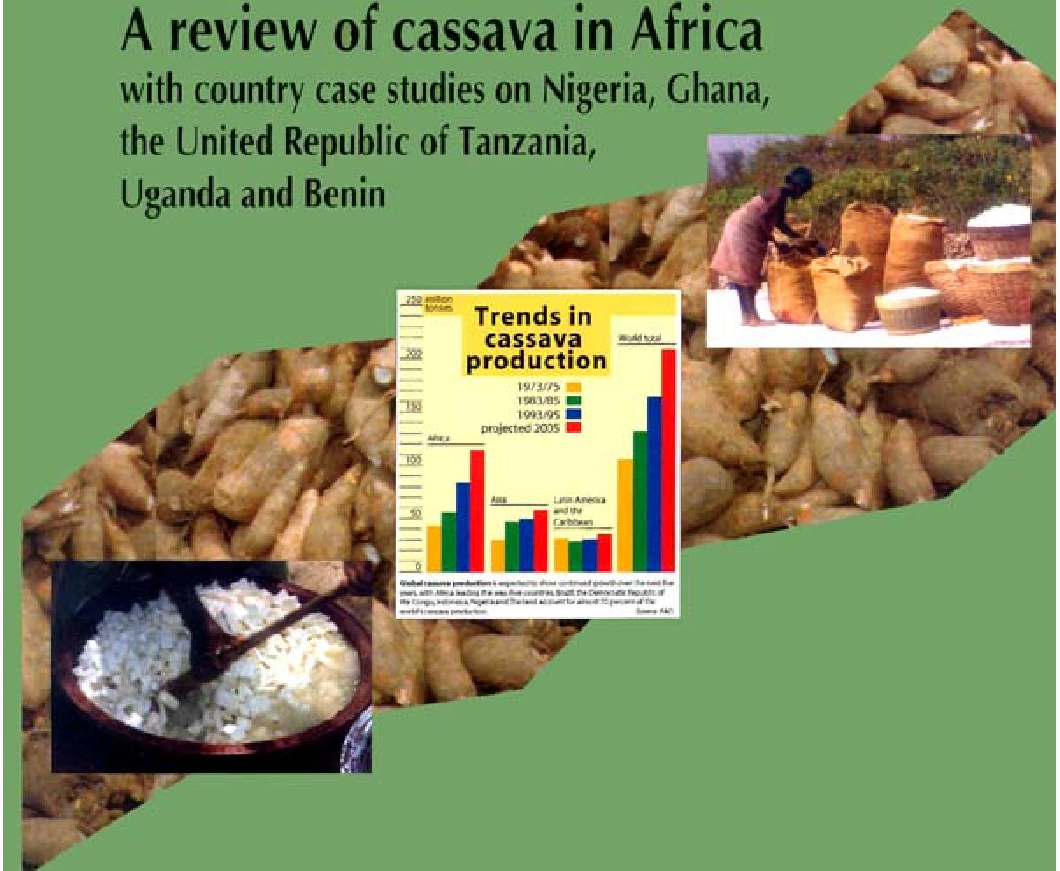
PROCEEDINGS OF THE VALIDATION FORUM
ON THE GLOBAL CASSAVA DEVELOPMENT STRATEGY
Volume 2

A review of cassava in Africa

with country case studies on Nigeria, Ghana, the United Republic of Tanzania, Uganda and Benin



IFAD
INTERNATIONAL
FUND FOR
AGRICULTURAL
DEVELOPMENT
FIAT PANIS

PROCEEDINGS OF THE VALIDATION FORUM

ON THE GLOBAL CASSAVA DEVELOPMENT STRATEGY

Volume 2

A review of cassava in Africa
with country case studies on Nigeria, Ghana, the United Republic of Tanzania, Uganda and Benin

INTERNATIONAL FUND FOR AGRICULTURAL DEVELOPMENT
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2005

TABLE OF CONTENTS

STATUS OF CASSAVA IN TANZANIA

CASSAVA DEVELOPMENT IN UGANDA

ORGANISATION DE LA FILIÈRE DU MANIOC AU BÈNIN (lére PARTIE)

ORGANISATION DE LA FILIÈRE DU MANIOC AU BENIN (2ème PARTIE)

PREFACE

Cassava was first introduced to the Africa continent, close to the mouth of the Congo River by Portuguese explorers and traders from Brazil, South America in the course of the 16th and 17th centuries. From there it was diffused by Africans, to many parts of sub-Saharan Africa over a period of two to three hundred years. In the course of its spreading across the continent, cassava has replaced traditional staples such as millet and yam, and has been successfully incorporated into many farming systems. It was initially adopted as a famine reserve crop as it provided a more reliable source of food during drought, locust attacks and the hungry season, the period before seasonal food crops are ready for harvesting.

At present, approximately half of the world production of cassava is in Africa where it is cultivated in around 40 countries, stretching through a wide belt from Madagascar in the southeast to Senegal and Cape Verde in the northwest. Approximately 75 percent of Africa's cassava output is harvested in Nigeria, the Democratic Republic of Congo, Ghana, Tanzania and Mozambique. Cassava is grown by millions of poor African farmers, many of them women, often on marginal land. For these people, the crop is vital for both food security and income generation.

On the basis of current projections, it is expected that by 2020, over 60 percent of global cassava production will be in sub-Saharan Africa, where economic growth will be slow but population growth fast. Cassava, therefore, will be a favoured source of cheap carbohydrates in the countryside and will also continue to serve as a food security crop. Furthermore, as urbanization continues in the continent, more people in cities and towns will purchase their food rather than grow it themselves. This will continue to give small farmers a source of cash income from cassava; some of it will reach the market in a processed form. The resulting gain in poverty reduction and greater food security will depend in part on an integrated set of research and development outputs that include higher-yielding, pest-resistant varieties; improved crop management and integrated protection measures as well as processing equipment and procedures; better linkages among producers, processors, and consumers through capacity-building in market analysis and enterprise development; and improved policies that facilitate the development and adoption of these innovations.

The vision for cassava in Africa is that if the cassava food system is improved, it will enhance rural industrial development and raise incomes for producers, processors and traders. Cassava will contribute more to the food security status of its producing and consuming households, and will become an even more important cash crop that can promote rural development.

To achieve this vision, the Global Cassava Development Strategy was formulated with the participation of a large number of stakeholders and with support from FAO and IFAD. The essence of the Strategy is to use a demand/market-driven and commodity chain approach to promote and develop cassava-based industries with the assistance of a coalition of stakeholders including cassava producers and their organizations, governments and policy-makers, donors, technical and research institutions and their networks, NGOs and the private sector. The Strategy recognizes the need to support NEPAD's Pan-African Initiative, which is in support of the existing National and “Presidential” Initiatives, and public-private partnerships and multidonors' programmes on cassava in sub-Saharan Africa.

As a contribution to the development of the Global Cassava Strategy, IFAD's generous financial assistance supported the preparation of the Africa Regional Review on Cassava, the Country Case Studies on Nigeria, Ghana, Tanzania, Uganda and Bening, and the Report of the Africa Consultations on the Global Cassava Development Strategy. These were presented at the Validation Forum that was jointly organized by FAO and IFAD in FAO headquarters, Rome, April 2000.

The Crop and Grassland Service of the FAO Plant Production and Protection Division has compiled these documents and is now pleased to publish the Proceedings in order to disseminate the information to stakeholders, cassava producers and their organizations, governments and policy-makers, donors, technical and research institutions and their networks, NGOs and their networks, the private sector - as well as to scholars, experts and interested individuals.

It is hoped that this information will help to strengthen institutional and technical capacity in support of sustainable development and management of the cassava sub-sector, and value-added agro-enterprise enhancement, in order to contribute to increased food availability, poverty reduction, employment, better economic opportunities and wealth creation for improved livelihoods of the poor and vulnerable population of Africa.

Mahmoud B. Solh
Director
Plant Production and Protection Division
Food and Agriculture Organization of the United Nations

ACKNOWLEDGEMENTS

The FAO Crop and Grassland Service would like to acknowledge the contribution of the following authors: Felix Nweke for the paper on cassava transformation in Africa; Dunstan Spencer and associates for the cassava overview on Africa; Adeoye Adeniji, Lawrence Ega, Malachy Akoroda, A.A. Adeniyi and Boniface Ugwu for the case study on Nigeria; Francis Ofori, E.V. Doku, Ramanatu Al-Hassan, J.J. Afuakwa, D. Pessey, R.K. Noamesi and W. Amoa-Amwuah for the case study on Ghana; Regina Kapinga, January Mafuru, Simon Jeremiah, Elizabeth Rwiza, Ruth Kamala, Fredrick Mashamba and Nicholas Mlingi for the case study on Tanzania; G.W. Otim-Nape, A. Bua, G. Ssemakula, G. Acola, Y. Baguma, S. Ogwal and R. Van der Grift for the case study on Uganda and N. Maroya, G. Houngnibo, C. Medenou, A. Lagbadohossou, S.F. Djogbenou, B. Soude and J. Monhouanou for the case study on Benin.

Felix Nweke, Adeoye Adeniji, Lawrence Ega, Boniface Ugwu, Malachy Akoroda, Francis Ofori, Regina Kapinga, January Mafuru, Simon Jeremiah, Elizabeth Rwiza, Otim-Nape, Anton Bua, Norbert Maroya and Adrianna Gabrielli are thanked for editing and Rita Ashton for preparing the camera-ready text.

Special acknowledgements are due to NeBambi Lutaladio (Agricultural Officer, Crop and Grassland Service, FAO) who has patiently coordinated, guided and made possible the release of this publication within the framework of the Global Cassava Development Strategy.

Eric A. Kueneman
Chief
Crop and Grassland Service
FAO Plant Production and Protection Division

LIST OF CONTRIBUTORS

Acola, G.	Namulonge Agricultural and Animal Production Research Institute, Uganda
Adeniji, A.A.	Federal Department of Agriculture, Ijebu-Ife, Nigeria
Adeniyi, A.A.	Federal Agricultural Coordinating Unit, Abuja, Nigeria
Afuakwa, J.J.	Crop Research Institute, Kumasi, Ghana
Akoroda, M.O.	University of Ibadan, Ibadan, Nigeria
Al-Hassan, R.	University of Ghana, Legon, Ghana
Amoa-Awuah, W.	Food Research Institute, Accra, Ghana
Baguma, Y.	Namulonge Agricultural and Animal Production Research Institute, Uganda
Balogun, de A.	Ogun State Agricultural Development Project, Abeokuta, Nigeria
Bua, A.	Namulonge Agricultural and Animal Production Research Institute, Uganda
Djogbenou, S.F.	Direction de l'agriculture, Cotonou, Bénin
Doku, E.V.	University of Ghana, Legon, Ghana
Ega, L.A.	Benue State University, Makurdi, Nigeria
Houngnibo, G.	Centre d'actions rurales pour le développement régional, Ouémé, Bénin
Jeremiah, S.	Ministry of Agriculture and Cooperatives, Tanzania
Kamala, R.	Ministry of Agriculture and Cooperatives, Tanzania
Kapinga, R.	Ministry of Agriculture and Cooperatives, Tanzania
Lagbadohossou, A.	Ministère du développement rural, Cotonou, Bénin
Mafuru, J.	Ministry of Agriculture and Cooperatives, Tanzania
Maroya, N.	Institut national des recherches agricoles du Bénin, Cotonou, Bénin,
Mashamba, F.	Ministry of Agriculture and Cooperatives, Tanzania
Medenou, C.	Minister du développement rural, Cotonou, Bénin
Mlingi, N.	Ministry of Agriculture and Cooperatives, Tanzania
Monhouanou, J.	Institut national des recherches agricoles du Bénin, Niaouli, Bénin
Noamesi, R.k.	Glucosett GhanaLtd., Accra, Ghana
Nweke, F.I.	Michigan State University, East Lansing, USA
Ofori, F.	Crop Services, Ministry of Food and Agriculture, Accra, Ghana
Ogwal, S.	Namulonge Agricultural and Animal Production Research Institute, Uganda
Otim-Nape, G.W.	Namulonge Agricultural and Animal Production Research Institute,

	Uganda
Pessey, D.	Transport and commodity General, Donkokrom, Ghana
Rwiza, E.	Ministry of Agriculture and Cooperatives, Tanzania
Ssemakula, G.	Namulonge Agricultural and Animal Production Research Institute, Uganda
Soude, B.	Programme d'interventions locales pour la sécuritéalimentaire, Bénin
Spencer, D.S.C.	Dunstan Spencer and Associates, Sierra Leone
Ugwu, B.O.	National Root Crop Research Institute, Umudike, Nigeria
Van der Grift, R.	Namulonge Agricultural and Animal Production Research Institute, Uganda

ACRONYMS AND ABBREVIATIONS

ACMD	African Cassava Mosaic Disease
ADP	Agricultural Development Project
AGDIV	Agricultural Diversification Project
AGDP	Agricultural Gross Domestic Product
APMEU	Agricultural Projects Monitoring and Evaluation Unit
ASARECA,	Association for Strengthening Agricultural Research in Eastern and Central Africa
ASIP	Agricultural Sector Investments Project
BEA	Block Extension Agent
BLP	Better Life Programme
BS	Breeder Seeds
CAD	Cassava Anthracnose Disease
CARDER	Centre d'actions rurales pour le développement régional
CBB	Cassava Bacterial Blight
CEDMA	Centre départemental de matériels agricoles
CENAP	Centre National d'Agro Pédologie
CGIAR	Consultative Group on International Agricultural Research
CGM	Cassava Green Might
CGSM	Cassava Green Spider Mite
CIAT	Centro Internacional de Agricultura Tropical
CIRAD	Centre de cooperation internationale en recherche agronomique pour le développement
CM	Cassava Mealybug

CMD	Cassava Mosaic Disease
CMP	Cassava Multiplication Project
CMP-CU	Cassava Multiplication Project-Coordinating Unit
CMVD	Cassava Mosaic Virus Disease
COOPROMA	Coopérative des producteurs de Manioc
CORAF	(Conférence des responsables de recherche agronomique africains
COSCA	Collaborative Study on Cassava in Africa
CPDU	Cassava Processing Demonstration Unit
CRI	Crops Research Institute
CS	Certified Seeds
DAGRI	Direction de l'agriculture, Bénin
DAPS	Direction de l'analyse, de la prévision et de la synthèse
EARRNET	Africa Root Crops Research Network
EPHTA	Ecoregional Programme for the Humid and Subhumid Tropics of Sub-Saharan Africa
ESCaPP	Environmentally Sustainable Cassava Plant Protection
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FDA	Federal Department of Agriculture
FFA	Framework for Action
FGN	Federal Government of Nigeria
FIIRO	Federal Institute of Industrial Research, Oshodi, Lagos
FIIRO	Federal Institute of Industrial Research
FMANR	Federal Ministry of Agriculture and Natural Resources
FRI	Food Research Institute
FS	Foundation Seeds
FSA	Faculté des Sciences Agronomique
GCDS	Global Cassava Development Strategy
GS	Global Strategy for Cassava Development
GSM	Green Spider Mite
ha	Hectare
HST	Humid and Subhumid Tropics
IARC	International Agricultural Research Centre
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association

