rising trends in cassava production whilst flours occur disproportionately in villages with a falling

[10] S. Carter and P.G. Jones, COSCA site selection procedure. Working paper no. 2, Resource and Crop Management Program, International Institute of Tropical Agriculture, 1989.

[11] See table 6.

[12] Some of the 233 villages did not possess information on population density; the percentages relate to the 213 villages that did.

cent) out of the 233 villages and falling or static in 67. Roasted granules, fermented pastes and cooked roots are associated with rising trends in cassava production whilst flours occur disproportionately in villages with a falling or static production trend.

The statistical significance of tables 4 and 5 supports the contention that there is some underlying relationship between population densities and product type.[13] A possible relationship is that the highly marketable products (amongst which roasted granules must be the epitome due to extended storability) are associated with high population densities due to easier market access in high population density areas. Additionally, there may be some relationship between the marketable, labor-intensive products (such as roasted granules) and high population densities due to their importance as a source of cash income where alternative employment, both on and off-farm, is becoming more limited due increasing population and resultant over-supply of labor.

Table 5. Product types by cassava trend

Product	PRODUCTION TREND				TOTAL
	Rising		Falling/Static		
	number	per cent	number	per cent	
Cooked roots	81	74	28	26	109
Roasted granules	65	96	3	4	68
Steamed granules	22	69	10	31	32
Flours/dry pieces	164	60	111	40	275
Fermented pastes	54	74	19	26	73
Sedimented starch	19	68	9	32	28
TOTAL					585

Note: degrees of freedom 5; chi squared: 36.18

5. Seasonality of production

Seasonality data from phase I indicate that there are pronounced peaks and troughs in the processing of certain products. Before looking in detail at these patterns, it is necessary to make some clarifications.

The comparison of seasonality data can be misleading. Where seasonality data is aggregated, as in figures 1 to 7, there is a possibility that distinct seasonal peaks and troughs may cancel each other out, giving the appearance of constant output. To minimize the chances of this occurring, comparisons should only be made on the basis of one key variable[14]. For example, to identify the seasonality of flour production, comparison might be based on when the dry season occurs. Once such a variable is identified, comparison should take place between areas where the key variable occurs at the same time of the year. Otherwise, there is a risk of masking the true peaks and troughs of production.

To clarify further, take two areas, A and B, where flours are processed. The rainy season lasts from January to June in A, and from July to December in B. If flour production surges during the dry season, the separate graphs depicting seasonality of flour production in each country will show a peak for country A in the first half of the year and a trough in the second half, and a peak for country B in the second half of the year with a trough in the first half. If data on country A and B are now combined on one single graph, the peaks and troughs will cancel each other out, giving the appearance of constant output throughout the year.

[13] The comparison of trends in cassava production and population density reveals a chi-squared figure of 15.33 (with DR = 1): a significant figure.

[14] Usually the variable which is thought to be the major influence when specific products are processed.