IDESSA	Institut des Savannes
IFAD	International Fund for Agricultural Development
IITA	International Institute of Tropical Agriculture
INRAB	Institut national des recherches agricoles du Bénin
INSAH	Institut du Sahel
IPM	Integrated Pest Management
ISTRC-AB	International Society for Tropical Root Crops - Africa Branch
Kcal	Kilocalories
km	Kilometres
LGA	Local Government Areas
LGB	Larger Grain Border
MDR	Ministére du dèveloppement rural, Bénin
MOFA	Ministry of Food and Agriculture, Ghana
MSADP	Multi-State ADP
MSADP	Multi-State Agricultural Development Projects
MTADP	Medium-Term Agricultural Development Programme
NAEP	National agricultural Extension Project
NAFCON	National Fertilizer Company
NAFPP	National Accelerated Food Production Programme
NARIS	National Agricultural Research Institutes
NARO	National Agricultural Research Organization
NARP	National Agricultural Research Project
NARS	National Agricultural Research System
NCRP	Nationally Coordinated Research Programme
NCWS	National Council of Women Societies
NGO	Non-Governmental Organization
NIYAMCO	Nigerian Yeast and Alcohol Manufacturing Company
NRCRI	National Root Crops Research Institute
NRI	National Resources Institute
NRTCIP	National Root and Tuber Crops Improvement project
NSPRI	National Stored Products Research Institute
NSS	National Seed Service
NTRCIP	National Root and Tuber Crops Improvement Project
OFAR	On-Farm Adaptive Research
OFN	Operation Feed the Nation

ONASA	Office National d'Appui à la Sécurité Alimentaire
ORSTOM	Institut de recherches scientifiques pour le développement en coopération
PADSA	Programme d'appui au développement du secteur agricole
PADSE	Projet d'Appui à la diversification des systèmes d'exploitation
PILSA	Programme d'interventions locales pour la sécurité alimentaire, Bénin
PISEA	Projet d'insertion des sans emploi dans l'Agriculture
PRODA	Product Development Agency
PROMIC	Projet de micro-finances et de commercialisation
PRONAM	Programme national du manioc
RAIDS	Rural Agro-Industrial Development Scheme
REFILS	Research-Extension-Farmers-Linkage-System
RMRDC	Raw Materials Research and Development Council
RRA	Rapid Rural Appraisal
RRPMC	Regional Research Project on Maize and Cassava
SACCAR	Southern African Centre for Cooperation in Agricultural Research and Training
SAP	Structural Adjustment Programme
SARRNET	Southern Africa Root Crops Research Network
SDC	Swiss Development Corporation
SPAT	Small Plot Adaptive Trial tonne
SRDP	Smallholder Rehabilitation and Development Programme
SSA	Sub-Saharan Africa
T&V	Training and Visit
TMS	Tropical Manioc Selection
USS	United States dollar
WATI	World Agricultural Trade Indicators
WIA	Women-in-Agriculture

THE CASSAVA TRANSFORMATION IN AFRICA

Prepared by

Felix I. Nweke[1]
Michigan State University, USA[2]

1/ Formerly, leader of the Collaborative Study of Cassava in Africa 1989–97, International Institute of Tropical Agriculture, Nigeria.

2/ Visiting Professor, Agric.

1 INTRODUCTION

In Africa (sub-Saharan Africa), the diffusion of cassava can be described as a self-spreading innovation. Cassava was introduced into Africa by Portuguese traders from Brazil in the 16th century (Okigbo, 1980). It was initially adopted as a famine-reserve crop. In the Democratic Republic of Congo (hereafter referred to as "the Congo") where the crop was first introduced, millet, banana and yam were the traditional staples but farmers adopted cassava because it provided a more reliable source of food during drought, locust attack and during the hungry season [1]. Although there was some local trade in cassava, production was mostly for home consumption and cassava was prepared in the simplest fashion, i.e. slicing and boiling (Jones, 1959).

Currently, about half of the world production of cassava is in Africa. Cassava is cultivated in around 40 African countries, stretching through a wide belt from Madagascar in the Southeast to Senegal and to Cape Verde in the Northwest. Around 70 percent of Africa's cassava output is harvested in Nigeria, the Congo and Tanzania (IFAD and FAO, 2000). Throughout the forest and transition zones of Africa, cassava is either a primary staple or a secondary food staple.

Africa is a continent in crisis; it is racked with hunger, poverty and the HIV/AIDS pandemic. Africa is also the region with the fastest population growth, the most fragile natural resource base and the weakest set of agricultural research and extension institutions.

The average GNP per capita in Africa in 2000 was US$480 (World Bank, 1999). Civil strife and authoritarian regimes have destabilized many countries. Around three-quarters of the poor in Africa are rural people who secure their livelihood from agriculture. Africa's population is expected to double to 1.2 billion in 2020; and its urban population will grow at a faster rate (McCall, 1999).

Without question, domestic food production and/or food imports will have to be increased to meet Africa's growing food demand. Due to poverty and a lack of foreign exchange, Africa's net cereal imports are expected to remain low (Pinstrup-Anderson et al., 2000). Therefore, the urgent challenge before African nations is to increase domestic food production.

Maize is Africa's most important food crop and it is held up as a model food crop to meet Africa's growing urban demand for convenient food products (Mellor et al., 1987, Blackie, 1990 and Byerlee and Eicher, 1997). Maize production however, is risky because of unpredictable rainfall. Cassava is Africa's second most important food staple in terms of per capita calories consumed. Cassava is a major source of calories for roughly two out of every five Africans. In some countries, cassava is consumed daily and sometimes more than once a day. In the Congo, cassava contributes more than 1 000 calories per person per day to the average diet and many families eat cassava for breakfast, lunch and dinner.

Cassava has the potential to increase farm incomes, reduce rural and urban poverty and help close the food gap. Without question, cassava holds great promise for feeding Africa's growing population. Cassava can be produced with family labour, land and a hoe and machete, making it an attractive and low-risk crop for poor farmers. Also, cassava is available to low-income rural households in the form of simple food products (for example, dried roots and leaves) which are significantly cheaper than grains such as rice, maize and wheat. Similarly, urban households in many parts of West Africa consume cassava in the form of gari[2] (Nweke et al., 2001).

Cassava has several other advantages over rice, maize and other grains as a food staple in areas where there is a degraded resource base, uncertain rainfall and weak market infrastructure. It is drought tolerant; this attribute makes it the most suitable food crop during periods of drought and famine.

Cassava has historically played an important famine-prevention role in Eastern and Southern Africa where maize is the preferred food staple and drought is a recurrent problem.

However, cassava has been neglected for numerous reasons by researchers, African policy-makers and by most donor and international agencies. Cassava is a marginalized crop in food policy debates and burdened with the stigma of being an inferior food, ill suited and uncompetitive with the glamour crops such as imported rice and wheat because of several long-standing myths and half-truths. Many food policy analysts consider cassava as an inferior food because it is assumed that its per capita consumption will decline with increasing per capita incomes (Nweke et al., 2001).

Until the late 1980s, information was very scarce on cassava in Africa. However, in 1989, a Collaborative Study of Cassava in Africa (COSCA) was initiated by the Rockefeller Foundation and based at IITA. During an eight-year period (1989 to 1997), COSCA researchers collected information from 1 686 households in 281 villages in six countries: the Congo, Côte d'lvoire, Ghana, Nigeria, Tanzania and Uganda.

The goal of the Global Cassava Development Strategy (GCDS) is to analyse cassava production and utilization trends; identify constraints and opportunities in the cassava sector with emphasis on poverty alleviation, equity, food security and environmental protection; and develop a set of priorities for future intervention in the cassava sector (Spencer and Associates, 1997). This review is based on information from the six COSCA study countries supplemented with secondary data from FAO and various information collected from African farmers, researchers, traders and processors throughout Africa from the beginning of the COSCA study in 1989 to 2001.

This review shows how the planting of new Tropical Manioc Selection (TMS) cassava varieties developed and released to farmers in Nigeria in the 1970s by IITA, has transformed cassava from a low-yielding famine-reserve crop to a high-yielding cash crop. The review also shows that with the aid of mechanical graters to prepare gari, cassava is increasingly being produced and processed as a cash crop for urban consumption in Ghana and Nigeria. The next stage in the cassava transformation is from a food crop to a raw material for livestock feed and industries in order to raise farm income.

[1] The period before seasonal food crops are ready for harvest.

[2] *Gari* is a granulated and toasted cereal-like cassava food product which is convenient for consumption in urban environments because it is in a ready-to-eat form and it has an extended shelf life.

2 THE CASSAVA TRANSFORMATION

Traditionally, cassava is produced on small-scale family farms. The roots are processed and prepared as a subsistence crop for home consumption and for sale in village markets and shipment to urban centres. Over the past 30 to 50 years, smallholders in Ghana and Nigeria have increased the production of cassava as a cash crop, primarily for urban markets. This shift from production for home consumption to commercial production for urban consumers, livestock feed and industrial uses can be described as the cassava transformation (Table 1).

During the cassava transformation, high-yielding cassava varieties increase yields while labour-saving harvesting methods and improved processing technology reduce the cost of producing and processing cassava food products to the point where they are competitive with food grains such as wheat, sorghum and rice for urban consumers[3] . Looking ahead, as the costs of cassava production, harvesting, processing and marketing are reduced, one can expect cassava to play an expanded role as a source of industrial raw material in Africa and as a source of foreign exchange earnings through the export of cassava pellets for livestock feed.

[3] This does not mean transformation in the processing sense from fresh root to processed forms.

3 PRODUCTION TRENDS

In the early 1960s, Africa accounted for 40 percent of world cassava production and Brazil was the world's leading cassava producer. However, thirty years later in the early 1990s, Africa produced half of the total world cassava output and Nigeria replaced Brazil as the leading producing country globally (FAOSTAT). Two forces explain this dramatic growth. First, demand for cassava has expanded because of rapid population growth and increased poverty thus, encouraging consumers to search for cheaper sources of calories. Second, the supply of cassava has expanded because genetic research and better agronomic practices have boosted cassava yields, especially in Ghana and Nigeria.

3.1 AREA CULTIVATED

In the early 1960s in Africa, cassava was planted in 5.6 million ha per year. Thirty-five years later, in the late 1990s, it was planted in 10 million ha per year. The six countries which currently account for most of the cassava area are the Congo, Côte d'lvoire, Ghana, Nigeria, Tanzania and Uganda. The cassava planted areas increased almost three fold in Ghana and Nigeria from 1961 to 1999 (Table 2).

One of the critical variables in the expansion of the cassava area is the availability of improved processing equipment to remove water from the roots (the roots are 70 percent water) and thereby reduce the cost of transportation. Improved processing and food preparation methods reduce bulk and make it possible for cassava products to be transported at reduced costs over poor roads to distant urban market centres. One example is the steady shipment of dried roots (cossettes) from Bandundu region of the Congo to the capital city, Kinshasa, by boat along the Congo River or by trucks over extremely poor road conditions.

The COSCA study found that in Ghana and Nigeria, all the villages where farmers had access to mechanized cassava graters, reported an increase in the area planted to cassava. By contrast, only 60 percent of the villages where farmers did not have access to a mechanized cassava grater in the two countries, reported an increase in the area planted to cassava.

To summarize, between 1961 and 1999, the cassava planted areas have increased several fold in two of the six most important cassava producing countries in Africa, namely Ghana and Nigeria. The increase in the cassava area in Ghana and Nigeria was driven by availability of processing technologies and improved road access to market centres.

Table 1. Stages of the cassava transformation

	I. Famine Reserve Crop	II. Rural Food Staple	III. Cash Crop for Urban Consumption	IV. Livestock Feed & Industrial Raw Material
COSCA COUNTRIES	Tanzania	Congo, Côte d'Ivoire and Uganda	Ghana and Nigeria	
CASSAVA PRODUCTION OBJECTIVE	* Mostly for home consumption * Cassava is the secondary food staple	* Mostly for home consumption * Cassava is the primary food staple in the Congo * Cassava is a secondary food staple in Côte d'Ivoire & Uganda * Cassava is a family food staple in households producing tree crops, such as cocoa in Côte d'Ivoire and coffee in Uganda	* Mostly for sale as *gun* in urban centres	* Industrial starch and pellets for export
POLITICAL AND ECONOMIC ENVIRONMENT	* In areas with uncertain rainfall: - Colonial governments encouraged cassava production as a famine-reserve crop starting in the 1920s - Since independence, the Government of Tanzania encouraged cassava production during periods of drought	* The governments of the Congo and Côte d'Ivoire encourage the importation of rice and wheat	* Increasing urban demand for convenient foods * Improved rural roads for easy farmer access to market centres * Government policies encourage the replacement of imported wheat and rice with cassava food products	* Policy of substitution of cassava starch for imported starch * Export promotion
TECHNOLOGY DEVELOPMENT				
1. Genetic improvement	* Colonial governments established research stations in Congo, Nigeria Tanzania, etc. * Research priorities focused on controlling cassava mosaic virus and brown streak virus	* IITA developed high-yielding TMS varieties * IITA organized training programmes for national cassava scientists		* Early (under 12 months) bulking varieties * Cassava roots suitable for mechanical harvesting and peeling
2. Seed	* Farmer to farmer exchange of planting materials	* National research and extension programmes and private-sec tor agencies multiply and distribute planting materials of improved varieties		* Private seed companies
3. Agronomic practices	* Farmers planted at will, compatible with labour demand schedule for cash crop	* Timely planting * High stand density * Low frequency of intercropping		* Timely planting * Optimum stand density * Mono-cropping
4. Weeding	* Occasional weeding using hand hoe by family labour	* Regular weeding with hand hoe by hired labour		* Regular weeding * Mechanized weeding
5. Harvesting	* Partial harvesting with hand hoe, using family labour	* Complete harvesting * Harvesting at 12 months or less * Harvesting with hand hoe * Use of hired labour		* Harvesting in 12 months or less * Mechanized harvesting
6. Processing	* Manual processing with hand tools	* Partly manual, partly mechanized		* Fully mechanized
7. Food products	* Roots eaten in fresh form, or as pastes, as well as dried roots	* Convenient food products		

Table 2. COSCA countries: Total area (million ha) planted to cassava per year, 1961 to 1965 compared with 1995 to 1999

Country	1961 to 1965	1995 to 1999	% Change
Congo	1.37	2.19	60
Côte d'Ivoire	0.20	0.33	65
Ghana	0.15	0.60	300
Nigeria	0.83	2.94	254
Tanzania	0.59	0.62	5
Uganda	0.29	0.35	21

Source: Nweke et al. 2001

3.2 YIELD

In 1954, the average cassava yield in Africa was between 5 and 10 tonnes per ha (Jones, 1959). The COSCA study found that the average yield was between 10 and 15 tonnes per ha in the six COSCA countries in the early 1990s. Therefore, one can safely say that the cassava yield was increasing in Africa in the early 1990s because of the planting of high-yielding varieties and the adoption of better agronomic practices[4].

In early 1991, the COSCA yield measurements showed that the average on-farm cassava fresh roots yield (hereafter yield) for the six COSCA study countries was 11.9 tonnes per ha[5]. The average farm-level yield was highest in Nigeria where the mean was 14.7 tonnes per ha followed by Ghana where the mean was 13.1 tonnes per ha (Figure 1). The mean yield was around 10 tonnes per ha in Côte d'Ivoire, the Congo, Tanzania and Uganda, respectively.

In 1973, Lagemann studied cassava yields in three villages in southeastern Nigeria with different population densities and concluded that cassava yield declined as population pressure increased (Lagemann, 1977). Lagemann found the mean yields for the three villages to be 2 tonnes per ha in the high population density village; 3.8 tonnes per ha in the medium; and 10.8 tonnes per ha in the low population density village.