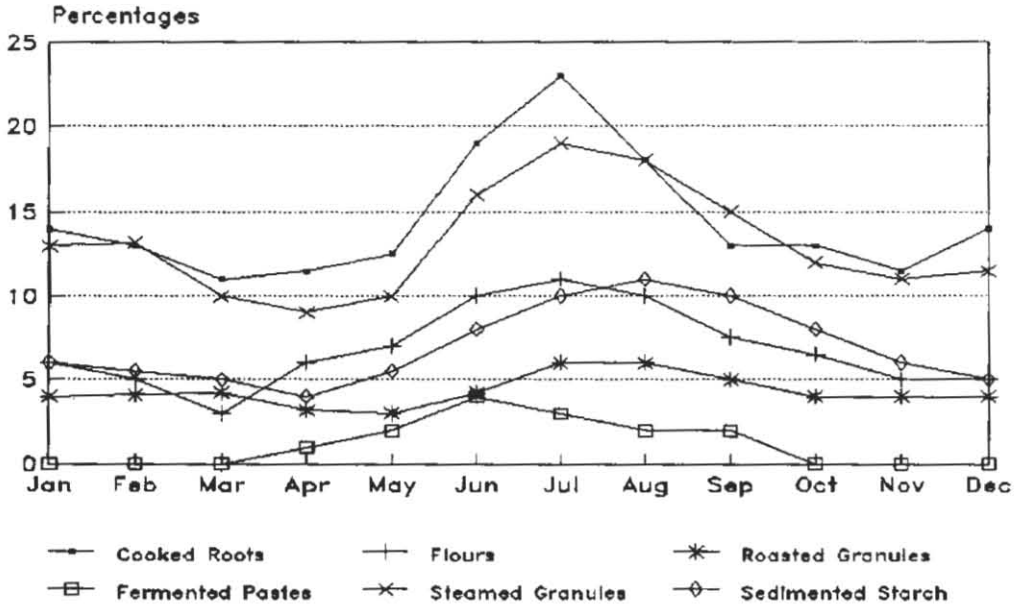


Figure 1. Seasonality of Processing—Côte d'Ivoire

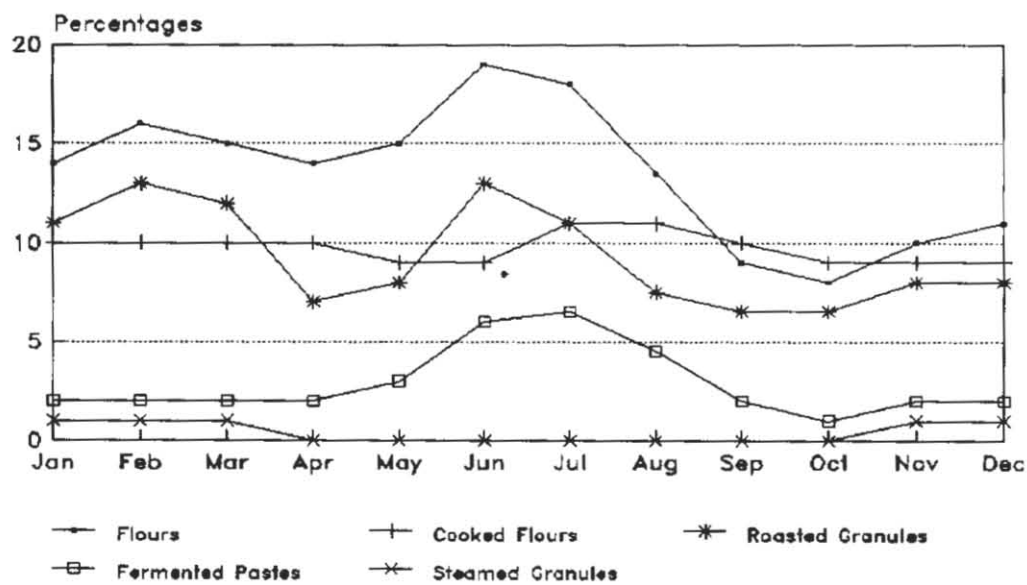


Figure 2. Seasonality of Processing—Ghana

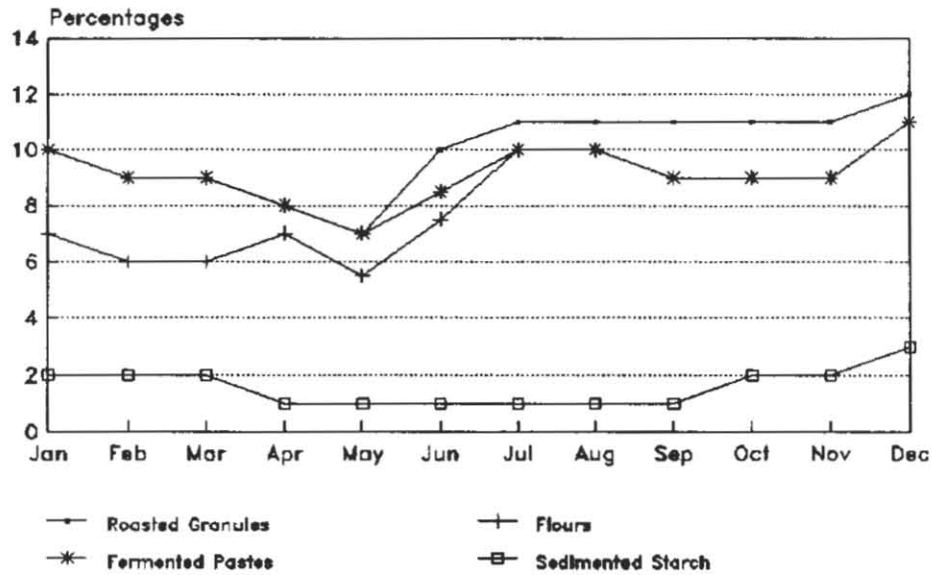


Figure 3. Seasonality of Processing—Eastern Nigeria

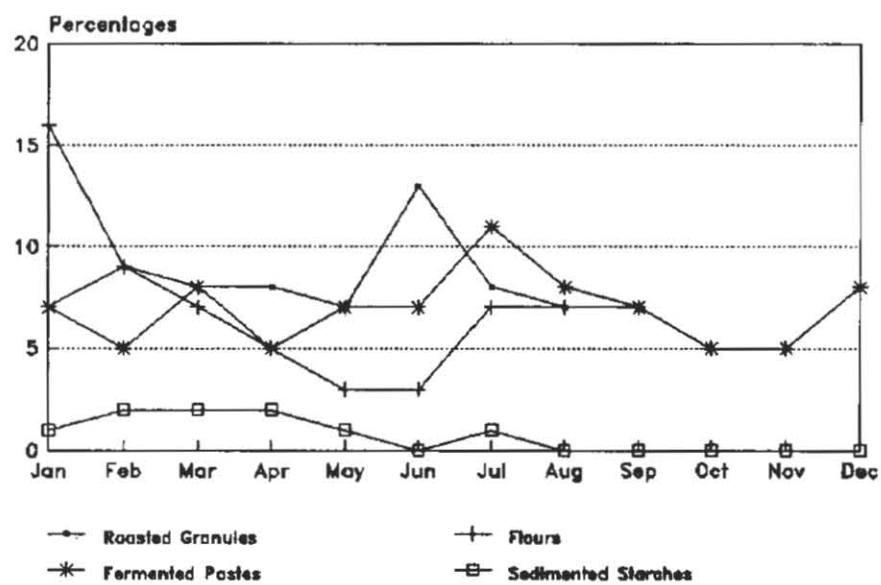


Figure 4. Seasonality of Processing—Western Nigeria

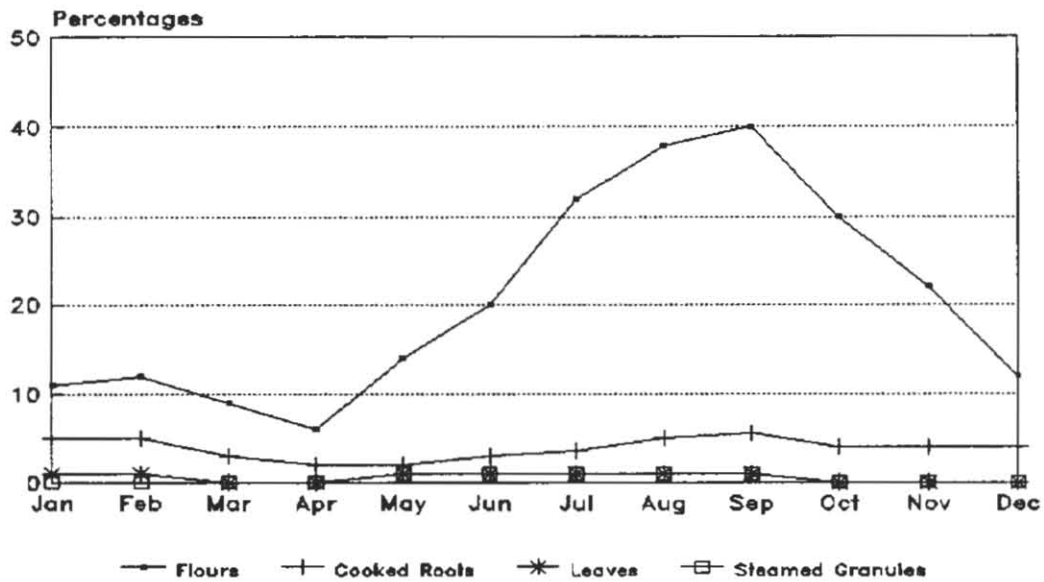


Figure 5. Seasonality of Processing—Tanzania

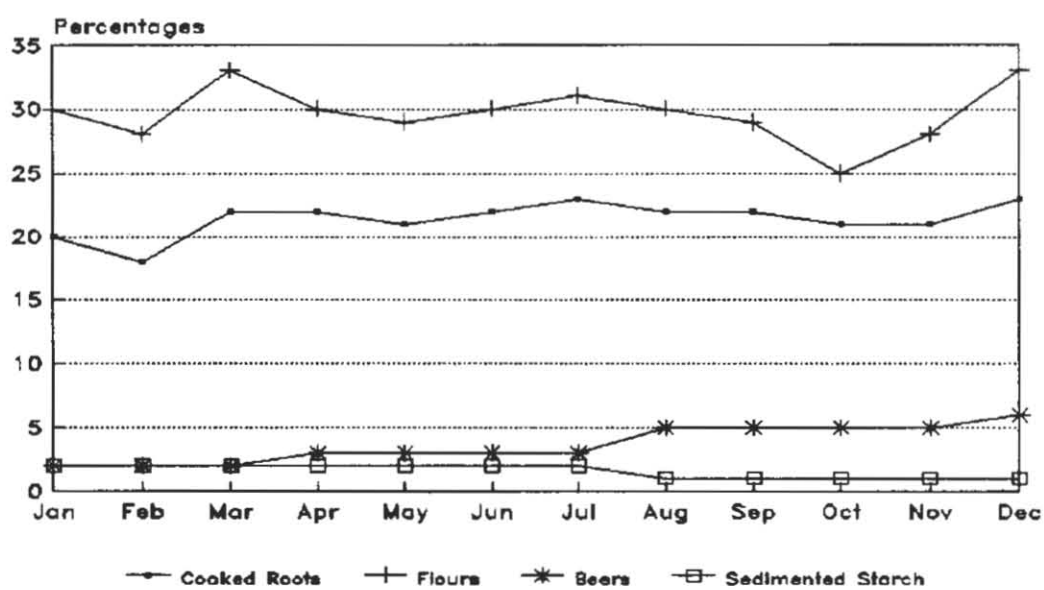


Figure 6. Seasonality of Processing—Uganda

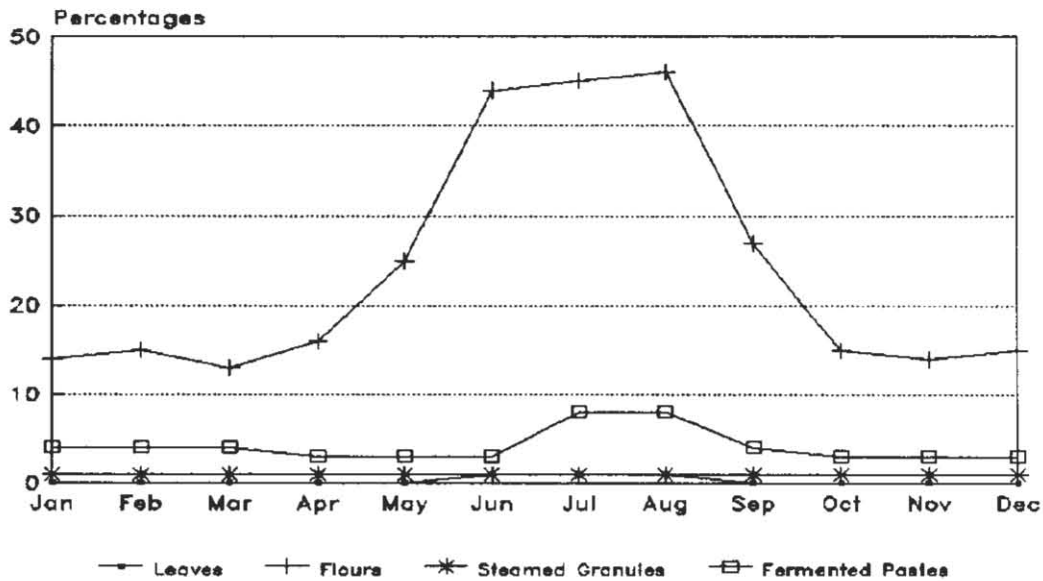


Figure 7. Seasonality of Processing—Zaire

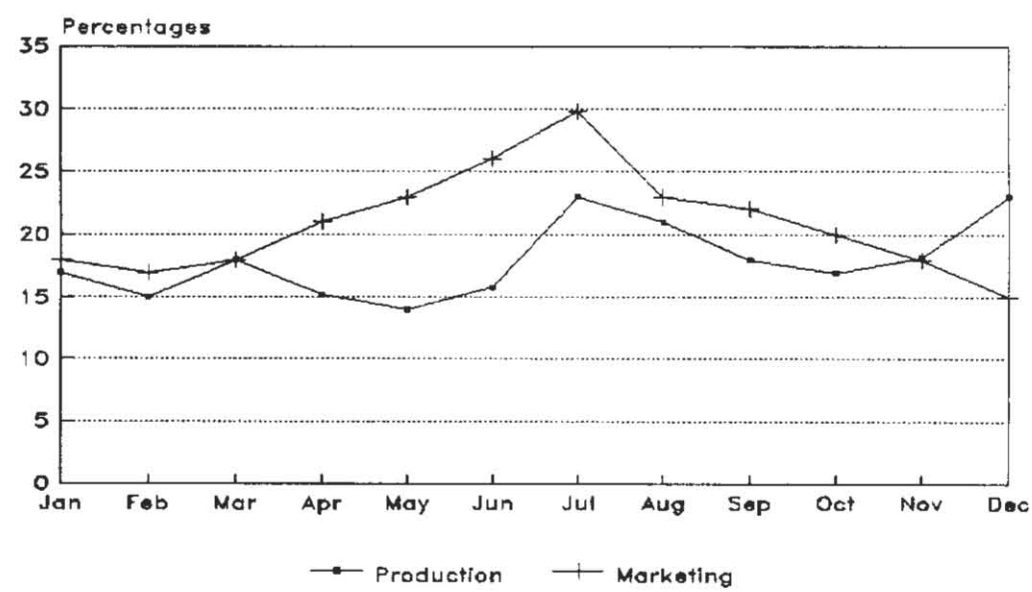


Figure 8. Seasonality of sales and processing of gari in Nigeria

Figures 1 to 7 are presented on a country basis in order to minimize these possible aggregation errors. Products are not compared across agro-ecological zones as variation in the key variables is likely to be greater between agro-ecological zones[15] than between countries. Nonetheless, substantial variations will still occur within each country, masking some of the seasonal effects.

Looking at figures 1 - 7, many products reveal a seasonal peak between June and August. This is demonstrated most clearly in the cases of Zaire, Côte d'Ivoire and (less clearly) Ghana. Interesting exceptions occur for flours in Eastern Nigeria (December/January peak), flours in Tanzania (June to November peak) and roasted granules in Western Nigeria (December peak).

Table 6. COSCA villages by agro-ecological zones

Country	Low Humid (A)	Low Semi-Hot (C)	Low Continental (E)	Low Semi-Arid (G)	High Humid (J)	Total
Côte d'Ivoire	27	8	2	0	0	37
Ghana	17	9	0	0	0	26
Nigeria	20	41	2	2	0	65
Tanzania	3	13	0	5	0	21
Uganda	20	0	0	0	12	32
Zaire	27	7	2	0	0	36
Total	114	78	6	7	12	217

Table 7 shows the extent of "zero seasonality" in production, that is, where production is said to be at a constant level all year round.[16] The figures must be interpreted with reference to table 1; since the percentage figures give no indication of the sample size. Ugandan products appear to be subject to least seasonality, with 46 per cent of the products exhibiting no change in output over the year. Western Nigeria, Eastern Nigeria and Côte d'Ivoire exhibit the greatest degrees of seasonality, although the graphs do not make this apparent. From the evidence of the table 7, roasted granules show the greatest degree of seasonality.

Table 7. Incidences of stable annual processing

Product	Côte d'Ivoire %	Ghana %	Western Nigeria %	Eastern Nigeria %	Tanzania %	Uganda %	Zaire %	% of Total
Cooked roots	23	60	--	18	44	42	--	37
Roasted granules	14	21	22	4	--	--	--	15
Steamed granules	20	0	--	--	--	--	100	22
Flours/dry pieces	14	26	6	9	31	46	26	27
Fermented pastes	0	0	32	5	0	--	30	17
Leaves	--	--	--	--	0	67	50	50
Beers	--	--	--	--	--	50	--	50
Sedimented starches	18	--	33	0	--	--	--	18
Per cent of Total	18	30	21	7	32	46	28	26

[15] The main difference between the key "humid" and "semi-hot" zones (see table 6) is the length of the rainy season, not when the rainy season occurs. "Humid" is used where precipitation is over 60 mm per month for 0 to 3 months; "semi-hot" indicates a duration of 4 to 6 months.

[16] The wording of the question asked during the survey was "during what month(s) of the year is production of these cassava products highest? (enter 1 for highest)". Constant production, or "zero seasonality" is taken as occurring where a "1" has been entered against each month in the year. Products where a blank appeared for each month of the year were not counted as exhibiting "zero seasonality" since the likelihood is that it shows this part of the questionnaire was not filled in.

Various hypotheses could be invented to explain the seasonality of products. Timing of rainfall, for example, may be the prime determinant of the timing of flour production. Similarly, labor demand in other household activities will influence timing. Unfortunately, the scope of phase I database means that there is no data which could be used to adequately test these hypotheses.