In 1993, the COSCA study team re-visited the same three villages to assess the trends in the cassava yield 20 years after the Lagemann 1973 study. The COSCA team found that the mean yields for the same villages were 4.04 tonnes per ha in the high population density village; 4.77 tonnes per ha in the medium density; and 9.27 tonnes per ha in the low population density villages. Between 1973 and 1993, the cassava yield doubled in the high-density village, increased by 25 percent in the medium-density village and declined by 15 percent in the low-density village (Figure 2). This is a surprising result that deserves to be carefully examined.

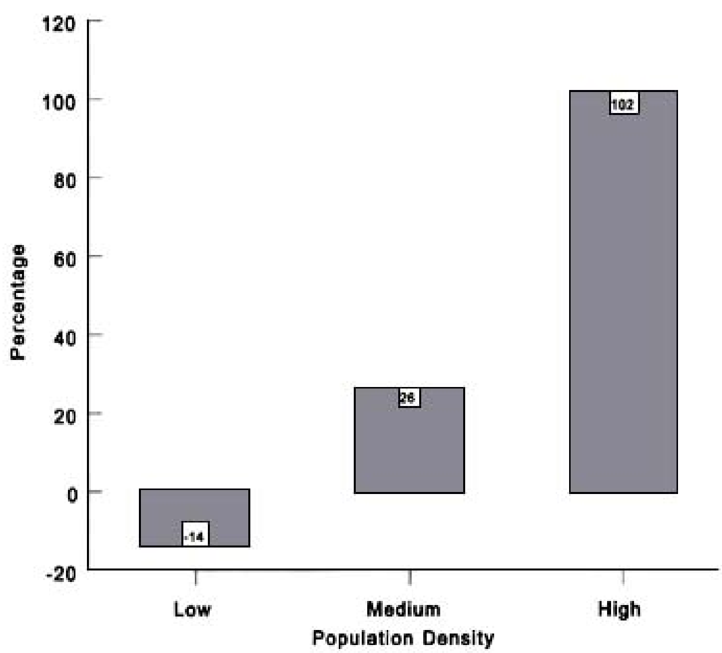
The doubling of cassava yield in the high population density village is because farmers planted the high-yielding TMS varieties at high stand densities, employed hired labour and enjoyed ready access to a nearby market[6]. By contrast, yields declined in the low population density village because farmers planted local varieties at low stand densities (Enete et al., 1995). The evidence from the COSCA study demonstrates that farmers have adopted new technologies such as the improved varieties and the improved agronomic practices as a response to increased population pressure on land. This finding adds evidence to the Boserup hypothesis that increased population pressure can help induce intensification of agricultural production (Boserup, 1981).

[4] In Africa, long-term research from the 1930s to the 1970s led to the development of high-yielding cassava varieties (the TMS varieties) that increased farm yields by 40 percent without the addition of fertilizer. The TMS varieties were released to farmers in Nigeria in the late 1970s.

[5] Root yield as distinct from root yield; in some cassava producing countries in Africa such as the Congo and Tanzania, cassava leaves are harvested and eaten as a vegetable.

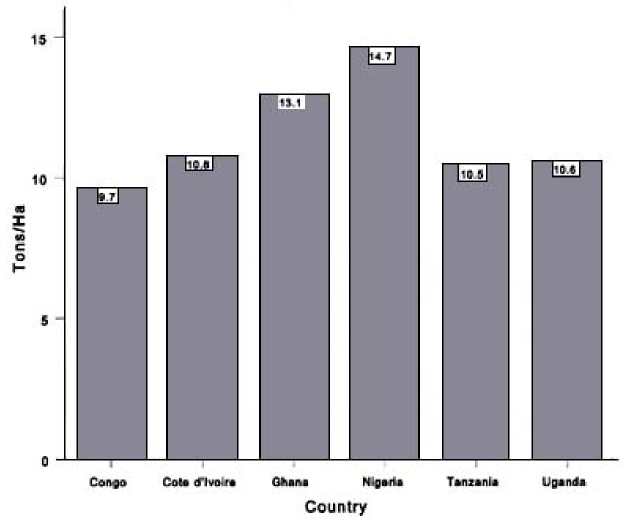
[6] There is a positive relationship between stand density and yield. Farmers in high population density villages plant at high stand densities because of shortage of land.

Figure 1. Southeast Nigeria: Percentage changes in cassava yield from 1973 to 1993 in Low-,Medium-, and high-population density villages



Sources: COSCA study, Lagemann 1977

Figure 2. Cassava yield (tonnes/ha) in the Congo, Côte d'Ivoire, Chana, Nigeria, Tanzania and Uganda, 1991



Source: COSCA study

3.3 PRODUCTION

Between 1961 and 1999, total cassava production in Africa nearly tripled from 33 million tonnes per year in the early 1960s to 87 million tonnes per year in the late 1990s (FAOSTAT). Food shortages precipitated by a combination of political and civil unrest, economic stagnation, erratic rainfall patterns and rapid population growth have had a much greater influence on cassava production in Africa than anywhere else in the world (Scott *et al.,* 2000).

Most of the dramatic increase in cassava production in Africa was achieved in Ghana and Nigeria. In both countries, the production growth rate was higher than the rate of population growth. In the other COSCA study countries, an increase in cassava production kept pace with population growth. The dramatic increase in cassava production in both Ghana and Nigeria was achieved through an increase in both area and yields. The availability of cassava graters to farmers in both countries released labour, especially female labour, from cassava processing for planting more cassava. Common use of hired labour in both countries and wide adoption of the high-yielding TMS cassava varieties were responsible for higher cassava yields than in the other COSCA countries.

3.4 CASSAVA VARIETIES

Farmers in Africa grow several cassava varieties. For example, the COSCA researchers identified over 1 000 local cassava varieties in six counties of the study, namely the Congo, Côte d'lvoire, Ghana, Nigeria, Tanzania and Uganda. The farmers group the local cassava varieties into the bitter and the sweet varieties[7]. The sweet varieties are more popular in Côte d'lvoire, Ghana and Uganda while the bitter varieties are more common in the Congo, Nigeria and Tanzania. The COSCA farmers reported that the bitter varieties are more resistant to pests, higher yielding and store better in the ground than the sweet varieties.

Farmers, however, plant sweet varieties in the forest zone more than in the transition and the savannah zones because limited sunshine in the forest zone makes it difficult to sun-dry the roots after they have been soaked to eliminate cyanogens. Tree crop farmers also plant sweet varieties which they eat without the soaking and sun-drying (and not fearing cyanide poisoning). As the productivity of the cassava system increases and more cassava is processed as *gari*, the issue of the sweet or the bitter cassava varieties will become irrelevant.

3.5 PESTS AND DISEASES

Cassava has been under attack by pests and diseases, such as the mealybug, green mite, mosaic disease and the bacterial blight. The biological control method has been used to bring the mealybug under control while the biological control of the green mite is still in progress (Herren et al., 1987 and Yaninek, 1994). The most promising method of controlling the mosaic disease and the bacterial blight is breeding resistant varieties, which involves a long and painstaking process of breeding and diffusion. Meanwhile, the green mite, mosaic disease and the bacterial blight continue to cause yield losses in various parts of Africa.

In the late 1980s, an epidemic of an extremely severe form of the mosaic disease spread through most of Uganda. Researchers discovered that a new form of cassava gemini virus caused the virus epidemic. The Uganda variant of the gemini virus is now widely distributed in Uganda (Harrison et al., 1997).

African farmers usually do not attempt to control the cassava pests and diseases with pesticides because of the limited access to chemicals and because it is not profitable to apply pesticides on cassava. However, farmers use the following agronomic practices to achieve partial control of the cassava pests and diseases: fallow rotation, crop rotation and selection of the pests and diseases-resistant local varieties.

Most of the major cassava pests and diseases are new in Africa as they were introduced only within the last 30 years. Improved quarantine inspection is needed to prevent, as much as possible, further introduction of new problems. There is a need for better preparedness to control new problems before they spread and take root in Africa.

3.6 GENETIC IMPROVEMENT

Cassava genetic improvement research has been conducted by African smallholders, by researchers in colonial and post-independent research stations and by scientists in international research centres such as IITA and Centro Internacional de Agricultura Tropical (CIAT). Farmers selected self-seeded plants from local varieties that possessed the superior attributes which they desire such as high yield, early bulking, in-ground storage, pest and disease tolerance, processing qualities, large canopy and low cyanogens level.[8]

The colonial governments' research on cassava was inspired by the appearance and rapid spread of the mosaic disease in East Africa and by the colonial governments' determination to encourage the planting of cassava as a famine-reserve crop in their colonies. The colonial governments set up cassava research programmes in various countries in West, Central and East Africa, but the most successful was the one set up at the Amani Research Station in Tanzania in the 1930s. The mosaic disease-resistant hybrids developed at the Amani research station between 1935 and 1957 served as the foundation for IITA's research programme on cassava in the 1970s and 1980s.

Soon after most African countries became independent in the 1960s, cassava research languished in most national research programmes. In 1971, IITA established a research programme on cassava. IITA's programme built on local materials and on materials collected from various parts of the world (particularly from the Amani Research Station), helped national agricultural research systems to establish cassava programmes and establish partnerships with farmers, the private sector and numerous national cassava programmes.

For example, IITA realized that national cassava research programmes were under funded and in a state of disarray. Most national agricultural research systems in Africa did not have cassava research programmes in the early 1970s. IITA needed to help develop strong national cassava research programmes in cassava producing countries in Africa in order for IITA's cassava varieties and agronomic practices to be evaluated over a wide range of African agro-ecologies. IITA took steps to persuade governments of several of the large cassava producing countries to establish cassava research programmes in the agricultural research system[9].

To facilitate cooperation among scientists in national programmes, the International Society for Tropical Root Crops - African Branch (ISTRC-AB) was founded in 1978 by IITA. Regional root crop research networks were set up in Eastern and Southern Africa in 1987/88 with support from IITA. The national research capacity which IITA helped to build, made it possible for IITA's varieties and field practices to be evaluated over a wide range of environments in Africa.

IITA developed high-yielding mosaic-resistant varieties in six years (1971 to 1977) of research. These new high-yielding mosaic-resistant varieties included TMS 50395, 63397, 30555, 4(2)1425 and 30572 (hereafter cited as TMS varieties). The new TMS varieties out-yielded local varieties on farmers' fields by 40 percent without fertilizer. COSCA studies in Nigeria found that the TMS varieties are superior to local varieties in terms of yield, earliness and pest and disease tolerance and they are as good as the local varieties in terms of various post-harvest attributes and for intercropping.

The evolution of cassava breeding in Africa can be described as a human ladder. Starting in the 1930s, one generation of breeders climbed on the shoulders of the past generations until they hit the jackpot with the TMS varieties in the mid 1970s (Table 3).

The cassava genetic improvement in Africa however, represents work in progress. For example, although the TMS varieties bulk earlier than the local varieties, they are not suitable for intensive commercial production because they take 13 to 15 months to attain maximum bulking. If farmers plant cassava under continuous cultivation, it will be harvested at less than 12 months and before it has attained its maximum yield. Cassava producers in Nigeria who plant the TMS varieties and make gari available for sale in urban markets, complain that the peeling of the roots of the TMS varieties is labour intensive. The roots of the TMS varieties are not suitable for the development of mechanized peeling because they lack uniform shape and size.

[8] Cassava does not have a period of maturity. As the plant grows the root continues to bulk (swell) until after a stage of three or four years when deterioration begins.

[9] For example, in the Congo, the Programme National du Manioc (PRONAM) was established in 1974; in Nigeria, the National Root Crops Research Institute (NRCRI) was established in 1975; in Côte d'lvoire, the cassava programme of the Institut des Savannes (IDESSA) was established in 1979; and in Uganda, the National Root Crop Research Programme was established in 1981. These programmes were established with IITA's technical assistance and with financial assistance secured with IITA's support from international donor agencies such as the USAID, IFAD, Gasby Foundation, etc.

3.7 DIFFUSION OF TMS VARIETIES

The TMS varieties are widely diffused in Nigeria and to a lesser extent in Ghana and Uganda.

Diffusion in Nigeria. The rapid diffusion of the TMS varieties in Nigeria starting in 1977 was facilitated by the 40 percent increase in farm-level yield, the profitability of the new varieties, the collaboration of National Root Crops Research Institute (NRCRI), the oil sector, the World Bank, IFAD, churches, the Nigerian Cassava Growers Association; and by government oil revenue and the availability of low cost gasoline.

The diffusion in Nigeria was also facilitated by the physical presence of IITA in Nigeria. IITA's cassava diffusion programme multiplied and distributed TMS planting materials directly to farmers and indirectly through informal channels such as schools and churches. IITA's diffusion programme mobilized the private sector, particularly the oil sector, for assistance in the distribution of the TMS varieties. IITA's cassava programme also mobilized the mass media including the newspapers, radio and television to publicize the availability and benefits of the TMS varieties.

The boom in the petroleum industry in the 1970s and the resultant economic expansion in Nigeria led to an increase in the purchasing power of urban consumers and an increase in demand for convenient food products such as *gari*. With the aid of the petroleum revenue, Nigeria was able to improve rural roads; expand agricultural research, extension and higher education institutions and finance nationwide demonstrations of the TMS varieties.

Yet it is important to point out that improved cassava food preparation technologies, namely *gari* preparation and the mechanized grater, were in place at the farm-level in

Nigeria before the TMS varieties were introduced to farmers in the late 1970s. The availability of mechanized processing equipment and *gari* preparation technologies greatly increased the profitability of the TMS varieties.

Finally, farmers were able to utilize mechanized graters because diesel and gasoline were cheap and readily available. Mechanized graters have saved labour and shifted the labour constraint from grating to the labour-intensive tasks of harvesting, peeling and toasting. The labour requirements for those tasks increase in direct proportions with yield. The end result is that farmers who adopted the TMS varieties are often restricted in the amount of cassava they can produce by the labour bottlenecks at the harvesting, peeling and toasting stages.

Mechanization of any of the harvesting, peeling and toasting tasks will enable farmers to plant a larger area to the TMS varieties. There is an urgent need for breeders to develop varieties which attain a maximum yield in less than 12 months and have uniform roots in shape and size in order to facilitate the development of mechanical harvesters and peelers.

Diffusion in Ghana and Uganda. In 1988, IITA helped the Government of Ghana to secure financial assistance from international donor agencies to launch a nationwide programme of on-farm testing of the TMS varieties. It took five years, 1988 to 1993, to evaluate the TMS varieties under field conditions and multiply the stem cuttings. In 1993, sixteen years after the release of the TMS varieties in Nigeria in 1997, the Government of Ghana officially released three TMS varieties, namely TMS 30572, TMS 50395 and TMS 4(2)1425. In 1998 the Root and Tuber Improvement Programme was initiated by the Ministry of Food and Agriculture in Kumasi to multiply and distribute plant cuttings of TMS varieties. In December 2000, the total area planted with the TMS varieties for multiplication was 1 142 ha (Otoo and Afuakwa, 2001).

The diffusion of the TMS varieties in Ghana from 1993 to 2001 has not been documented. However, in early 2001, cassava researchers at the Crops Research Institute, Kumasi reported that TMS varieties covered large areas of farmers' fields in the Eastern, Greater Accra and Volta regions where farmers prepare *gari* for sale in urban centres (Otoo and Afuakwa, 2001).

Ghana's official release of the TMS varieties in 1993, 16 years after they were released in Nigeria, represents a delayed diffusion, which is attributed to a variety of reasons. First, the Government historically invested in maize research, the primary food staple and only initiated cassava research in the national agricultural research systems (NARs) in 1980. Second, some influential Ghanaian scientists did not encourage the Government to import the TMS varieties because the influential Ghanaian scientists were proud of their breeding work.