Data does exist, however, on the seasonality of marketing of products. Taking the product which, according to table 7, showed the greatest degree of seasonality (or the least non-seasonality) and comparing its processing seasonality with the record of marketing seasonality of that product, a relationship may be discernible. Figure 8 shows the pattern for peak sales of gari/roasted granules in Nigeria as a whole, as well as the seasonality of the processing of gari reproduced from figures 3 and 4. The result shows that one of the processing peaks for gari coincides with the marketing peak. Where lines diverge, such as in the November/December period, there is inferred storage, increased domestic consumption and decreased commercial demand.

In conclusion, the seasonality data illustrate that output of cassava products varies according to the season, but further work is necessary to generate estimates which will point to the factors that are the most important in determining the timing of production.

6. Testing hypotheses

A major aim of the first phase of COSCA was to test some of the hypotheses set out in the first COSCA working paper.[17] Those which relate to the processing of cassava include hypothesis a8 ("there are no economies of scale in cassava processing"), hypothesis a10 ("high labor requirements for processing cassava is a major constraint to expanded production"), and hypothesis b10 ("gender roles in cassava processing change as we move to more commercial production"). Other hypotheses also contain references to processed cassava but are predominantly production or marketing questions which have their own sections elsewhere in the COSCA project.

Within the context of the phase I database, the above hypotheses cannot be fully tested. The hypothesis of the economies of scale can only be tested if there is information about the inputs and outputs from different processes. In phase I there is no such data. The hypothesis concerning the constraining effect of the demand for processing labor cannot be tested since there is no information in the database on processing labor time.[18]

The hypothesis concerning changing gender roles relates to the movement to 'more commercial production'. The nearest convenient proxy that can be used for degree of production commercialization is the question on why cassava is produced; for home consumption or for sale. Thus, a table (8) has been produced which contrasts this information with the question of which sex has the greater role in production. The chi squared statistic is categorically not significant in this case, so the hypothesis goes unconfirmed.

7. The role of women in cassava processing

It is clear from the phase I database that women play a major role in processing cassava. In answer to the question: "What is the gender of those who do most processing of this product?" Only 9 instances are recorded where the answer was given as "males", and four of these involved the production of alcohol. In contrast, in 372 cases the answer was given as "females".

Unfortunately, the question "who does most processing?" was not asked for the first ranked, and hence most important, processed product. There is, therefore, the possibility that men may be responsible for most of the processing of the first ranked products if responses to this question alone are used to analyze gender roles.

---

[17] Nweke, 1988.

[18] There is data on the time taken for processing stages which last a day or more, such a drying, but this is not the same thing as active labor input.

Table 8. Hypothesis b10 Gender roles and increasing commercialization

Cassava Production Objectives	GENDER ROLES		Total
	Female	Male	
For home consumption	198	5	203
For sale	94	2	96
Total	292	7	299

Degree of freedom 1; Chi squared: 0.0

Fortunately, additional information does exist. Table 9 summarizes the information on gender-differentiated processing tasks for all ranked processed products and demonstrates that 82 per cent are performed mainly by women, with only 7 per cent performed mainly by men. When comparable figures are assembled for first ranked products only, the proportions are almost identical, at 81 per cent and 7 per cent respectively.