Table 3. The human research ladder: Linkages between cassava research in Tanzania and Nigeria, 1935 to 2000

Station	Year	Researcher	Goal/Approach	Achievement/Comment
			TANZANIA 1935 TO 1957	
Amani	1935 to 1937	Storey	Control cassava mosaic virus and cassava bacterial blight by introduction of resistant varieties	Over 100 cassava varieties were introduced from various parts of the world
	1937 to 1951	Storey and Nichols	Rubber tree species x cassava hybridization	Developed rubber tree x cassava hybrids resistant to mosaic
	1951 to 1957	Storey and Jennings	Intercross the Storey/Nichols hybrids to increase resistance to mosaic disease	Developed hybrids that showed higher and more stable resistance over a wide area (including the Ceara rubber x cassava hybrid, 58308) than the hybrids created by Storey and Nichols and distributed them to several countries including Nigeria. The Amani research programme was terminated in 1957
			NIGERIA: 1958 TO 2000	
Moor Plantation	1958 to 1960	Beck and Ekandem	Combine the mosaic disease resistance genes of the Ceara rubber x cassava hybrid, 58308, with the genes for high yield from West African varieties	Programme was transferred to Umudike research station at independence in 1960
Umudike	1960 to 1970	Ekandem	Combine the mosaic disease resistance genes of the Ceara rubber x cassava hybrid, 58308, with the genes for high yield from West African varieties	
IITA, Ibadan	1971 to 1994	Hahn	Combine the mosaic-resistant genes of the Ceara rubber x cassava hybrid, 58308, with genes from local and exotic varieties with high yield, good root quality, low cyanogens and resistance to lodging	The famous TMS varieties were developed from 1971 to 1977 and released to farmers in Nigeria in 1977
			Enhance earliness of bulking and root carotene, develop appropriate canopy sizes for leaf harvest and intercropping and improve pests and diseases resistance	Developed varieties that are resistant to more pests and diseases and have different canopy sizes and distributed them to national cassava research programmes in Africa for on-farm testing and selection

Source: Nweke et al 2001

In Uganda, government and donor interest in the diffusion of the TMS varieties was sparked by the appearance and rapid spread of the rare form of cassava mosaic disease in the late 1980s. Beginning in 1991, TMS 6014, TMS 30337 and TMS 30572 were multiplied. In 2000, approximately 80 000 ha of the mosaic-resistant TMS varieties were being grown in Uganda (Otim-Nape *et al.,* 2000).

3.8 AGRONOMIC PRACTICES

Fallow systems. There are three main fallow systems in Africa: the long fallow, short fallow and continuous cultivation. Due to population growth, cassava cultivation under the long fallow system has declined in Africa. The distribution of cassava fields surveyed by COSCA researchers was as follows: long fallow, 5 percent; short fallow, 75 percent; and continuous cultivation, 20 percent. Most farmers now produce cassava under the short fallow system because of cassava's long growth period, pests and disease problems and compatibility with crops such as yam and maize, which are grown in association with cassava. Cassava production under continuous cultivation is an increasing practice in many African countries in response to the increasing population pressure on land. Increasing production of cassava under continuous cultivation points to the need for early-bulking and pests and diseases-resistant cassava varieties.

Cassava planting. In Africa, the main source of cassava planting materials is from the farmers' fields, neighbours and sometimes cassava marketing middleperson. Some farmers who produce cassava as a cash crop, plant healthy-looking cuttings from plants not older than 12 months. Some farmers do not always discard stems affected by pests or diseases even though this is a common way of spreading the pests and diseases (Rossel *et al.,* 1994).

In the forest zone where biomass production is higher than the savannah zone, there is an abundance of cassava stem cuttings for planting. However, in the savannah zone, cuttings for planting are often in short supply. The COSCA study found that farmers in the savannah zone discontinue the use of varieties, which produce low yields of the planting material. Farmers need help with the supply of healthy cassava planting materials particularly in the savannah zone.

The cassava plant density is an important agronomic consideration because it is positively and strongly correlated with the cassava yield. The most commonly recommended spacing for cassava is 1 m x 1 m which is equivalent to a plant density of 10 000 stands per ha (Onwueme, 1978). The average farm-level plant density for the six COSCA study countries was 8 000 plants per ha. The cassava stand density in the farmers' fields varies widely from 500 plants per ha to 40 000 plants per ha depending on climatic zone, the cassava morphological characteristics such as branching type and leaf shape, soil fertility status, seed-bed type and cropping pattern, etc. Farmers who plant cassava as a cash crop plant at higher plant densities than farmers who plant the crop as a famine-reserve crop or as a rural food staple.

The factors surrounding cassava plant density are so numerous that the optimal plant density for high cassava yield is location specific. Local agronomic research is needed to determine the optimum cassava plant density. Research on cassava is not carried out at the required local level in any of the six COSCA study countries because the NARs do not have the resources necessary for detailed cassava field experiments.

In Africa, cassava is frequently grown as an intercrop with other crops (Fresco, 1986). In the six COSCA study countries, 60 percent of the cassava fields are intercropped and 40 percent mono-cropped. Cassava/maize intercrop is the most common, constituting about 50 percent of all cassava-based intercropped fields. Other combinations are cassava/bean (or pea), cassava/banana (or plantain), cassava/rice, cassava/millet (or sorghum), cassava/yam and cassava/sweet potato. Cassava's flexible planting schedule, its wide interspacing and its slow rate of growth relative to maize, for example, make it suitable for intercropping.

Cassava does not have a critical planting date as long as there is enough moisture at planting for rooting to commence. The actual date of planting is determined by the arrival of the rainy season. In West Africa, cassava is planted from the beginning of the rainy season (February–March) to the end of the rainy season (October-November).

The cassava planting date is also significantly influenced by the intercropping needs of farmers. Farmers delay the planting of cassava in intercropped fields, depending on the growth cycle of the associated crop. If the associated crop is a short-cycle crop such as maize, cassava is often planted one month later than the maize. If the associated crop such as yam has a long growing period, cassava is often planted as much as three months later than the yam. The delayed planting strategy reduces competition for insulation and soil fertility between cassava and the intercrops thus allowing the mono-crop stand density to be maintained for cassava. The strategy is possible because cassava is drought resistant provided there is enough moisture at planting for rooting to commence.

To summarize, farmers need assistance with a supply of healthy cassava planting materials. Local agronomic research is needed to determine optimum plant stand densities. Cassava's flexible planting date enables farmers to plant high-yielding large-canopy cassava varieties in intercropping. The cassava intercrops are grown on small family plots. For example, the COSCA study found that the average cassava field area per household was less than one hectare in all the COSCA study countries. The predominance of intercropping and small farm size in cassava production has implications for development of cassava production technologies in Africa.

Production and harvesting. Cassava is reputed to be a crop that requires relatively low labour inputs for production. However, COSCA research confirms that this conventional wisdom is valid only where cassava is produced as a famine-reserve crop or as a rural food staple. When cassava is produced as a cash crop, farmers use significantly more labour. In most of the COSCA study villages, all the field tasks for cassava production are done manually, using simple implements such as a hand hoe and a cutlass. In Nigeria where the TMS varieties and improved agronomic practices have boosted yields by 40 percent, the labour constraint has shifted from cassava weeding to cassava harvesting. Harvesting is now proving to be a serious constraint on the spread of TMS varieties because labour for cassava harvesting increases in direct proportion to yield.

The general food supply outlook, market conditions and labour availability for harvesting and processing influence the cassava-harvesting schedule. During drought and a period of attractive market prices farmers harvest their cassava early, sometimes before roots attain their maximum bulking. For the six COSCA study countries, the average age of cassava fields at harvest was 11.9 months with a range of six to 49 months.

Cassava is planted as a cash crop in Ghana and Nigeria. The amount of cassava harvesting labour per hectare was higher in Ghana and Nigeria than in the other COSCA study countries. In fact, Table 4 shows that harvesting cassava is the most labour-intensive field task in Ghana and particularly in Nigeria where the TMS varieties and improved agronomic practices have boosted yields by 40 percent. In Ghana and Nigeria, the labour constraint has shifted from cassava weeding to cassava harvesting. Harvesting is now proving to be a serious constraint on the spread of TMS varieties. It is not surprising that those farmers who plant TMS varieties in Nigeria have sometimes had to suspend planting because they were unable to hire sufficient labour to harvest previously planted cassava fields.

Table 4. Cassava production by task and days per ha in the Congo, Côte d'lvoire, Ghana, Nigeria, Tanzania and Uganda

Task	Congo	Côte d'lvoire	Ghana	Nigeria	Tanzania	Uganda
Land clearing	66	53	44	49	54	45
Seed-bed preparation	21	29	31	41	27	31
Planting	39	22	28	32	27	28
Weeding	27	28	34	38	28	32
Harvesting	48	44	53	62	46	52
Total days	201	173	191	222	182	187

Source: Nweke et al 2001

To date, most public sector research on cassava has focused on genetic research. Very little research has focused on developing machines to harvest cassava. Without question, a mechanical revolution is now needed to break the labour bottleneck in cassava harvesting among farmers in Ghana and Nigeria who are planting the TMS varieties.

3.9 SUMMARY

The analyses in this section show that farmers will introduce new agronomic practices (length of fallow period, quality of planting material, plant density, planting date, cropping pattern, quality of weeding and age of the cassava roots at harvest) as cassava production becomes profitable. However, progressive farmers who adopt improved agronomic practices are facing production and harvesting labour bottlenecks which are limiting the amount of cassava they can grow.

Without question, agronomic and genetic-induced productivity changes are important sources of growth in the cassava industry. Mechanical technology for cassava production and harvesting is needed to complement improved agronomic practices and high-yielding varieties. The mechanization of harvesting is needed to break labour bottlenecks, increase labour productivity and encourage the farmers to increase the use of TMS varieties.

4 CASSAVA PROCESSING

4.1 FIVE MAJOR CASSAVA FOOD PRODUCTS

In Africa, there are five common groups of cassava products: fresh root, dried roots, pasty products, granulated products and cassava leaves[10].

Fresh root. The roots of sweet cassava varieties are eaten raw, roasted in an open fire, or boiled in water or oil. The cyanogens in the roots are destroyed by slowly cooking the roots. Starting with cold water, gradual heating promotes the hydrolysis of the cyanogen (Grace, 1977).

Dried roots. Dried cassava roots are stored or marketed as chips, balls and flour. Chips and balls are milled into flour at home by pounding with a pestle and mortar in preparation for a meal. There are two broad types of dried cassava roots: fermented and unfermented. Preparing unfermented dried cassava roots by sun- or smoke-drying is the simplest method of cassava preparation. Since this method is inefficient in the elimination of cyanogens, it is used mostly for preparing sweet cassava varieties, which have low cyanogen content.

In the case of fermented dried cassava roots, the fermentation is accomplished in one of two ways: stacking in heaps or soaking in water for a number of days. The fermentation process, whether in water or in heaps, influences the taste of the final product. The longer the fermentation period, the stronger is the sour taste. Taste is an important attribute, especially for consumers who eat fermented cassava products and who desire the strong sour taste.

The recent introduction of a grater has eliminated stacking and fermentation and therefore saves time. The roots are simply peeled, washed and grated[11]. The pulp is placed in a perforated container, covered and a weight put on it for about three hours and the cyanogens are squeezed out along with effluent. The half-dried pulp is then dried in the sun (Alyanak, 1997).

In Africa, cassava is sun-dried on virtually any surface in the open air such as a large flat rock in the field, on the shoulders of a paved road, on flat roof tops, in a flat basket, or even on bare ground. Bright colour is an important attribute desired by consumers[12] . The colour of dried roots depends on the method and duration of the fermentation, on the method of drying, the efficiency of the drying energy and the cleanliness of the drying environment.

Pasty products. Two forms of pasty cassava products are common in Africa: uncooked and steamed pastes. The most popular is called uncooked paste because it is stored or marketed without cooking. To prepare the uncooked paste, the roots are soaked in water for three to five days, during which time the roots soften and ferment. The soaked roots are manually crushed and sieved by shaking it in a basket in a sack under water, thereby separating the pulp into the sack while collecting the fibre in the basket.

Cooked cassava pasty products have been recently introduced in Nigerian urban markets. Every evening in major cities in the cassava growing areas of Nigeria, it is common to find women selling cooked cassava paste wrapped in plastic bags. As women go home from work or from the market, they stop and buy some for the evening meal. Although more research is needed on preparation methods, cooked cassava paste is a promising food for busy urban consumers.

Steamed paste (for example *chickwangue* in the Congo) is a product that can be stored or marketed in a steamed form. To prepare the paste, fibre is removed by hand from roots fermented by soaking in water. The roots are then stacked in a heap to further ferment. The pulp is ground with a stone or pounded in a mortar. The resulting fine pulp is firmly wrapped in leaves and steamed.

The double fermentation as well as the steaming imparts a long shelf-life to steamed paste. The sour flavour achieved through extended fermentation is a characteristic that is cherished by regular customers. It is also a turn-off to potential new consumers.

Steamed paste is stored or marketed in a ready-to-eat form. Preparing steamed paste is expensive because many steps are involved and each one requires additional inputs. For example, grinding and sieving are labour-intensive. The soaking step is water-use intensive and steaming is fuel wood-use intensive. In the Congo, steamed paste -*chickwangue*- is prepared entirely by women.

Granulated products. In Africa, there are three common types of granulated cassava products: *gari*, *attieke* and *tapioca*. The methods for making granulated cassava products originated in Brazil. To prepare *gari*, fresh cassava roots are peeled, washed and grated. The resulting pulp is put in a porous sack and weighted down with a heavy object for three to four days to express effluent from the pulp while it is fermenting. The de-watered and fermented lump of pulp is pulverized and sieved and the resulting semi-dry fine pulp is toasted in a pan. The grating, effluent expressing, pulverization, toasting and the addition of palm oil are adequate to reduce cyanogens to a safe level (Hahn, 1989).

Fermentation imparts a sour taste to *gari*. The duration of fermentation varies depending on consumer preference for sour taste. The COSCA study found that commercial *gari* processors in Nigeria ferment cassava for different lengths of time depending on the market. Toasting extends the shelf-life so that *gari* can be easily transported to urban markets. If kept in a dry environment, *gari* will store better than grain because *gari* is not known to be attacked by weevils (Okigbo, 1984).

The second type of granulated cassava products is *attieke,* a type of steamed cassava that is found only in the Côte d'lvoire. *Attieke* is made in much the same way as *gari* with more or less the same inputs. However, instead of toasting, *attieke* is steamed. *Attieke* is available in a wet form and it has a shorter shelf-life than *gari.*

The third type of granulated cassava product is *tapioca,* which is primarily consumed in Benin, and Togo[13]. To prepare *tapioca,* cassava is grated and then put in water, pressed and kneaded to release the starch. The starch is permitted to settle at the bottom of the container and the water is drained off. The operation is repeated several times to prepare a high quality product. The damp starch is spread on a pan and toasted in the same way as *gari,* to form a coarse granular product.

Cassava leaves. Cassava leaves are edible and a more convenient food product than fresh roots. Cassava leaves are storable in dry form and since they have lower water content, they are less expensive to dry than the roots. If leaf harvesting is properly scheduled, it does not have an adverse effect on cassava root yield (Dahniya, 1983 and Lutaladio and Ezumah, undated). Cassava leaves have a nutritive value similar to other dark green leaves and are an extremely valuable source of vitamins A (carotene) and C, iron, calcium and protein (Latham, 1979). The consumption of cassava leaves helps many Africans compensate for the lack of protein and some vitamins and minerals in the roots. Cassava leaves are prepared by leaching them in hot water, pounding them into pulp with a pestle and mortar before boiling in water along with groundnuts, fish and oil. This process eliminates cyanogens from the leaves, making them safe for human consumption.

Cassava leaves are an important vegetable in the Congo and Tanzania. The COSCA study found that farmers in the Congo select cassava varieties with a large canopy of leaves. In Tanzania, farmers plant tree cassava -*mpiru* - for the production of leaves. In countries where cassava leaves are eaten as vegetables, producers earn additional income by selling cassava leaves. Truck loads of cassava leaves, locally called *pondu* in the Congo, are a common sight on the roads from the provinces to urban markets in Kinshasa.

Cassava leaves are not eaten in Uganda because their consumption is considered an indicator of low economic status (Otim-Nape, 1995). Cassava leaves are not eaten in West Africa, except in Sierra Leone, because several indigenous plants supply vegetables traditionally consumed with yam (Okigbo, 1980). Most of these vegetables are however, available only during the rainy season. Therefore, there is a seasonal gap in the availability of vegetables in West Africa which cassava leaves could fill.

[10] It is difficult to separate cassava processing from cassava food preparation because some combinations of the cassava processing and food preparation activities lead to final cassava food products which are in ready-to-eat forms. Other combinations of the cassava processing and food preparation activities lead to intermediate products which are stored until the need arises for conversion into ready to eat forms.

[11] This method was recently developed at IITA and it is now widely used by farmers in the major cassava producing countries.

[12] Fifty percent of the farmer groups interviewed in the six COSCA study countries considered bright colour as the most important quality in the cassava food products, namely the dried cassava roots, the granulated cassava food products and the pasty cassava food products. Twenty-five percent considered texture, 15 percent considered taste and 10 percent of the village groups considered other qualities as the most important in the cassava food products.

[13] It is also a common food used in making pudding for desert in the United States.

4.2 SUMMARY

To summarize, the traditional methods used to make five cassava products are simple and are able to reduce cyanogens in cassava to safe levels. The methods have been influenced by the availability of sunlight, water, fuel wood and wage rates. This diversity of natural resources and differentiated wage rates have contributed to an array of cassava products in Africa. There is regional variation in cassava preparation methods in Africa and a major challenge is to diffuse the best practices from one region to other regions within Africa.

4.3 MECHANIZED PROCESSING

There are three common types of mechanized cassava processing machines in use in Africa: graters, pressers and mills.

Mechanized grater. The traditional method of grating cassava was by pounding it in a mortar with a pestle. Later, artisans developed a manual grater in the form of a sheet of perforated metal mounted onto a flat piece of wood. The mechanized graters were first introduced to Republic of Benin, by the French in the 1930s and later modified in Nigeria in the 1940s by welders and mechanics, using local materials such as old automobile motors and scrap metal. Village entrepreneurs, who provide a grating service to farmers, own the mechanized graters. The mechanized grater operators allow the farmers flexibility in terms of working time and quantity of cassava grated. The fee charged is a small fraction of the cost of grating by hand.

In Ghana and Nigeria, commercial *gari* processors use the mechanized grater. The use of a mechanized grater has reduced *gari* processing costs by 50 percent and dramatically increased the profitability of *gari* production with the TMS varieties in Ghana and Nigeria. Since the grating task is mechanized, peeling is now the most labour-intensive task followed by the toasting in *gari* preparation. In Côte d'Ivoire, many *attieke* processors do not use the mechanized grater because the texture of *attieke* made with the mechanized grater is not as good as that of hand-made *attieke.* The planting of the TMS varieties is not profitable to farmers who process cassava as *attieke* because hand grating is labour-intensive.

Mechanized presser. Since cassava has high water content (70 percent), various methods have been developed to extract the water during processing. Traditionally, effluent is drained from grated cassava mash by putting it in a basket, covering it with leaves and placing a heavy object such as stone on top of it for three to five days. Fermentation takes place at the same time. Nowadays, most commercial *gari* makers in Nigeria and *attieke* makers in Côte d'lvoire use a screw jack to extract the effluent. The mechanized presser is a simple hand-operated machine, which is made from wooden plates and a used automobile jack, both of which are available in villages. In Nigeria, mechanized graters and pressers are often both operated and maintained by the same village entrepreneurs in major areas of commercial cassava production. This enables farmers to have access to grating, pressing, pulverizing and sieving services in a convenient location.

Mechanized pressing reduces the processing time from several days to a few hours, but the inherent disadvantage of the mechanized presser is that it performs only the pressing step and it eliminates the fermentation step. Fermentation imparts a sour taste, which is cherished by consumers in some places such as in southwestern Nigeria. Fermentation is not essential for the elimination of cyanogens in the preparation of *gari* because grating, pressing, pulverization, sieving and toasting steps reduce the cyanogen in cassava to such a low level that *gari* is safe for human consumption.

Mechanized mill. The traditional method of preparing cassava.flour from dried cassava roots is to pound the roots in mortar with a pestle. Today, mechanized mills are common place in the urban centres in the six COSCA study countries. The mills were also observed in several COSCA villages in Ghana, Nigeria and Uganda but in only a small percentage of the COSCA villages in the Congo, Côte d'lvoire and Tanzania. The components of the mechanized mill are also fabricated locally from scrap materials.

4.4 NEW CHALLENGES IN MECHANIZED PROCESSING

The following new challenges in mechanized cassava processing flow from the above-mentioned discussion:

- the Ghana/Nigerian mechanized grater should be introduced in the other major cassava producing countries in Africa. The grater is made from local materials and the machines are reliable and cost effective;
- engineers and breeders should join forces and figure out how to mechanize the peeling task by developing cassava roots that are uniform in shape and size and having skins that meet certain specifications;
- new technology is needed to reduce the amount of labour in the toasting stage of *gari* preparation;
- a mechanized grater should be developed to make *attieke* with a texture as good as hand-made *attieke.*

In the past, attempts have been made in the various COSCA countries by private entrepreneurs to process cassava on a large-scale using integrated grating, pressing, pulverizing, sieving and toasting machines in a factory style of operation. However, all of these firms failed because of an array of problems: lack of sustained public or private investment in research and development, shortage of cassava roots, fragmented market for cassava products, unacceptable consumer taste and high cost of labour for hand peeling.

Numerous public sector agencies were established in Nigeria in the 1970s and 1980s to develop and diffuse mechanized cassava processing machines. However, farmers have not adopted the machines developed by the government agencies because the machines are not as convenient and reliable as those developed by the small-scale private artisans.

Important lessons for mechanization of food processing in Africa emerge from this analysis of the evolution of mechanized cassava processing methods. Mechanization of food processing must be for products that have a market demand such as *gari*. Since most villages in Africa do not have electricity and petroleum fuel is scarce and expensive, mechanized machines should be small and easy to fabricate and repair by village artisans using local materials such as old engines and scrap metals. Machines that are manually driven are more suitable for remote villages provided they can be fabricated and maintained by village artisans using local materials.

The customary sweet and bitter cassava varieties depend upon the amount of cyanogens (prussic acid) in the edible parts of the roots (Jones 1959, p. 12). The roots of sweet cassava are low in cyanogens, mealy after cooking and usually eaten as a raw vegetable, boiled, or roasted in an open fire. Bitter cassava varieties are high in cyanogens, waxy after cooking and are harmful to humans and animals unless they are peeled, grated and toasted or soaked in water for a few days and boiled or sun-dried.

5 CASSAVA CONSUMPTION

5.1 CONSUMPTION LEVEL

Cassava production in Africa is used almost exclusively for consumption as food. In fact, 95 percent of the total cassava production, after accounting for waste, was used as food in Africa in the late 1990s[14] In Africa, total cassava consumption more than doubled from 24 million tonnes per year in the early 1960s to 58 million tonnes per year in the late 1990s (FAOSTAT). The large increase in the total cassava consumption in Africa is due to a significant increase in per capita consumption in countries such as Ghana and Nigeria where cassava is produced as a cash crop for urban consumption. The availability of cassava in a convenient food form, such as *gari*, played a major role in the increase in the per capita cassava consumption in Ghana and Nigeria. Future increases in cassava consumption in other African countries will depend on how well cassava is prepared into food forms, which make an alternative to wheat, rice, maize and sorghum to urban consumers.

Cassava roots are the single largest source of calories in seven African countries having 40 percent of the population in the late 1990s'[15] . In these seven countries, cassava contributed an average of nearly 600 calories per person per day. In another 11 countries with about 25 percent of Africa's population, cassava was the second largest source of calories[16] . In those countries, cassava provided more than 300 calories per person per day in the late 1990s (FAOSTAT). Thus, in Africa, cassava roots are an important source of calories for about 65 percent of the total population.

These averages underestimate the importance of cassava in specific countries. In the Congo, for example, many families eat cassava for breakfast, lunch and dinner. In the Congo, cassava contributed over 1 000 calories per person per day or about 55 percent of the average daily calorie intake in the late 1990s (FAOSTAT). Cassava leaves are widely consumed as a vegetable in several places where cassava is grown such as in the Congo and Tanzania. Since cassava leaves are rich in protein, vitamins A and C and some minerals (iron and calcium) (Latham, 1979, p. 172) they partially compensate for, the shortage of these nutrients in the roots.

Cassava was found to be the cheapest source of calories among all food crops in each of the six study countries. As family incomes increased, the consumption of cassava as dried root flour declined while consumption in convenient food forms such as *gari* increased. Dried cassava root flour is cheaper than *gari* because of the high cost of processing *gari.* Medium and high income families were found to consume *gari* because it is cheaper and more convenient to cook than grains. The future of cassava as a rural and urban food staple will depend on cassava's ability to compete with wheat, rice, maize, sorghum and other grains in terms of cost, convenience and availability in urban markets. Cassava can retain its competitive edge only through investments in labour-saving production, harvesting and processing technologies.

[14] Waste was estimated to be 28 percent of the total cassava production in Africa from 1994 to 1998 (FAO 1999).

[15] The countries are: Angola, the Central African Republic, the Congo, the People's Republic of Congo, Ghana, Mozambique and Nigeria.

[16] The countries arc: the Republic of Benin, Cameroon, Côte d'lvoire, Guinea, Liberia, Madagascar, Sierra Leone, Tanzania, Togo, Uganda and Zambia.

5.2 INCOME OF ELASTICITY OF DEMAND[17]

The income elasticity of demand estimates for cassava products were found to be positive at all income levels. For some cassava products, the income elasticity of demand was above one (Table 5). For example, in Nigeria, it was surprising to discover that the income elasticity of demand for *gari* was significantly higher than that of maize at all income levels. Among high-income urban households, the income elasticity of demand for *gari* was also higher than that of rice. In Ghana, the income elasticity of demand for cassava (all products combined) was higher among urban than rural households. These estimates provide convincing evidence that cassava has a strong market demand in the COSCA study countries.

[17] The income elasticity of demand provides an insight into the level of market demand for a commodity. The income elasticity of demand measures the percent of change in the quantity of a commodity purchased (consumed) by consumers in response to one percent change in their incomes. A negative income elasticity of demand means that the quantity of the commodity purchased by consumers will decline with rising incomes. A zero percent income elasticity of demand means that the amount of the commodity demanded will be unchanged with rising incomes. An income elasticity of demand between zero and one percent implies that a one percent increase in incomes will cause consumers to increase the amount of the commodity they are willing to purchase although by less than one percent. Finally, an income elasticity of demand of more than one percent implies that market demand is very high for the commodity. Scholars and policy-makers who dismiss cassava as an inferior good assume that the income elasticity of demand for cassava is negative or zero.

Table 5. Income elasticity of demand for cassava and other food staples for rural households in Nigeria, Tanzania and Uganda; rural and urban households in Ghana

Staple	Nigeria'			Tanzania *			Uganda [1]			Ghana [2]	
	All Sample Households	Low Income Households	High Income Households	All Sample Households	Low Income Households	High Income Households	All Sample Households	Low Income Households	High Income Households	Rural Households	Urban Households
All cassava	0.78	0.84	0.76	0.77	0.80	0.66	1.00	1.00	1.00	0.73	1.46
Fresh roots	1.24	1.28	1.21	0.79	0.79	0.67	0.95	0.96	0.94	-	-
Gari	0.85	0.85	0.77	-	-	-		-	-	-	
Dried roots	0.55	0.57	0.53	0.75	0.80	0.66	1.17	1.15	1.13	-	
Maize	0.71	0.74	0.65	0.98	0.98	0.97	0.91	0.85	0.91	0.84	0.83
Rice	1.12	1.13	1.13	1.14	1.25	1.11	1.36	1.59	1.25	1.00	1.50
Pulses	1.02	1.01	1.02	1.06	1.05	1.07	0.78	0.84	0.69	-	-
Banana	2.06	1.97	1.69	0.94	0.93	0.95	1.22	1.38	1.16	0.13	1.10
Yam	0.91	0.90	0.92		-		-		-	-	
Sweet potato	-	-	-	0.97	0.97	0.74	0.79	0.64	-	-	-

1. *COSCA study, Ezemenari et al. 1998 and Nweke et al. 2001*
2. *Alderman 1990*

The conclusion that emerges from the new data presented is that in Africa, cassava is not an inferior food. Rather, in certain forms, cassava is superior to some grains. *Gari* has substantial market demand among low-, medium- and high-income rural and urban households. The degree to which the future market demand for cassava for food consumption can be expanded however, would depend largely on the extent to which the quality and variety of cassava food products can be improved to make them attractive to a range of consumers in rural and urban centres.

The measures needed to reduce the cost of making cassava available to consumers in convenient food forms include:

- development and diffusion of labour-saving technologies for cassava field tasks, especially for the harvesting task;
- development and diffusion of labour-saving methods for cassava processing tasks for which such methods have not been developed, particularly the peeling task; and
- diffusion of existing cassava processing technologies in areas where such technologies are not available.

6 NEW USES FOR CASSAVA

6.1 EXPANDING THE USE OF CASSAVA IN LIVESTOCK FEED

In Africa, cassava is not widely used in the livestock feed industry. For example, in Nigeria in the late 1990s, only 1.5 million tonnes of cassava (5 percent of total production) per year was used in the livestock industry compared with 9.8 million tonnes (50 percent of total production) per year in Brazil (FAOSTAT). In Nigeria, the amount of cassava used in the livestock industry increased from 0.56 million tonnes per year in the mid 1980s after the Government banned the importation of maize in 1985/86 and feed mills were forced to use local raw materials such as cassava. After the import restrictions on maize and other crops were removed in 1995, there was no incentive for feed millers to reduce the quantity of cassava they were using because cassava is cheaper than maize and farmers were getting higher yields from TMS varieties.

In Nigeria, the 5 percent of total cassava production that is used as feed is significantly lower than in Brazil (50 percent) because in Nigeria, cattle, sheep and goats are free grazed and pigs rummage on household waste. Also the poultry industry only has 125 million birds in Nigeria as compared with 867 million in Brazil in 1998 (FAOSTAT)[18].

Due to the pessimistic outlook for a major increase in cassava fed to livestock in Nigeria, the logical step is to examine the global outlook for Nigerian cassava exports for livestock feed. The key country to examine is Thailand because it has dominated the export of cassava pellets for livestock feed for more than three decades.