Table 9. Gender roles in cassava processing

Subprocess	(A) Women	(B) Men	(C) Others	A\A+B+C %	B|A+B+C %	Total
Washing	273	2	24	91	1	299
Peeling	318	11	60	82	3	389
Soaking	88	6	6	88	6	100
Slicing	173	9	20	86	4	202
Grating	48	35	16	48	35	99
Milling	44	24	6	59	32	74
Pounding	165	5	17	88	3	187
Sieving	187	5	23	87	2	215
Roasting	33	4	7	75	9	44
Sun-drying	179	13	21	84	6	213
Frying	52	3	5	87	5	60
Wrapping	25	0	1	96	0	26
Fermenting in sacks	106	24	26	68	15	156
Total	1,691	141	232	82%	7%	2,064

From table 9 it can be seen that in 75 per cent to 91 per cent of villages, women or women and children are responsible for the tasks of peeling, washing, pounding, roasting and frying. Men tend to assume significant responsibility only for the tasks of milling, grating and fermenting in sacks — tasks which often involve the use of machines. Table 10 compares the relative frequencies of male participation in milling, grating and dewatering, the three tasks which make the most extensive use of machinery. Figures for villages where machines are present ("mechanized villages") are compared with figures for all villages, [19] with the relative frequency of male participation in these tasks noted. The results show that the relative frequency of male responsibility is higher when a machine is present. In the case of grating, this frequency is almost twice the standard village level.

[19] Figures for "all villages" are taken from table 9.

Table 10. Comparison of gender responsibilities for selected mechanized processing stages

Machine	Stage	(A) Mainly Women	(B) Mainly Men	(C) Others	Mechanized Villages		All villages	
					Women %	Men %	Women %	Men %
Mill\grinder	Milling	36	22	6	56	34	59	32
Grater	Grating	12	32	5	24	65	48	35
Screw-press	Dewatering	19	6	0	76	24	68	15

With respect to the marketing of cassava products, in 180 out of a possible 233 instances women are responsible for the selling of the products, whilst only 27 instances of men performing this task are recorded.

8. Product types, quality preferences and varietal preferences

As shown in table 11, color, texture and taste were the most frequently cited quality characteristics of product types by villagers. Color is a particularly important quality characteristic for flours and fermented pastes whilst texture and taste are most important for cooked roots.

Table 11. Desired quality characteristics

Products	Color	Texture/ Mealiness	Taste	Other
Cooked roots	16	43	35	6
Roasted granules	24	11	18	15
Steamed granules	7	6	8	8
Flours\dry pieces	166	47	30	29
Fermented pastes	44	17	3	11
Sedimented starches	7	8	5	3

$v = 15\ x^2 = 116.06$

In 60 per cent of the phase I survey villages, the preferred cassava variety for processing is a sweet variety and in 40 per cent the favored variety is bitter. Table 12 shows the relationship between product type and the bitterness or sweetness of the main cassava variety grown for processing. The relationship is statistically significant, and supports the observation that villagers tend to use sweet varieties for cooked fresh roots.

Table 12. Bitter/sweet varietal preferences

Product	Bitter	Sweet
Cooked roots	11	94
Roasted granules	32	32
Steamed granules	5	12
Flours/dry pieces	127	147
Fermented pastes	44	26
Sedimented starches	9	15
Total	228	326

$v = 5;\ x^2 60.64$

There is the possibility that the statistical significance noted in table 12 is due to the unremarkable tendency for villagers to use sweet varieties as cooked fresh roots. It is, therefore, worth excluding cooked fresh roots from the tabulation to further test the relationship. As shown in table 12, the relationship remains significant when fresh roots are removed, indicating a preference for sweet or bitter varieties extending into other product categories.

9. Mechanization of cassava processing

Table 13 shows the number of villages using machines to process cassava. Nigeria has both the highest number and the greatest diversity of cassava processing machines with 11 of the villages in Western Nigeria using grinders, graters and screw presses. In Zaire, there is no mechanization of cassava processing, whilst in Tanzania and Uganda only mills or grinders are used, given the importance of flours in the two countries. The use of screw presses is restricted to Côte d'Ivoire and Nigeria.

Machines for peeling cassava roots were not encountered in any of the phase I survey villages despite the labor intensity of this processing stage.

Figures 9 and 10, derived from table 14, show the use of machines for the production of particular products.[20] In the case of flours, figure 9 shows that the majority of village production in Ghana, Nigeria and Uganda utilizes a grinder or mill. Graters are only used for flour production in Ghana, Côte d'Ivoire and Nigeria, countries which have alternate uses of these machines for the production of steamed and or roasted granules. Screw presses are only encountered in flour production in Nigeria and Côte d'Ivoire, again reflecting their use in the production of other products (see figure 10).

Table 13. Extent of mechanized processing

Country	Mills/ Grinders	Graters	Screw Press
Côte d'Ivoire	6	4	28
Ghana	24	5	0
W. Nigeria	14	18	13
E. Nigeria	22	16	7
Tanzania	9	0	0
Uganda	24	0	0
Zaire	0	0	0
Total	99	43	48

Figure 10 illustrates the different machine combinations used in the production of roasted granules in Côte d'Ivoire, Ghana and Nigeria. Ghanaian production tends to make extensive use of mills or grinders and graters, with no use of presses. Nigerian producers make use of all three machine types, whilst Côte d'Ivoire producers make most use of screw presses.

Table 14 illustrates that 80 per cent of attieke production in Côte d'Ivoire utilizes screw presses, whilst only 20 per cent of production utilizes mills and 10 per cent, graters.

Table 14. Mechanization of processing — total and relative frequency of use

Product	Country	Total Product	Mill/ Grinder	Grater	Screw Press
Roasted granules	Côte d'Ivoire	7	1(14%)	1(14%)	7(100%)
	Ghana	19	14(74%)	4(21%)	0(0%)
	Nigeria	42	21(50%)	31(74%)	17(40%)
Steamed granules	Côte d'Ivoire	30	6(20%)	3(10%)	24(80%)
Flours	Côte d'Ivoire	21	3(14%)	4(19%)	10(48%)
	Ghana	27	23(85%)	2(7%)	0(0%)
	Nigeria	52	36(69%)	20(38%)	14(27%)
	Tanzania	61	16(26%)	0(0%)	0(0%)
	Uganda	52	37(71%)	0(0%)	0(0%)
	Zaire	66	0(0%)	0(0%)	0(0%)

[20] Figures 9 and 10 should be interpreted in conjunction with table 14 to gain a perspective of sample sizes.