Beginning in the 1960s, the Government of Thailand encouraged private firms to set up private pellet factories and produce cassava pellets for export to the EU (European

Union). Exports increased from 100 000 tonnes in 1966 to a peak of nine million tonnes in 1989. However, due to competition with U.S. grain exports to the EU market, the price of cassava pellets has declined, making it unattractive for Thailand to produce cassava for export. Due to low prices, Thailand did not meet its export quota from 1994 to 1998. In fact, Thai pellet exports declined from 9 million tonnes in 1989 to 3 million tonnes in 1998 (Ratanawaraha *et al.*, 1999, p. 18).

The EU has allocated a quota of 145 000 tonnes of dried roots per year to the World Trade Organization (WTO) members excluding China, Indonesia and Thailand. This quota has never been reached. In Ghana, some entrepreneurs sought to exploit the opportunity offered by the WTO quota (Graffham and Westby, 1999). Exports of dried roots from Ghana increased from about 1 000 tonnes in 1995 to over 51 000 tonnes in 1996 (FAOSTAT). In 1997, world cassava prices fell from US$150 to US$100 per tonne. In Ghana in the same year, the price of the dried roots for food stood at US$0.13 per kg when the exporters were willing to pay only US$0.04 per kg to producers (Graffham and Westby, 1999). Consequently, the exports of dried roots from Ghana declined to 36 000 tonnes in 1997; 7 000 tonnes in 1998; and less than 5 000 tonnes in 1997 (FAOSTAT). The implication of all this is that faced with depressed world prices of cassava, African cassava producing countries should concentrate on expanding the use of cassava in livestock feed at home rather than trying to break into the EU market at this time.

What can be done to increase the use of cassava in livestock feed in Africa? In Nigeria, a poultry feed trial has shown that if cassava roots and leaves were combined in a ratio of four to one, the mixture could replace maize in poultry feed and reduce feed cost without a loss in weight gain or egg production (Tewe and Bokanga, 2001). If this important research finding is diffused and adopted by farmers and livestock feed producers, the amount of cassava used in livestock feed in Africa would increase. At present, cassava leaves have no market value except in countries such as the Congo and Tanzania where the leaves are consumed as a vegetable[19].

[18] In 1996 to 1998, there were 19.3 million cattle and 4.5 million pigs in Nigeria compared with 156 million cattle and 28 million pigs in Brazil (FAO, 2000). In Nigeria, nomadic herders move their cattle to wherever grass is available and tsetse is not a problem. The nomads neither respect boundaries nor do they pay for grazing rights. Frequently, they are halted by crop farmers, including cassava farmers, when cattle graze on fields with crops.

[19] Cassava leaves are returned to the soil as organic matter. The cassava leaves are a good source of protein and vitamins and they are safe for human and animal consumption.

6.2 EXPANDING THE USE OF CASSAVA IN FOOD MANUFACTURING

Technologies exist for the use of cassava as a partial substitute for wheat in bread-making and biscuits, pastries and snack foods manufacture (Satin, 1988, Eggleston and Omoaka, 1994, Defloor, 1995 and Onabolu *et al.*, 1998). In Africa, the amount of cassava used for food manufacture by the food industries is insignificant. For example, in Nigeria in the late 1990s, an insignificant 3 tonnes of cassava was used per year for food manufacture compared with maize, 133 000 tonnes (FAOSTAT). Use of cassava as a partial substitute for wheat in food manufacture will increase if the practice can result in a reduction in the prices of the manufactured composite cassava and wheat flour food products compared with the prices of the same products made with 100 percent wheat flour.

In Africa, due to an array of reasons, the composite cassava and wheat flour food products are not cheaper than the 100 percent wheat flour food products. For example, a partial substitution of cassava for wheat in bread flour requires expensive supplementary viscosity enhancers such as eggs, milk and gums to compensate for the lack of gluten in cassava (Eggleston and Omoaka, 1994, Defloor, 1995 and Onabolu *et al.*, 1998).

Using cassava flour for bread-making and for the manufacture of biscuits, pastries and snack foods requires a reliable supply of cassava flour with constant quality (Delfoor, 1995). In Africa, cassava flour available on the market varies widely in quality because of the wide range of traditional methods of preparation used. Cassava flour of standard high quality will be more expensive and will increase the cost of the food products.

Other important factors such as the cassava variety, age of the cassava root and the cassava growing environment also influence the quality of the food products in which cassava flour substitutes partially for wheat flour (Eggleston and Omoaka, 1994 and Defloor, 1995). Measures to standardize cassava varieties, age of cassava roots and the cassava growing environments will further increase the costs of the food products in which the cassava flour is used to substitute partially for wheat flour.

In Nigeria, the technologies for the use of cassava as a partial substitute for wheat flour in food manufacture that were developed at IITA and other research centres were adopted by food industries when wheat flour was made scarce by the wheat import ban in the mid 1980s. When the wheat import ban was removed in the mid-1990s, however, the food industries readily reverted to the use of 100 percent wheat flour in food manufacture (Bokanga and Tewe, 1998).

In Africa, the increase in the use of cassava in food manufacturing industries does not depend on technologies for partial substitution of cassava flour for wheat flour in bread, cookies and pastries, etc., but the increase in the use of cassava in food manufacturing industries requires the development of technologies for industrial manufacture and packaging of traditional African cassava food products, which have a snack value such as *gari, attieke* and *chickwangue.*

It was explained earlier that in Africa, past attempts to manufacture *gari* and *chickwangue* industrially failed because they were unprofitable. In Brazil, however, recent development in the use of cassava in food industries shows that sustained investment in research and development can make industrial manufacture of 100 percent cassava starch traditional food product profitable. For example, the main cassava-based fast food in Brazil is *pao de queijo,* a type of bread made with sour cassava starch, which has been fermented and dried (Vilpoux, Olivier and Marco Tulio Ospina, 1999).

In Brazil, the preparation of *pao de queijo* by traditional methods has similar problems as the preparation of *gari, attieke* and *chickwangue* in Africa. For example, in Minas Gerais, one of the traditional *pao de queijo* production states in Brazil, almost every family has its own recipe. Sour starch gives *pao de queijo* a very acid taste, which is appreciated in the Minas Gerais state. In other states however, where consumption is more recent, people prefer *pao de queijo* with a mild taste. Sour starch is important in *pao de queijo* preparation because of its expansion characteristics, which result from the combined action of fermentation and sun-drying. Industrial manufacture of *pao de queijo* needs a standard product with consistent quality. These criteria are difficult to maintain in *pao de queijo* because of the low and unstable quality of sour starch. Making sour starch is labour-intensive. The sour starch industry is competitive with a large number of small producers. The small capacity limits the possibility to access modern technologies and market information (Vilpoux, Olivier and Marco Tulio Ospina, 1999).

Through sustained investment in research and development, *pao de queijo* was transformed from a small-scale home-made product to a large-scale factory-manufactured product by first replacing fermentation and sun-drying with a chemical process in making the sour starch. Later, the sour starch was replaced with other types of cassava starch which are acceptable to consumers. Since the early 1990s, the preparation of *pao de queijo* by small-scale manufacturers in the traditional production states such as Minas Gerais has been declining while larger more modern companies are expanding in other states. The entrance of large companies changed most of the industry. The operators of the large companies have better education, better access to new technologies and market information.

In Brazil, the research and development in the improvement of *pao de queijo* were carried out mostly by the private sector. The expansion in the consumption of the *pao de queijo* was facilitated by political support. For example, the consumption was endorsed by the former President of Brazil, Itamar Franco. He required that *pao de queijo* be present at all official meetings. Since the mid-1990s, Brazilian consumption of *pao de queijo* has increased greatly, changing from a regional to a nationwide fast food. It is also possible to find *pao de queijo* in other South American countries such as Argentina and Peru (Vilpoux, Olivier and Marco Tulio Ospina, 1999).

To summarize, there are technologies for use of cassava as a partial substitute for wheat in food manufacture. In Africa, cassava is not used for food manufacture because food products made with 100 percent wheat flour are cheaper and preferred by consumers. Sustained investment in research and development on industrial manufacture of African cassava food products such as *gari, attieke* and *chickwangue* which have snack values can lead to the increased use of cassava in food manufacturing industries.

6.3 CASSAVA AS AN INDUSTRIAL RAW MATERIAL: A NIGERIAN CASE STUDY

In Nigeria in the early 1990s, only about 700 tonnes of cassava starch was produced per year because Nigerian cassava starch is considered to be of low quality by Nigerian industries and none is exported. In the mid-1990s, cassava starch only accounted for 5 percent of the 17 000 tonnes of starch used each year as industrial raw material in Nigeria

(RMRDC, 1996). The bulk of the starch used as industrial raw material during the mid-1990s was imported corn starch which represented 80 percent of the total. The remaining 15 percent was an unspecified type of starch. The quantity of industrial starch used in Nigeria in the late 1990s was low. Even if most of it was made from cassava, the impact on the total demand for cassava would be small.

The scope for increasing the use of cassava starch in Nigeria's industries is to a large extent, limited by the ready availability of high quality imported corn starch and Nigeria's meagre research and development investment in preparing cassava starch for industrial uses. Nigerian private investors do not have the incentive to invest in cassava research and development because of the lack of patent protection. Also, Nigeria's industries that use starch as a raw material have access to cheaper and higher quality starch from imported sources.

Table 6 illustrates the potential industrial uses for cassava and research priorities for developing cassava starch and dried cassava roots as industrial raw materials in six different industries in Nigeria: textile, petroleum drilling, pharmaceutical, soft drink, beer malt and ethanol/alcohol industries. The potential is high in three industries.

Table 6. Nigeria: Industrial potential for cassava and research and development priorities

Industry	Cassava-based Raw Material	Potential for Increasing Cassava Utilization	Required research and development activity
Textile	Cassava starch in direct form	Medium	Improve the quality of cassava starch by improving the method of drying cassava roots
Petroleum drilling	Cassava starch in direct form	Medium	Make cassava starch gelatinize in cold water
Pharmaceutical	Cassava starch hydrolysates including glucose, maltose, sucrose, fructose and syrup	Medium	Set up industries to make glucose, maltose, sucrose, fructose and syrup from cassava starch
Soft drinks	Syrup concentrate	High	Prepare syrup concentrate from cassava starch and test it for suitability for making soft drinks
Beer	Dried cassava roots	High	Develop a method of making beer malt using dried cassava roots
Ethanol	Dried cassava roots	High	Set up cassava-based small-scale alcohol units; and carry out feasibility study of producing ethanol from cassava in Nigeria and ethanol from cassava in Ghana.

Source: Nweke et al 2001

The first is syrup concentrate for the soft drink industry. In Nigeria, the soft drink industry is dominated by Coca Cola which imports the syrup concentrates and keeps them as a trade secret. Syrup concentrate has been successfully made from cassava starch by IITA post-harvest technologists. A pilot project is needed to determine its acceptability and potential profitability in making soft drinks.

The second potential use of cassava is in the beer industry. Beer has been brewed in Nigeria with imported barley malt for many decades. However, in 1985/86, Nigeria banned grain imports and the brewery industry began to produce beer malt with sorghum produced in northern Nigeria. The initial concern that sorghum beer would not be acceptable to consumers proved to be without basis as beer consumption did not decline after sorghum malt was used to replace barley malt. The Nigerian beer industry currently uses about 200 000 tonnes of sorghum each year to make beer malt (RMRDC, 1996). No attempt has yet been made to prepare beer malt from dried cassava roots produced in southern Nigeria where most of the beer industries are based. However, biochemists at the National Root Crops Research Institute (NRCRI) believe that given the right enzyme, it is possible to prepare beer malt from dried cassava roots. The manager of the Golden Guinea Brewery, Umuahia believes that consumers would accept cassava malt beer judging from their ready acceptance of sorghum beer in the mid 1980s. However, the manager reported that Golden Guinea would be reluctant to invest in research on making beer malt from cassava roots because patent law is not enforced in Nigeria. Research is needed to develop the technology for making beer malt from dried cassava roots.

The third potential for cassava as an industrial raw material is a cassava-based alcohol industry. Currently, Nigeria imports about 90 million litres of alcohol annually with about 80 million litres being used by the liquor industry. If the 80 million litres were produced from cassava, it would require 500 000 tonnes of dried cassava roots which would increase the demand for cassava, raise farm income, generate on-farm and off-farm jobs and save foreign exchange. However, a cassava-based ethanol industry should be of more help to other cassava producing countries that import petroleum because Nigeria is subsidizing the retail price of gasoline. A feasibility study should be carried out to determine the economics of a cassava-based alcohol industry in Nigeria and a cassava-based ethanol industry in other African cassava producing countries that import petroleum.

7 IMPLICATIONS OF THE CASSAVA TRANSFORMATION FOR ENVIRONMENT, GENDER, POVERTY ALLEVIATION AND EQUITY

7.1 ENVIRONMENT

Historically, many scholars have asserted that cassava depletes the soil. For example, Hendershott, *et al.*, reported that cassava is well known not only for producing large quantities of carbohydrate, but also for exhausting the soil (1972, p.60). Similar assertions have been made by Davesne (1950), Irvine (1953) and Grace (1977). Soil fertility is a subject of major importance in a discussion of expanding food production in Africa (IITA, 1998). Human-induced land degradation is severe in Africa. Numerous researchers claim that a lack of replenishment of nutrients is leading to rapid deterioration in soil fertility. Fertilizer use is low because of high transport costs, late delivery and the risks associated with food production in marginal areas (Pinstrup-Anderson *et al.*, 2000).

To test the hypothesis that cassava depletes the soil, COSCA researchers collected soil samples from 1 501 fields planted with staple crops in 281 villages in the cassava growing areas of the Congo, Côte d'lvoire, Ghana, Nigeria, Tanzania and Uganda. The soil samples collected over the 1991 to 1992 period revealed that the amount of clay, silt and sand did not differ between cassava fields and the levels found in the fields of other crops[20]. In fact, soils of cassava fields were higher in total N, organic matter, Ca, Na, TEB, ECEC and pH[21].

A twenty-year cassava yield-experiment conducted by S. K. Hahn at IITA's high rainfall station at Ibadan in the transition zone from the early 1970s until the early 1990s found that the yield dropped significantly from an average of 40 tonnes per ha during the first four years and then stabilized at around 20 tonnes per ha from the fifth to the twentieth year. Cassava was grown every other year in a two-year rotation without chemical fertilizer. Hahn concluded that cassava produces a large amount of foliage which is recycled as manure to the soil. Hahn's landmark twenty-year study shows that cassava yields are sustainable under continuous cultivation. The COSCA soil survey and Hahn's twenty-year yield experiment provide evidence that the assertion that cassava depletes the soil is a half-truth.

The myth of cassava being a soil depleting crop may be attributed to the fact that cassava is widely grown in the forest zone where high rainfall and sandy soil accelerate organic matter decomposition, leaching and soil erosion at a faster rate than in the transition and the savannah zones[22]. For example, an eight-year experiment in the forest zone of Ghana revealed that cassava yields declined under a continuous rotation of cassava and maize with fertilizer. In the transition zone, a similar experiment was carried out without the application of fertilizer and cassava yields declined but at a slower rate than in the forest zone (Nye and Greenland, 1960 cited in Odurukwe and Oji, 1981).