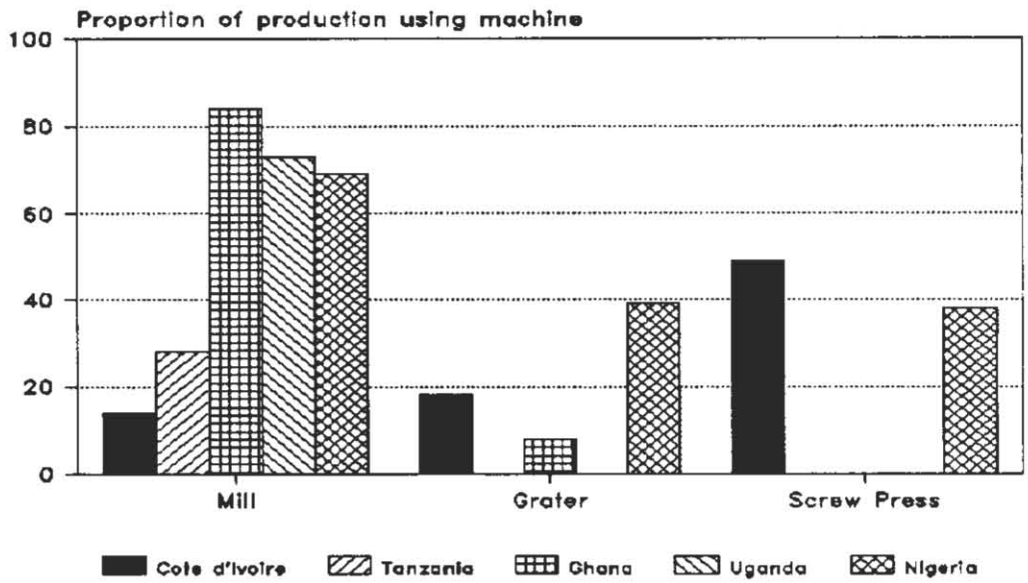


Figure 9. Use of machines in the production of flours

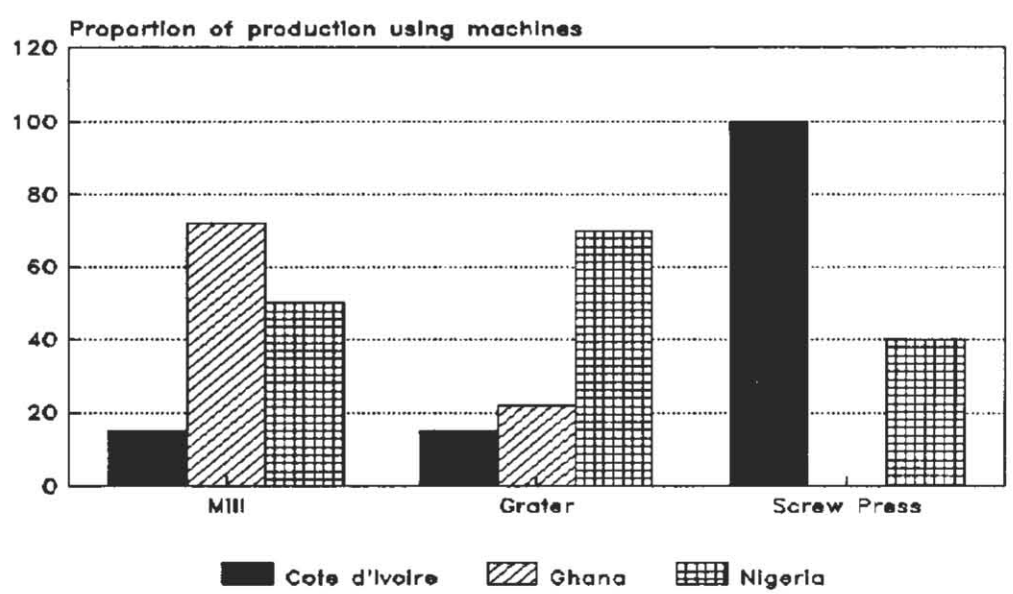


Figure 10. Use of machines in production of roasted granules

10. Organization of cassava processing units

Most cassava processing was conducted by households, with processing by individual commercial units in 22% of the survey villages. Although no co-operative processing of cassava was recorded, this may be due to co-operative processing having been equated with formal co-operative organizations.There were factories processing cassava in 15 of the 233 survey villages: six in both Tanzania and Uganda and three in Eastern Nigeria. All the cassava processing factories in Uganda were government owned. Since no definition of "factory" was specified, there may be inconsistencies between countries.

11. Fuel usage

Table 15 presents data on the usage of different types of fuel for cooking and processing. This original question did not restrict itself to the processing\preparation of cassava and did not list firewood as a fuel. It is nevertheless clear from the table that kerosine\gasoline and crop residues are important fuels, whilst charcoal and gas are rarely used.

Table 15. Fuel usage by number of users

Fuel type	none	few	many	most
Charcoal	159	58	4	4
Crop Residue	141	20	23	40
Kerosene\gasoline	111	59	10	3
Gas	205	16	2	0
Other	192	3	0	10

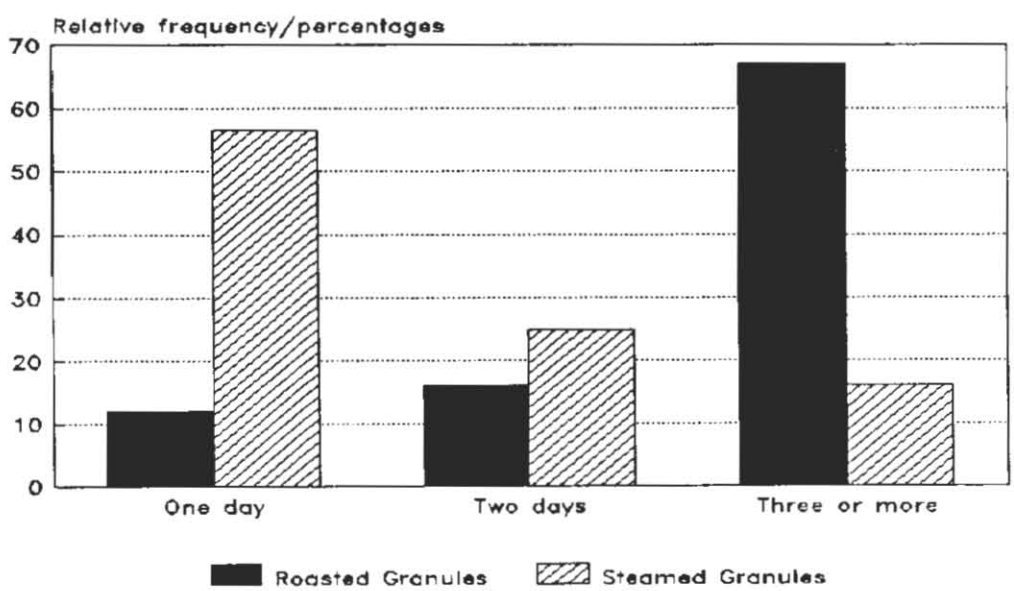


Figure 11. Dewatering times for roasted and steamed granules

12. Distribution of product type by ethnic group

Table 16 presents cross-tabulations of product type by principal ethnic groups in each of the six study countries. Since a total of 67 ethnic groups were encountered in the phase I database, it would be advantageous statistically if these are rationalized before further investigation on these variables is undertaken.

13. Duration of fermentation stages

The analysis of fermentation is complicated by the possible ambiguity of the sun-drying and smoking processing stages. Sun-drying and smoking may not be explicit fermentation stages but will nevertheless result in microbial growth, occasioning fermentation. Similarly, there are complications arising out of the definition of 'dewatering': the database does not allow the processing stage "dewatering" to be distinguished from fermentation in sacks. The problem arises from the fact that fermenting in sacks invariably involves the loss of moisture whether the sack is weighted down with stones or simply left on a rack. Yet many households will use a press, for example, in addition to "dewatering" in the sack. In this report, dewatering and fermenting in sacks\baskets are, therefore, used interchangeably.

Bearing in mind these complications, four distinct methods of fermentation were identifed during phase I.

a. fermentation in sacks or baskets
b. soaking in water for 1 day or more
c. fermentation in heaps for one day or more
d. sun-drying or smoking of products for two days or more

In this report, (a) and (b) are referred to as 'acidic' fermentations and (c) and (d) as 'air' fermentations. It should be noted in this definition that air-fermented products cannot be acid-fermented but that acid fermented products may also be air-fermented (acid-fermented flours, for example, are frequently dried for more than two days).

Since there are seven different processing stages which could be deemed to involve microbial growth[21] total fermentation time will involve, in most cases, the combined duration of these stages. However, very different product qualities are imparted when different fermentation methods are used. For example, a product which is soaked for three days and dried for three days will have different properties from one which is merely dried for six days; that is, the mere comparison of times across the range of fermentation methods is not appropriate.

Nevertheless, some interesting pointers can be gleaned from the database on fermentation times. Figure 11 illustrates the differing "dewatering" times (i.e. fermentation in sacks) for steamed and roasted granules, predominantly attieke and gari respectively. The graph illustrates clearly that steamed granules appear to need less time to dewater than roasted granules. A possible explanation is that roasted granules may be allowed to dewater for longer periods to improve the drying/roasting efficiency, whilst the steaming of granules is less dependent on moisture content. A second hypothesis might be that the practice of adding a starter culture, ubiquitous in attieke production in Côte d'Ivoire, produces a more rapid fermentation which may accelerate the loss of moisture.

On the subject of physico-chemical changes in the product and their relationship to water loss, figure 12 taken from table 17, shows the relationship between drying times for flours and the use of soaking as a processing stage. There is a slightly greater proportion of unsoaked flours in the one to six day categories than soaked flours. This is difficult to explain, indeed the reverse might have been expected due to the same physico-chemical changes postulated for the addition of starter cultures in the production of steamed granules.

[21] Processing stages 03, 12, 29 and 30 to 33 (see appendix 2).