The myth of cassava as a soil degrader has been used to downgrade cassava's role as an environmentally friendly crop. Cassava cultivation entails minimal soil disturbance especially in light soils which are susceptible to wind or water erosion. Cassava is normally grown on flat land in sandy soils and on ridges and mounds on heavy lateritic soils (Hahn, 1984). The plant provides soil cover so long as it grows; as a semi-perennial it does not shed all its leaves with senescence. As a semi-perennial, cassava plants serve as a planted fallow. Although there are places, especially high population density and market centre areas, where cassava is harvested from six to 12 months after planting, the normal time of harvest is 12 months or more. The cassava plant protects the soil by providing cover and recycles nutrients by shedding old leaves as it grows.

To summarize, in Africa, increased production of cassava will not lead to environmental degradation because contrary to conventional wisdom, cassava does not deplete the soil more than any other crop. Cassava is often grown on flat seedbed with minimum tillage.

It produces a large amount of foliage which is recycled as soil nutrient. As a semi-perennial crop, cassava provides year-round soil cover.

[20] The physical soil properties assessed are clay, silt and sand content. The chemical properties are total nitrogen (Total N), organic matter (OM), available phosphorous (Available P), calcium (Ca), magnesium (Mg), potassium (K), sodium (Na) and manganese (Mn) contents; total exchangeable bases (TEB), total exchangeable acidity (TEA), effective cation exchange capacity (ECEC), base saturation and soil pH. For more details see Asadu and Nweke, 1999.

[21] Several of the fields have been under continuous cultivation of cassava for a minimum of a decade.

7.2 GENDER

Cassava has been described as a women's crop by some scholars (Ikpi, 1989 and 1989a and Okorji, 1983). For example, Okorji (1983) found in the Abakaliki area of southeast Nigeria that women owned more cassava fields than men and concluded that cassava is a women's crop. COSCA researchers collected data from six countries and found that the categorization of cassava as a women's crop is a misleading half-truth that is based on anecdotal evidence and isolated village studies.

The COSCA studies show that the proportion of the household cassava field area (hereafter field) owned by women ranged from 4 percent in the Congo to 24 percent in Côte d'lvoire[23]. By contrast, the proportion of cassava fields owned by men ranged from 15 percent in Côte d'lvoire to 72 percent in Uganda and 81 percent in Nigeria. Joint ownership by both men and women account for the balance of the percentages in each country.

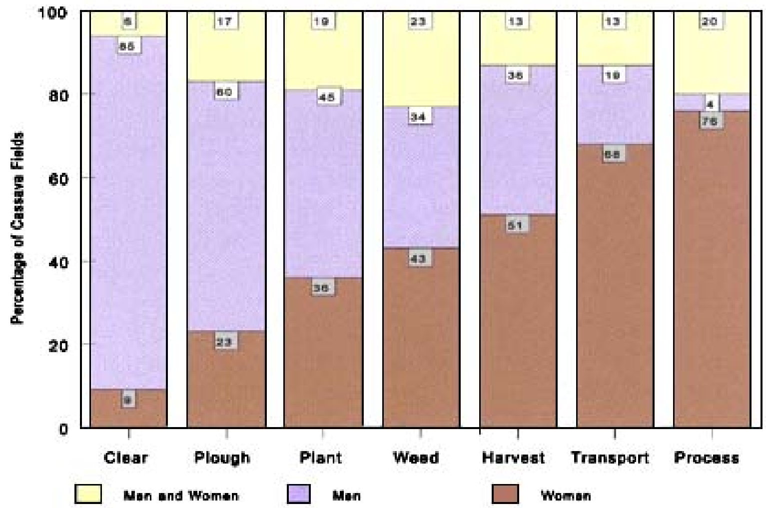
There is an important exception in tree crop-dominated rural economies. Among the six COSCA countries, women in Côte d'lvoire owned a higher proportion of the cassava fields than men. In Côte d'lvoire and in most other tree crop dominant-farming systems, the men concentrate on producing tree crops such as cocoa and coffee. Hence, although there are specific locations in certain countries where women owned more cassava fields than men (Okorji, 1983 and Ezumah and Domenico, 1995), these locations are exceptions and not the norm.

The COSCA studies found that both men and women make significant contributions of their labour to the cassava industry in most of the COSCA countries. However, men and women were found to specialize in different tasks. Men worked predominantly on land clearing, ploughing and planting while women specialized in weeding, harvesting, transporting and processing (Figure 3).

[22] Unpublished data from S. K. Hahn, IITA, lbadan.

[23] The agro-ecological zones of these countries include humid forest (hereafter the forest) zone, forest-savannah transition (hereafter the transition zone) zone and the moist savannah (hereafter the savannah) zone. The forest zone is characterized by 9–12 months of growing season, more than 22°C daily mean temperature and less than 10°C temperature range. The transition zone is characterized by five to seven months of growing season, above 22°C daily mean temperature and above 10°C temperature range. The savannah zone is characterized by three or four months of growing season, above 22°C daily mean temperature and above 10°C temperature range (Carter and Jones, 1989).

Figure 3. Percentage of cassava fields in which men, women, or men and women together, provided the bulk of labour for different tasks, average for six COSCA study countries



Women were found to contribute less than half of the total labour inputs in the cassava system in five of the six COSCA study countries (Nweke *et al.*, 2001). The exception was the Congo. Therefore, it is a vast overstatement to categorize cassava as a woman's crop. In fact, both men and women play strategic but changing roles during the cassava transformation process. As cassava becomes a cash crop produced primarily for urban centres, men increase their labour contribution to each of the production and processing tasks. For example, the proportion of the cassava weeding carried out by men was higher in Nigeria than in Tanzania because in Nigeria, cassava is produced as a cash crop for urban consumption and in Tanzania, it is a famine-reserve crop (Nweke *et al.*, 2001).

The COSCA studies found that the introduction of labour-saving technologies in cassava production and processing has led to a redefinition of gender roles in the cassava food system. In Nigeria, on farms where land clearing or ploughing was mechanized, men increased their labour inputs in planting, weeding and harvesting. In Nigeria, as the processing tasks became mechanized, the contribution of male labour to cassava processing increased because men operated all of the processing machines. When processing became mechanized, women shifted their labour to production tasks such as weeding and men managed the mechanized processing tasks.

The last two observations of the COSCA study challenge the validity of the claim that women's workload increases relative to men's as commercialization of agriculture proceeds.

The COSCA studies also found that women who wanted to plant cassava were not constrained by the lack of access to new cassava production technologies or to essential production inputs such as farmland, planting cuttings of the TMS varieties and hired labour. Both men and women were able to plant cassava on land that they had inherited, purchased or rented. Finally, although most of the cassava processing machines were owned by men in most of the COSCA countries, both men and women had access to the machines by paying a fee to the machine owners.

The COSCA studies show that the assertion that cassava is a women's crop in Africa is not valid because men are more important in terms of the ownership of cassava fields. The myth is also rejected because in terms of work in cassava fields, women do not produce more cassava than men in most of the COSCA studied households.

What are the policy implications that flow from these observations? Although there are persistent calls by donor agencies and gender experts on African policy-makers to hire more female agricultural extension workers in cassava growing areas, COSCA research shows that both men and women play significant and changing roles in the cassava food system in Africa.

Country specific studies are needed to determine appropriate policy measures for use of cassava to improve the welfare of men and women in Africa. For example, in Ghana and Nigeria where cassava is produced as a cash crop, more men are staying in the villages and working in cassava production and *gari* processing. Similarly, in the Congo, men are also staying in tree crop-producing villages and working on cassava for home consumption because they earn higher cash income from tree crops than from employment in urban areas. Outside the tree crop areas, young men migrate out of the Congolese villages to escape rural poverty. Women are therefore left to produce food for their families under conditions of extreme rural poverty.

The solution to poverty and low returns to both men and women engaged in cassava production and processing is to take a holistic approach and introduce improved varieties and processing technologies to improve the economic returns of cassava production and processing and drive down the real (inflation adjusted) price of cassava in rural and urban markets.

7.3 POVERTY ALLEVIATION AND EQUITY

Historically, cassava has been a subsistence crop when 90 to 95 percent of the people in Africa were in farming. Today, although only half to two-thirds of the people of Africa live in rural areas, there is still a myth that cassava is primarily a subsistence crop that is grown for home consumption by farmers and rural net food buyers. The increasing urbanization and consumer demand for convenient food products in Africa has stimulated the urban demand for cassava products such as *gari* and *attieke.* To meet the expansion in demand, cassava has emerged in many countries as an important cash crop for farmers and as an urban food staple.

The percentages of cassava fields planted for sale in the six COSCA countries were as follows: the Congo, 59; Côte d'lvoire, 51; Ghana, 57; Nigeria, 45; Tanzania, 32; and Uganda, 25. In the Congo, the proportion of cassava planted for sale was higher than for any other crop (Tollens, 1992). In Nigeria, the Congo and elsewhere, there are small-scale farms that produce 5–10 ha of cassava entirely for sale (Berry, 1993).

Table 7 shows that cassava is an important source of farm income in the COSCA study countries, but particularly in Ghana and Nigeria. In both Ghana and Nigeria, cassava cash incomes were the highest among farms with access to mechanized cassava processing equipment for the preparation of *gari*. The contribution of cassava to farm incomes was found to be low in Tanzania and Uganda because the majority of farmers in both countries lacked access to improved cassava processing equipment. In the COSCA study countries, cash income from cassava accrued to more households than cash income from any other food crop, confirming the relatively egalitarian spread of benefits from the production of cassava (Table 8).

The COSCA data from 281 villages in the six most important cassava producing countries in Africa dismiss the myth that cassava is a subsistence crop produced by and for rural households. Cassava is increasingly being transformed into a cash crop that is produced and marketed as an urban food staple in many countries in Africa. This discussion illustrates the need for measures to increase the productivity of the cassava food system in order to raise the income of farmers and those involved in processing and marketing and reduce the real cost of cassava for consumers over time.

8 CHALLENGES AND STRATEGIES FOR DEVELOPMENT

Increasing the productivity of the cassava food system can help both the rural and urban poor by driving down real (inflation-adjusted) cassava prices over time. However, since Africa's independence in the 1960s, cassava has been neglected by African policy-makers and international donor and development agencies because cassava is erroneously considered an inferior food, the consumption of which will decline if incomes increase in Africa. It is now time to focus sustained African and donor attention on the entire cassava production and utilization system and develop action plans to accelerate the cassava transformation. The solution to poverty and low returns to the men and women engaged in cassava production and processing is to concentrate on introducing improved varieties, agronomic practices, labour-saving harvesting and processing technologies and finding new industrial uses for cassava. There is a need to remove subsidies on imported rice and wheat in order to provide a level playing field for cassava in the food system.

Table 7. Percentage distribution of cash income of cassava producing households by source in Côte d'lvoire, Ghana, Nigeria, Tanzania and Uganda, 1992

Source	Côte d'lvoire	Ghana	Nigeria	Tanzania	Uganda
Cash Income Per capita (US$)	**114**	**108**	**177**	**51**	**48**
	Percentage				
Food crops	**15**	**55**	**55**	**16**	**28**
Cassava	5	13	12	4	6
Maize	2	13	8	3	8

Source	Côte d'lvoire	Ghana	Nigeria	Tanzania	Uganda
Rice	5	3	6	2	2
Yam	1	5	8	0	0
Cooking banana	0	0	0	3	2
Plantain	2	4	1	0	1
Sweet potato	0	0	1	0	2
Other food crops	0	17	19	4	7
Other crops*	**76**	**21**	**20**	**25**	**11**
Livestock	**3**	**3**	**7**	**4**	**7**
Non-farm	**6**	**21**	**18**	**55**	**54**
Total	**100**	**100**	**100**	**100**	**100**

US$ 1 = 266 CFA; 430 Cedi; 17 Naira; 285 Tsh.; 1 118 Ush
* *Other crops means industrial crops such as cotton, etc. and tree crops such as cocoa, coffee, oil palm, etc.*
Source: COSCA study

Table 8. Percentage of COSCA study households which earned cash income from food crops in the Côte d'lvoire, Ghana, Nigeria, Tanzania and Uganda

Crop	Côte d'lvoire	Ghana	Nigeria	Tanzania	Uganda
	Percentage				
Cassava	39	73	40	22	42
Maize	27	63	35	16	31
Rice	13	11	17	1	0
Yam	13	43	24	0	4
Cooking banana	1	3	0	9	13
Plantain	26	33	15	0	0
Sweet potato	1	1	7	6	18

Source: COSCA study

Without question, increased cassava production is a powerful but incomplete engine of rural economic growth. The fuel that drives the cassava transformation is the introduction of biological and mechanical technologies coupled with institutional innovations and balanced food policies. The introduction of new technology creates new bottlenecks which have to be broken by further innovations and changes in policies. Several examples illustrate this substitution process at work. The spread of the TMS varieties in Nigeria has shifted the labour constraint from the production to the harvesting task. The biological control of the mealybug shifted the control programme to the green spider mite and to the Ugandan variant of the mosaic disease. Likewise, the substitution of mechanized for hand grating has shifted the labour constraint to peeling. The lack of knowledge of the *gari* preparation technology has restricted its use in the Congo, Tanzania and Uganda. Finally, the lack of the knowledge of how to prepare cassava leaves has prevented consumers in Côte d'lvoire, Ghana, Nigeria and Uganda from taking advantage of the nutritional value of the cassava leaves in their diets.

The TMS story illustrates the substitution process at play. The TMS varieties have boosted yield by 40 percent without fertilizer application. Cassava producers in Nigeria are demanding mechanized harvesting technology to reduce the harvesting labour bottleneck created by the high yield of the TMS varieties. The TMS varieties attain a maximum yield in 15 months after planting but commercial farmers in Nigeria are demanding varieties that will achieve a maximum yield in 12 months or less in order that they can practice continuous cultivation of cassava.

To address the new bottlenecks that emerge with the cassava transformation, research and diffusion should be broadened beyond plant breeding and plant protection to include the following:

- the development and diffusion of labour-saving technologies for harvesting cassava;
- the development and diffusion of labour-saving methods for peeling cassava;
- development of the market pulls for cassava by improving roads;
- development of industrial uses for cassava;
- the diffusion of labour-saving cassava grating technologies to regions and countries where such technologies do not exist;
- the diffusion of *gari* preparation methods to regions and countries where such methods do not exist;
- the diffusion of methods to prepare cassava leaves in regions and countries where such methods do not exist;
- an in-depth study of industrial uses for cassava in the major cassava producing countries in Africa.

Country specific cassava transformation strategies are needed because the role of cassava varies significantly among African countries depending on the country's stage in the cassava transformation, cultural factors, agro-ecologies and market opportunities. This variation will determine whether cassava improvement strategies should emphasize one or more of the above-mentioned measures.

Table 9 identifies challenges for the six COSCA study countries that are consistent with the cassava sector development in each country. In both Ghana and Nigeria, the development of labour-saving mechanical harvesters and peelers will help make cassava more competitive with food grains in urban markets and with other plant starches that are used in livestock feed and as raw materials in industries. Also cassava varieties that can attain a maximum yield in less than twelve months will enable commercial farmers to grow cassava under continuous cultivation. To utilize the expanded production from the TMS varieties and improved agronomic practices, both Ghana and Nigeria need to more aggressively pursue new uses for cassava. International donor agencies should finance projects to develop new cassava food products and industrial uses such as preparing dried cassava roots malt for beer brewing, cassava syrup concentrate for soft drinks, small-scale cassava-based alcohol/ethanol production and manufacturing and utilizing cassava starch.