Table 16. Product type by ethnic group

Ethnic group	Product type*							
	1	2	3	4	5	7	8	9
CÔTE D'IVOIRE								
Agni-Ashanti	13	1	12	10	2	0	0	10
Krou	9	2	6	5	2	0	0	6
Mande du Nord	1	1	1	0	0	0	0	0
Mande du Sud	5	0	3	4	0	0	0	2
Koua	4	1	5	1	0	0	0	4
Mossi	2	1	2	1	0	0	0	0
GHANA								
Akan	14	11	0	15	3	0	0	0
Gouang	1	1	0	2	1	0	0	0
Ewe	1	2	1	1	3	0	0	0
Voltaic	2	2	0	4	1	0	0	0
Ga-Adangbe	1	2	0	3	2	0	0	0
Konkonba	1	0	0	1	0	0	0	0
Dagarti\Gagari	0	1	0	1	0	0	0	0
WESTERN NIGERIA								
Yoruba	0	11	0	13	12	0	0	1
Edo	0	3	0	1	4	0	0	0
Urhobo	0	2	0	0	3	0	0	1
Nupe	0	1	0	1	0	0	0	0
Igbirra	0	1	0	1	0	0	0	1
EASTERN NIGERIA								
Hausa\Fulani	1	0	0	12	0	0	0	0
Igbo	3	6	0	3	6	0	0	0
Ibibio	1	1	0	0	1	0	0	0
Tiv	0	2	0	2	2	0	0	0
Gwari	0	2	0	2	0	0	0	2
Katab	0	0	0	1	0	0	0	0
Jukun	0	0	0	1	0	0	0	1
Igala	0	3	0	5	3	0	0	0
Boki	1	1	0	0	1	0	0	0
Gwandara	0	0	0	1	0	0	0	0
Afo	0	1	0	1	0	0	0	0
Chip	0	0	0	1	0	0	0	0
Goemai	0	1	0	1	1	0	0	0
Eggon	0	0	0	2	0	0	0	0
Cheobo	0	0	0	1	0	0	0	0
Ichin	0	1	0	1	1	0	0	0
Dusang	1	1	0	0	1	0	0	0
Ekoi	1	1	0	0	1	0	0	0
Bisu	0	1	0	1	1	0	0	0

Table 16 continued

Ethnic Group	Product type							
	1	2	3	4	5	7	8	9
TANZANIA								
Wassukauma	2	0	0	14	1	1	0	0
Wasubi	0	0	0	2	0	0	0	0
Wajaruo	0	0	0	5	0	0	0	0
Waha	0	0	0	3	0	0	0	0
Wazaramo	2	0	0	13	0	0	0	0
Wamakonde	0	0	0	9	0	0	0	0
Wamakura	0	0	0	3	0	0	0	0
Wazigua	1	0	0	1	0	0	0	0
Wajita	0	0	0	1	0	0	0	0
Wanata	0	0	0	1	0	0	0	0
Wadigo	0	0	0	2	0	0	0	0
Wasambaa	2	0	0	1	0	0	0	1
WaZanzibari	1	0	0	2	0	0	0	0
UGANDA								
Buganda	14	0	0	19	0	2	2	0
Tchouezi	1	0	0	1	0	0	1	0
Nyawanda	1	0	0	2	0	1	0	0
Banyoro	3	0	0	2	0	0	0	0
Alur	2	0	0	4	0	0	0	0
Bakiga	1	0	0	2	0	0	0	0
Basogo	4	0	0	11	0	0	0	0
Langi	2	0	0	3	0	0	1	0
Bagishu	3	0	0	4	0	0	2	0
Badama	1	0	0	2	0	0	0	0
Baruli	1	0	0	2	0	0	0	0
ZAIRE								
Bakongo	0	0	0	31	13	2	0	0
Balunda	0	0	0	4	1	0	0	0
Code 6	0	0	1	8	4	0	0	0
Code 7	0	0	0	23	2	0	0	0

Key to products:
1 = cooked fresh roots
2 = roasted granules
3 = steamed granules
4 = flours\dried pieces
5 = fermented pastes
7 = leaves
8 = drinks
9 = sedimented starches

*6 = no class

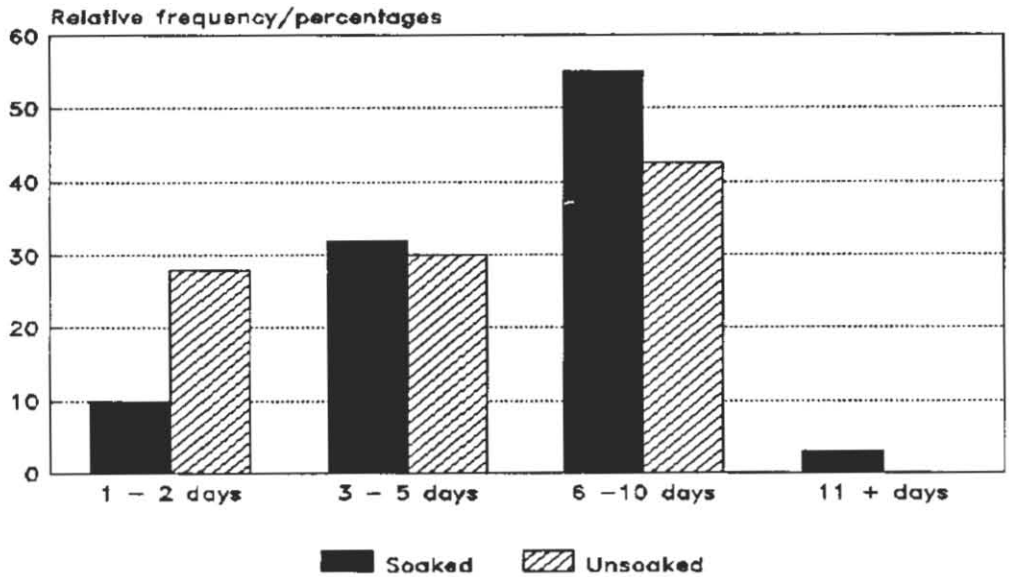


Figure 12. Relationship of drying time between soaked and unsoaked flours

Table 17. Drying times for soaked and unsoaked flours (days)

Days	1 - 2		3 - 5		6 - 10		11 +		Total	
	n	%	n	%	n	%	n	%	n	%
Soaked	18	11	50	31	87	54	6	4	161	100
Unsoaked	22	27	25	30	35	43	0	0	82	100

Table 18 and figure 13 show the duration of fermentation in sacks or baskets for roasted granules. Eastern Nigeria and Côte d'Ivoire seem to allow a large proportion (57% and 43% respectively) of roasted granules to ferment for only 1 or 2 days, although the techniques of production do not seem to vary to any great extent. There is little evidence to support the contention that climate will adversely effect the dewatering time. A possible explanation may lie in the selection of varieties for the production of roasted granules.

There are 279 instances of flours in the phase 1 data base, of which 150 are air fermented and 113 are acid fermented. The remaining 16 instances were deemed to be "unfermented". Twenty-one per cent of the acid fermented flours were subsequently turned into pastes whereas no air fermented flours were used to this end.

Table 18. Dewatering\fermentation duration—roasted granules (days)

Country	1 - 2		3 - 5		6 - 10		11 +		Total	
	n	%	n	%	n	%	n	%	n	%
Côte d'Ivoire	3	43	3	43	1	14	0	0	7	100
Ghana	1	5	14	74	4	21	0	0	19	100
Western Nigeria	4	22	13	72	1	6	0	0	18	100
Eastern Nigeria	13	57	10	43	0	0	0	0	23	100

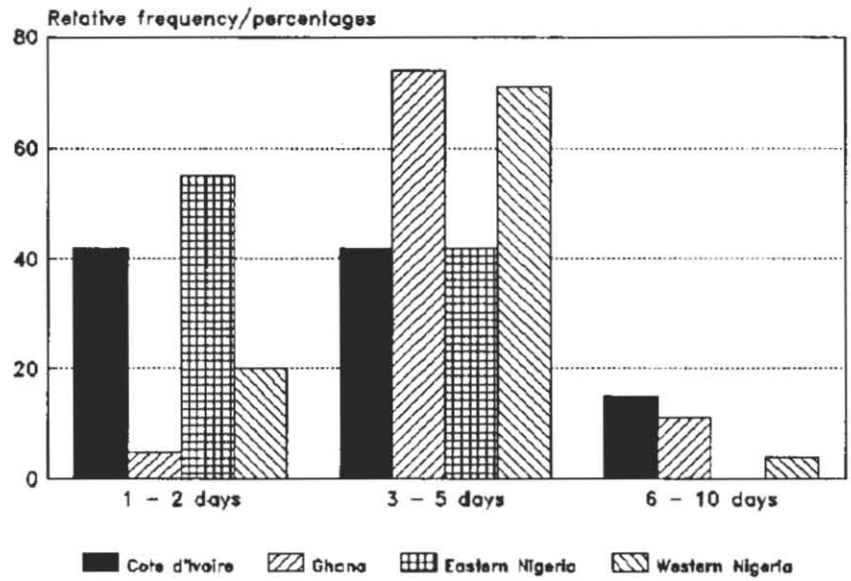


Figure 13. Duration of fermentation in sacks or baskets for roasted granules

Table 19 and figure 14 show the duration of what is effectively fermentation through sun-drying for air fermented flours. The tendency is for flours in Côte d'Ivoire, Ghana and Uganda to be sun-dried for a longer period than those in Nigeria[22] and, to a lesser extent, Tanzania. In 21 cases out of 44, however, Tanzanian households also fermented their flours in heaps.[23]

Table 19. Duration of sun-drying – air fermented flours (days)

Country	1 - 2		3 - 5		6 - 10		11 +		Total	
	n	%	n	%	n	%	n	%	n	%
Côte d'Ivoire	0	0	3	27	11	73	0	0	15	100
Ghana	0	0	2	10	19	90	0	0	21	100
Nigeria	3	23	8	62	2	15	0	0	13	100
Tanzania	10	22	17	37	19	41	0	0	46	100
Uganda	1	3	13	36	22	61	0	0	36	100
Zaire	1	50	1	50	0	0	0	0	2	100

Although the warning at the beginning of this section was that different types of fermentation are not directly comparable, it is instructive to analyze the total durations of the "fermentation" stages, if only to compare the time taken to produce the various products. From table 20 and figure 15 it is evident that the majority of starches, pastes, roasted granules and steamed granules take from 1 to 5 days to "ferment". The majority of flours take 6 to 10 days to ferment, with over 10 per cent taking 11 or over.

[22] Only 1 instance of air-fermented flour occurs in Western Nigeria.

[23] There is a perception in some quarters that high cyanogen content in processed bitter cassava may be related to short "fermenting" duration, particularly for sun-dried products. There are many provisos to this view, not least of which is the question of the true relationship between drying time and cyanogen content, plus the question of exactly how the flours in question are stored and cooked.

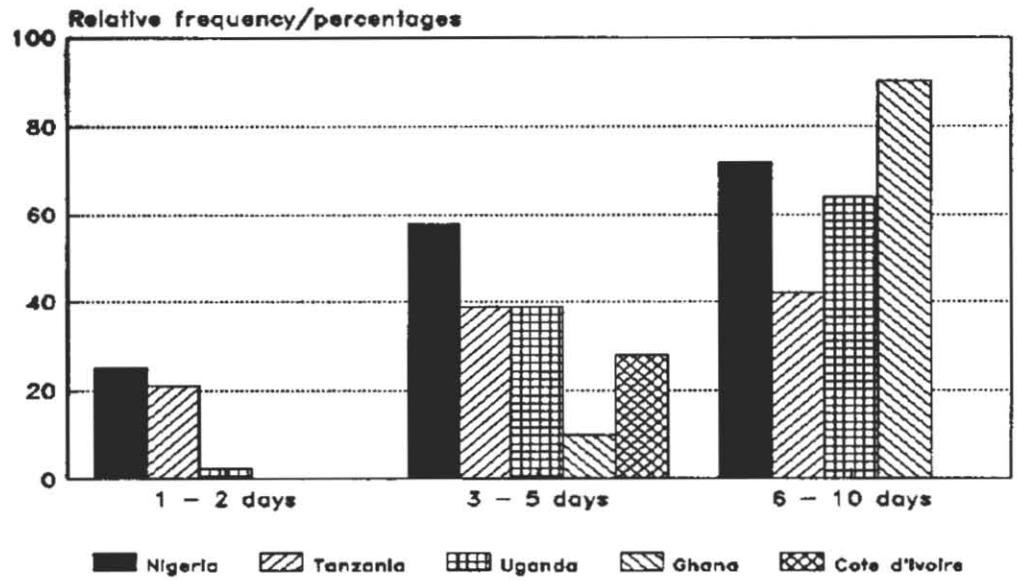


Figure 14. Duration of sun-drying for air-fermented flours

Table 20. Duration of total fermentation — by product (days)

Products	1 - 2		3 - 5		6 - 10		11 +		Total	
	n	%	n	%	n	%	n	%	n	%
Cooked Roots	10	83	1	8	1	8	0	0	12	100
Roasted Granules	22	32	40	59	6	9	0	0	68	100
Steamed Granules	12	43	13	46	3	11	0	0	28	100
Flours	11	4	70	27	152	58	30	11	263	100
(- acid fermented)	3	3	21	19	65	60	20	18	109	100
(- air fermented)	6	4	47	32	84	58	9	6	146	100
Fermented pastes	3	5	48	73	14	21	1	2	66	100
Beers	0	0	2	40	2	40	1	20	5	100
Sedimented Starch	10	43	12	52	0	0	1	4	23	100

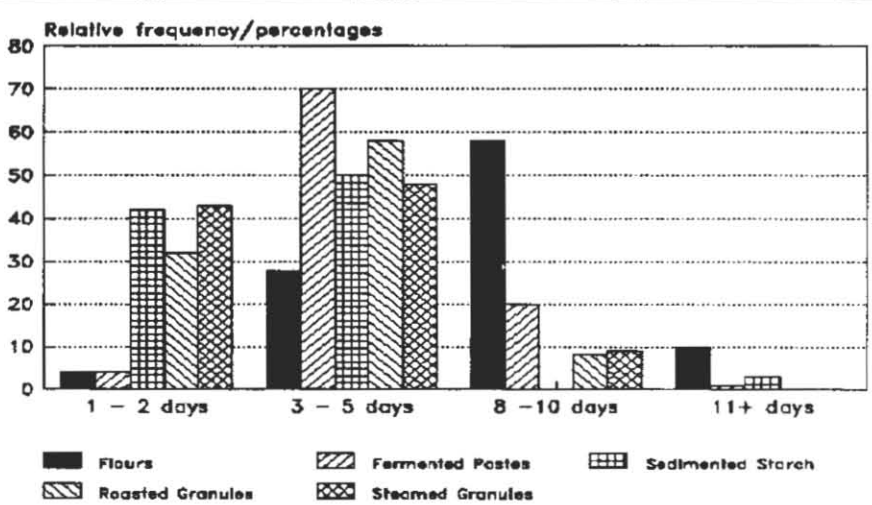


Figure 15. Duration of total fermentation by product

Table 21, and figures 16 and 17, elaborate on table 20, examining durations of fermentation of flours. Again it is manifest that, comparing Eastern Nigeria with the rest of Western Africa, less time is spent fermenting in Eastern Nigeria[24], Ghana and Côte d'Ivoire spend the greatest amount of time. In Eastern and Central Africa, the most protracted fermentation occurs in Zaire.

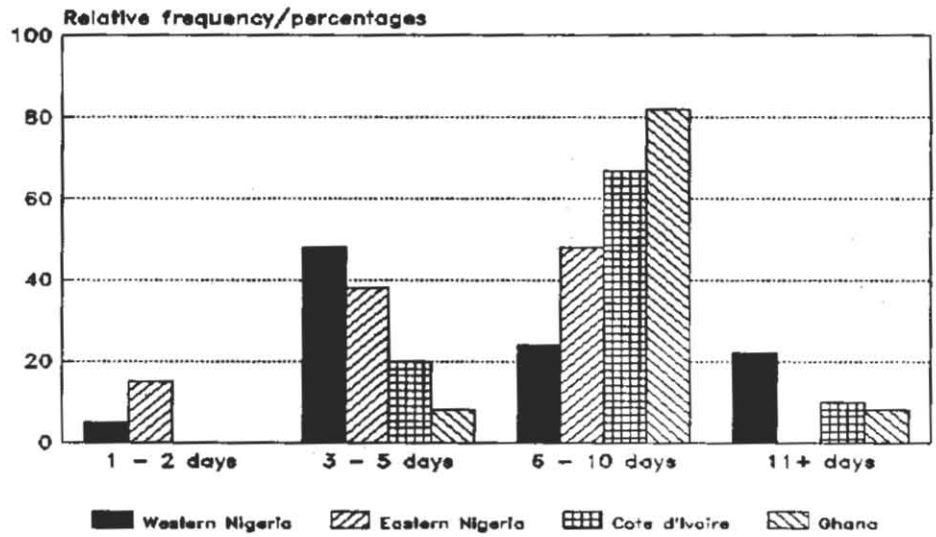


Figure 16. Duration of total fermentation by country—West Africa

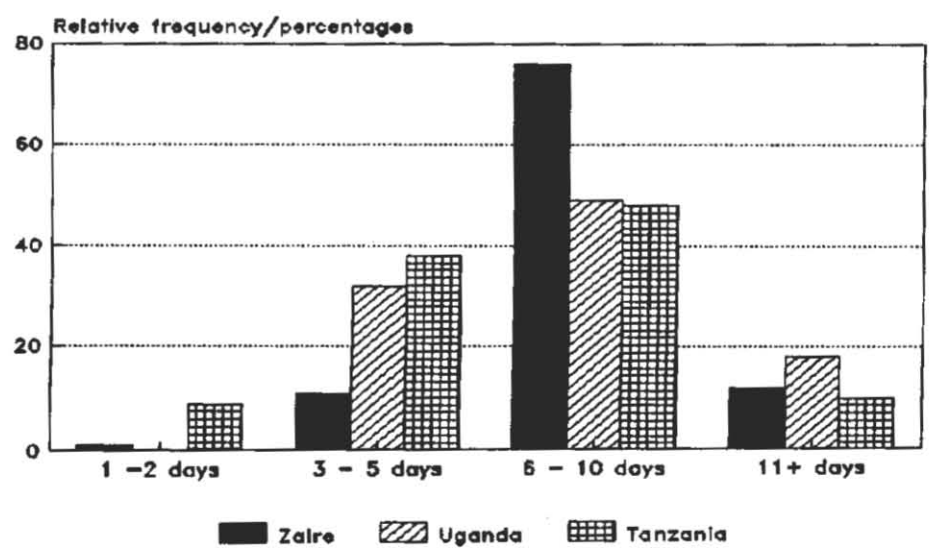


Figure 17. Duration of total fermentation by country—East Africa

[24] Eastern Nigeria is the only area where no products are fermented for longer than ten days.

Table 21. Duration of total flour fermentation — by country (days)

Country	1 - 2 days		3 - 5 days		6 - 10 days		11 + days		Total	
	n	%	n	%	n	%	n	%	n	%
Côte d'Ivoire	0	0	4	22	12	67	2	11	18	100
Ghana	0	0	2	8	22	85	2	8	26	100
Western Nigeria	1	6	8	47	4	24	4	24	17	100
Eastern Nigeria	5	14	13	37	17	49	0	0	35	100
Tanzania	4	7	21	36	27	47	6	10	58	100
Uganda	0	0	15	32	23	49	9	19	47	100
Zaire	1	2	7	11	47	76	7	11	62	100

Starter cultures were used in 66 cases, 54 of which were in Côte d'Ivoire. Given the much reduced dewatering time for steamed granules (which tend to use starter cultures) it would have been logical to compare the drying times for those products which had and those which had not used starter cultures. Unfortunately, there are only eight instances where products which use starter cultures have accompanying records showing the duration of drying; and of those, 2 were beers. Of the remaining six products (all flours) two were dried for one day, one for three days and three for seven days. With such a small sample it is not appropriate to make any inferences from the data.

14. Conclusion

Using DBase programming techniques, it has been possible to distinguish eight discrete cassava product categories. Using these categories the processing of cassava products in the six COSCA countries has been characterized.

The most common product encountered during the first phase of COSCA was 'flour' (a composite category of flour and dried pieces), which amounted to almost half of all products. Cooked roots accounted for another 17 per cent and roasted granules a further 12 per cent.

On a regional basis, West African countries tend consistently to produce a wide variety of products including cooked roots, granules, flours, pastes and sedimented starches. Eastern and Central African countries, on the other hand, showed much more of an accent on flours, with relatively few pastes and starches and only one occurrence of granules.

Cassava products exhibit a certain degree of seasonality, most often around the months of June, July and August. Alternate seasonal effects are discernible in the production of flours in Eastern Nigeria and Tanzania and roasted granules in Western Nigeria. The question why such seasonality should be encountered is one which cannot be answered from the information available in the phase I database. Nevertheless, the verified existence of seasonal effects on production has encouraged the adoption of questions for the third phase of COSCA which will allow some conclusions to be arrived at in explaining seasonality.

In common with the seasonality data, it proved difficult to apply some of the COSCA hypotheses concerning cassava processing to the phase I database. Attempts to test the gender hypothesis suggest that no relationship exists between the degree of commercialization and the gender of the processor.

Data from phase I confirms the view that African cassava processing is dominated by women. Where men took part in any significant numbers, there was a tendency for this to involve the use of machines. Thus, the introduction of machinery may have reduced the drudgery of some of the women's tasks, but the control of this machinery is not necessarily in their hands.

The West African states possess the most mechanized processing systems, although Côte d'Ivoire villages make little use of mills and graters. Tanzanian villages employ fewer mills than those in Uganda, but neither country employs graters or screw presses. This can be explained by the low technology requirements for the processing of flours, which represent the greater part of processed cassava output in these countries. Zairean villages made no use of machinery in the manufacture of cassava products.

The processing of cassava is marked by variations in the length of fermentation and processing techniques. While direct comparison across the complete database is not possible, due to the technical connotations of different fermentation techniques; there are some clear differences in fermentation strategies between countries and between products. The production of steamed granules in Côte d'Ivoire contrasts with that of roasted granules in Nigeria through the shorter duration of fermentation in Côte d'Ivoire. This may be explained by the prevalent utilization of 'starter cultures' in Côte d'Ivoire.

Similar variations can be detected in the relatively short duration of fermentation of roasted granules in Eastern Nigeria and of flours in Côte d'Ivoire, Ghana and Uganda. Taking the somewhat artificial figure for duration of total 'fermentation'[25], flours require the longest interval, whilst roasted and steamed granules and sedimented starches require the shortest.

[25] As explained on page 20

APPENDIX 1

PRODUCT DEFINITIONS

Eight discrete product types were distinguished by the followed taxonomic processing steps:

Product Type (revised product or new codes)	Taxonomic Processing Steps (sub-process codes)
Cooked Fresh Roots (1000)	Don't sediment (10, roast (11), fry (13), sun dry (12), granulate (28), smoke (29), or ferment (30, 31, 32, 33, 03 for more than one day). Do boil (15) or wash (01) or peel (02).
Roasted Granules (2000)	Don't sediment. Do grate (05), mill (06) or pound (07), THEN ferment in sacks (30 or 31), THEN sieve (09), THEN roast (11), or fry (13).
Steamed Granules (3000)	Don't sediment, roast or fry. Do grate, mill or pound. THEN, ferment in sacks, THEN granulate (28) or sieve, THEN boil or steam (27).
Flours/Dry Pieces (4000)	Don't sediment or steam. Don't roast or fry unless this is combined with blending with other staples (19). Do sun dry, smoke or start with flour (40).
Fermented Pastes (5000)	Don't roast, sun dry, fry, brew (20), distil (22), granulate, smoke or sediment (unless performed in combination with soaking). Do ferment, THEN, grate, mill, pound or sieve.
6000 no class	
Leaves (7000)	Do start with leaves (50).
Drinks (8000)	Do brew or distil.
Sedimented Starches (9000)	Don't soak (03). Do sediment.
Unclassified (0999)	Any product left unclassified by the above steps.

APPENDIX 2

Processing Codes

01 washing
02 peeling
03 soaking
04 slicing
05 grating
06 milling
07 pounding

09 sieving
10 sedimenting
11 roasting
12 sun-drying
13 frying
14 wrapping
15 boiling
16 molding/shaping
17 sprinkling with water
18 scraping
19 blending with other staples
20 brewing (beers and soft drinks)
21 making paste
22 distilling

25 adding a starter culture or inoculum
26 blending with spices, flavorings, colorings, salt
27 steaming
28 granulation (using curved board or bowl)
29 smoking
30 fermentation in sacks or baskets/dewatering for less than one day
31 fermentation in sacks or baskets/dewatering for one day or more
32 fermentation in water for one day or more

40 start with cassava flour

50 start with cassava leaves

COSCA Working Paper Series

No. 1 Nweke, Felix I. 1988. COSCA Project Description. International Institute of Tropical Agriculture, Ibadan, Nigeria.

No. 2 Carter, S.E. and P.G. Jones. 1989. COSCA Site Selection Procedure. International Institute of Tropical Agriculture, Ibadan, Nigeria.

No. 3 Nweke, Felix I., John Lynam and Coffi Prudencio, eds. 1989. Status of Data on Cassava in Major Producing Countries of Africa: Cameroon, Côte d'Ivoire, Ghana, Nigeria, Tanzania, Uganda and Zaire. International Institute of Tropical Agriculture, Ibadan, Nigeria.

No. 4 Nweke, Felix I., John Lynam and Coffi Prudencio, eds. 1990. Methodologies and Data Requirements for Cassava Systems Study in Africa. International Institute of Tropical Agriculture, Ibadan.

No. 5 Stoorvogel, J.J., and L.O. Fresco. 1991. The Identification of Agro-ecological Zones for Cassava in Africa with particular emphasis on soils. International Institute of Tropical Agriculture, Ibadan.

No. 6 Ugwu, B.O., and P. Ay. 1992. Seasonality of Cassava Processing in Africa and Tests of Hypotheses. International Institute of Tropical Agriculture, Ibadan, Nigeria.

No. 7 Natural Resources Institute. 1992. COSCA Phase I Processing Component. Chatham, United Kingdom.