Table 9. Country specific challenges for cassava sector development

Country	Policy Challenges	Genetic Research, Plant Protection, Agronomic Practices and TMS Diffusion	Food Preparation and Processing
Nigeria	- Research and development support for increasing the use of cassava in industry	- Develop varieties that attain a maximum yield in less than 12 months - Develop labour-saving technology for cassava harvesting	- Develop labour-saving method for toasting *gari* - Diffuse the cassava leaves preparation method
Ghana	- Research and development support for increasing the use of cassava in industry	- Develop varieties that attain maximum yield in less than 12 months - TMS multiplication and diffusion - Develop labour-saving technology for cassava harvesting	- Develop labour-saving method for toasting *gari* - Diffuse the cassava leaves preparation method
Uganda	- Research and development support for increasing the use of cassava in industry	- TMS multiplication and diffusion - Develop labour-saving technology for cassava harvesting	- Diffuse *gari* preparation methods - Diffuse mechanized grater technology - Diffuse the cassava leaves preparation method
Côte d'lvoire	- Eliminate subsidies on imported rice and wheat	- TMS multiplication and diffusion - Develop labour-saving technology for cassava harvesting	- Develop a grater that is suitable for *attieke* processing Diffuse the cassava leaves preparation method
Tanzania	- Improve road access to urban market centres		- Diffuse *gari* preparation methods - Diffuse the mechanized grater technology
Congo	- Improve civil stability - Road access to urban market centres - Eliminate import subsidies on rice and wheat		- Diffuse *gari* preparation method - Diffuse the mechanized grater technology

Source: Nweke et al. 2001

In Uganda, research, government, NGOs and donor agencies are struggling with the devastating cassava mosaic disease by introducing the TMS varieties. TMS varieties are reported to be spreading and farmers are getting higher yields (World Bank, 2001). Government, NGOs and international donor agencies in Uganda should continue to address disease control. The diffusion of *garb* preparation methods and the mechanized grater should be promoted because they can reduce processing costs and expand the urban demand for cassava. NGOs and donor agencies should support a pilot project on using cassava as a raw material in beer malt, syrup concentrate for soft drinks and ethanol industries as well as development of the cassava starch as a raw material for other industries.

In Côte d'lvoire, the "market pull" of cassava can be increased by eliminating the subsidies on imported rice and wheat. A grater for making *attieke* needs to be developed to reduce the cost of a product which has a strong urban demand. In Tanzania, maize is the preferred staple and cassava is a famine-reserve crop. The diffusion of the *gari* preparation technology and the mechanized grater can help cassava compete in the urban market. International donor agencies should support pilot activities to find non-food uses for cassava. In the Congo, increasing market pull by improving roads and the removal of subsidies on imported rice and wheat will help cassava farmers tap new rural and urban markets.

The survey of industrial uses for cassava in Nigeria that was undertaken by COSCA researchers in early 2001 should be supplemented with an in-depth study of industrial uses for cassava in the major cassava producing countries in Africa.

REFERENCES

Alyanak, Leyla. 1997. A modest grater means safer and quicker cassava in Uganda. News Highlights. News/1997/970508-e.rtf. FAO, Rome.

Asadu, C.L.A. & Nweke, Felix, I. 1998. The soils of cassava-growing areas in sub-Saharan Africa. COSCA Working Paper No. 18. Collaborative Study of Cassava in Africa, IITA, Ibadan.

Berry, S.S. 1993. Socioeconomic aspects of cassava cultivation and use in Africa: Implication for the development of appropriate technology. COSCA Working Paper No. 8. Collaborative Study of Cassava in Africa, IITA, Ibadan, Nigeria.

Blackie, Malcolm, J. 1990. "Maize, Food Self-sufficiency and Policy in East and Southern Africa." Food Policy 15:383–394, October.

Bokanga, M. & Tewe, O.O. 1998. Cassava: A premium raw material for the food, feed and industrial sectors in Africa. Pages 54–60 in Post-harvest technology and commodity marketing. Proceedings of a post-harvest conference, 2 November to 1 December 1995, Accra, Ghana by R.S.B. Ferris (editor). IITA, Ibadan.

Boserup, Ester. 1981. Population and Technological Change: A Study of Long-Term Trends . Chicago: University of Chicago Press.

Byerlee, Derek & Eicher, Carl, K. (eds). 1997. Africa's Emerging Maize Revolution. Lynne Rienner, Boulder, London.

Carter, S.E. & Jones, P.G. 1989. COSCA site selection procedure. COSCA Working Paper No 2. Collaborative Study of Cassava in Africa, IITA, Ibadan.

Dahniya, M.T. 1983. Evaluation of cassava leaf and root production in Sierra Leone. Proceedings of the International Society for Tropical Root Crops, Lima.

Davesne, A. 1950. Manual d'agriculture (Paris).

Delfloor, Isabelle. 1995. Factors governing the bread-making potential of cassava flour in wheatless bread recipes. Ph.D. dissertation, Katholieke University, Leuven.

Eggleston, G. & Omoaka, P. 1994. Alternative breads from cassava flour. Pages 243 to 248 in Tropical root crops in a developing economy by F. Ofori and S.K. Hahn (editors). Proceedings of the Ninth Symposium of the International Society for Tropical Root Crops, 20–26 October 1991, Accra, Ghana. International Institute of Tropical Agriculture, Ibadan.

Enete, Anselm, Nweke, Felix, I. & Okorjim Eugene, C. 1995. Trends in food crops yields under demographic pressure in sub-Saharan Africa: The case of cassava in southeast Nigeria. Outlook on Agriculture. Volume 24, No. 4. pp. 249–254.

Ezemenari, Kene, Nweke, Felix I. & Strauss, John. 1998. Consumption patterns and expenditure elasticity of demand for food staples in rural Africa: Focus on cassava growing area. Draft COSCA Working Paper, Collaborative Study of Cassava in Africa. IITA, Ibadan.

Ezumah, N.N. & Domenico, C.M.D. 1995. Enhancing the role of women in crop production: A case study of Igbo women in Nigeria. World Development 23(10): 1731–44.

Fresco, L. 1986. Cassava in shifting cultivation: a systems approach to agricultural technology development in Africa: Royal Tropical Institute, Amsterdam, the Netherlands.

Grace, M.R. 1977. Cassava processing. FAO Plant Production and Protection Series No. 3. Food and Agriculture Organization of the United Nations, Rome.

Graffham, Andrew & Westby, Andrew. 1999. Cassava Chips, global opportunities, case study: Ghana. Pages 130–136 in Global cassava market study: Business opportunities for the use of cassava (dTp Studies Inc.). The Global Development Cassava Strategy Validation Forum, 28 April 2000, FAO, Rome.

Hahn, S.K. 1984. Tropical root crops: Their improvement and utilization. Conference Paper 2. IITA, Ibadan.

Hahn, S.K. 1989. An overview of African traditional cassava processing and utilization. Outlook on Agriculture 18(3): 110–118.

Harrison, B.D., Liu, Y.L., Zhou, X., Robinson, D.J., Calvert, L., Munoz, C. & Otem-Nape, G.W. 1997. Properties, differentiation and geographical distribution of geminiviruses that cause cassava mosaic disease. African Journal of Root and Tuber Crops. Volume 2 (1 and 2). Pages 19–22. International Society for Tropical Root Crops - African Branch (ISTRC-AB). Ibadan, Nigeria.

Hendershott, C.H., *et al.* (eds.) 1972. A Literature Review and Research Recommendations on Cassava, Manihot esculenta, Crantz, University of Georgia, Athens, Georgia, USA.

Herren, H.R., Neuenschwander, P., Hennessey, R.D. & Hammond, W.N.O. 1987. Introduction and dispersal of *Epidinocarisi lopezi* (Hym. Encytidae), an exotic parastoid of cassava mealybug, *Phenococcus manihoti* (Horn. Pseudococcidae) in Africa. Agriculture, Ecosystems and Environments. Volume. 19. Pp.131–144.

IF AD (International Fund for Agricultural Development) and FAO (Food and Agriculture Organization of the United Nations). 2000. The world cassava economy: Facts and outlook. Rome. 31 pp.

IITA (International Institute of Tropical Agriculture). 1998. IITA (International Institute of Tropical Agriculture) Annual Report and Research Highlights for 1987–88. IITA, Ibadan, Nigeria. 161 pages.

Ikpi, Anthony E. 1989. Cassava development in Nigeria. Pages 1–15 in Cassava: Lifeline for the rural households. Edited by Anthony E. Ikpi and Nathalie D. Hahn. UNICEF, Lagos.

Ikpi, Anthony E. 1989a. Economic considerations of cassava development. Pages 117 – 125 in Cassava: Lifeline for the rural households. Edited by Anthony E. Ikpi and Nathalie D. Hahn. UNICEF, Lagos.

Irvine, F.R. 1953. A text book of West Africa agriculture, soils and crops. London.

Jones, W.O. 1959. Manioc in Africa. Food Research Institute, Stanford University, Stanford, USA.

Lagemann, J. 1977. Traditional African farming systems in Eastern Nigeria. African Studies. 98. Weltforum Verlag. Munchen.

Latham, M.C. 1979. Human Nutrition in Tropical Africa, FAO, Rome.

Lutaladio, N.B. & Ezumah, H.C. undated. Cassava leaf harvesting in Zaire (Congo). M'vuazi.

McCalla, Alex, F. 1999. Prospects for food security in the twenty-first century: with special emphasis on Africa. Agricultural Economics 20(95–103).

Mellor, John, W., Delgado, C. & Blackie, M. eds., 1987. Accelerating Food Production in Sub-Saharan Africa . Baltimore: Johns Hopkins University Press. Keys: AGRICULTURAL DEVELOPMENT

Nweke, Felix, I., Spencer, Dunstan, S. & Lynam, John, K. 2001. The Cassava Transformation: Africa's best kept secret. Michigan State University Press, East Lansing.

Nye, P.H. & Greenland, D.J. 1960. The soil under shifting cultivation. Herpenden, England, Commonwealth Bureau of Soils, Tech. Comm. 51.

Odurukwe, S.O. & Oji, U.I. 1981. The effects of previous cropping on yields of yam, cassava and maize. Pages 116–119 in Tropical Root Crops: Research Strategies for the 1980s. Proceedings of the First Triennial Symposium of the International Society for Tropical Root Crops - African Branch (ISTRC-AB), 8–12 September 1980, Ibadan, Nigeria. International Development Research Centre, Ottawa.

Okigbo, Bede, N. 1980. Nutritional implications of projects giving high priority to the production of staples of low nutritive quality. The case of cassava in the humid tropics of West Africa. Food and Nutrition Bulletin, 2(4). United Nations University, Tokyo.

Okigbo, Bede, N. 1984. Improved permanent production systems as alternative to shifting intermittent cultivation. Page 1–100 *in* Improved production systems as an alternative to shifting cultivation. FAO Soils Bulletin 53. Soils Resources Management and Conservation Service, Land and Water Development Division, Food and Agriculture Organization of the United Nations, Rome, Italy.

Okorji, E.C. 1983. Consequences for agricultural productivity of crop stereotyping along sex lines: a case study of four villages in Abakaliki area of Anambra state. M.Sc. thesis, Department of Agricultural Economics, University of Nigeria, Nsukka, Nigeria.

Onabolu, A., Abass, A. & Bokanga, M. 1998. New food products from cassava. International Institute of Tropical Agriculture, Ibadan, 40 pp.

Onwueme, I.C. 1978. The tropical tuber crops. John Wiley and Sons, New York, USA.

Otim-Nape, G.W. 1995. Personal communication.

Otim-Nape, G.W., Bua, A., Thresh, J.M., Baguma, Y., Ogwal, S., Ssemakula, G.N., Acola, G., Byabakama, B., Colvin, J.B., Cooter, R.J. & Martin, A. 2000. The current pandemic of cassava mosaic virus disease in East Africa and its control. Chatham, UK Natural Resources Institute.

Otoo, John & Afuakwa, J.J. 2001. Email message, February 27.

Pinstrup-Anderson, Per, Pandya-Lorch, P. & Rosegrant, Mark, W. 1999. World food prospects: Critical issues for the early twenty-first century. 2020 Vision, Food Policy Report, International Food Policy Research Institute, Washington, D. C.

Ratanawaraha, C, Senanarong, N. & Suriyapan, P. 1999. Status of cassava in Thailand: Implications for future research and development. The Global Cassava Development Strategy Validation Forum. FAO, Rome.

RMRDC (Raw Materials Research and Development Council). 1996. Update on techno-economic survey of the multi-disciplinary task force on textile, weaving apparel and leather sector. RMRDC, Abuja.

Rossel, H.W., Changa, CM. & Atiri, G.I. 1994. Quantification of resistance to African cassava mosaic virus (ACMV) in IITA improved mosaic-resistant cassava breeding materials. Pages 280–287 *in* Food crops for food security in Africa, edited by M.O. Akoroda. Proceedings of the Fifth Triennial Symposium of the International Society of Tropical Root Crops-Africa Branch (ISTRC-AB). 22–28 November 1992. ISTRC/CTA/IITA. Ibadan, Nigeria.

Satin, M. 1988. Bread without wheat. New Scientist. 28 April. Pp. 56–59.

Scott, Gregory, J., Rosegrant, Mark W. & Ringler, Claudia. 2000. Roots and tubers for the 21st century: Trends, projections and policy options. Food, Agriculture and Environment Discussion Paper 31, International Food Policy Research Institute (IFPRI), Washington D.C.

Spencer and Associates, Dunstan. 1997. Cassava in Africa: Past, present and future. The Global Cassava Development Strategy Validation Forum, FAO, Rome.

Tewe, O.O. & Bokanga, M. 2001, Unpublished data.

Tollens, E. 1992. Cassava marketing in Zaire - an analysis of its structure, conduct and performance. Katholieke Universiteit Leuven, Belgium (Mimeograph).

Vilpoux, Olivier & Ospina, Marco Tulio. 1999. Cassava foods, global opportunities, case study: Brazil. Pages 12–24 in Global cassava market study: Business opportunities for the use of cassava (dTp Studies Inc.). The Global Development Cassava Strategy Validation Forum, 28 April 2000, FAO, Rome.

World Bank. 1999. World development report, 1999/2000. The World Bank, Washington D.C.

World Bank. 2000. Women: Key to African development. News Release No: 2000/340/AFR. The World Bank, Washington D.C.

Yaninek, J.S. 1994. Cassava plant protection in Africa. Pages 26–37 *in* Food crops for food security in Africa, edited by M.O. Akoroda. Proceedings of the Fifth Triennial Symposium of the International Society for Tropical Root Crops-Africa Branch ISTRC-AB, ISTRIC/CTA/IITA, Ibadan, Nigeria.

CASSAVA IN AFRICA: PAST, PRESENT AND FUTURE

Prepared by

Dunstan Spencer and associates
Sierra Leone

1 INTRODUCTION

Cassava was introduced to Africa by the Portuguese during the late 16th century. It was readily adaptable to the different environmental conditions and well suited for integration into the farming systems and socioeconomic conditions of Africa. The crop is grown in African countries, stretching from the Island of Madagascar in the southeast to Senegal and the Cape Verde Islands in the northwest.

At a time when a variety of approaches to poverty alleviation are being considered by governments in the developing world and their development partners, increased attention is being paid to the potential of cassava as a food security, as well as a cash crop. For full potential of the crop to materialize, there is general agreement that there is a need for a global strategy for cassava development (IFAD, 1996). The strategy should highlight the national and global perspectives related to markets and end products, as well as achievements and lessons learned from developments so far. It would indicate the prospects for substantial public and private investment programmes and include a research agenda.

The International Fund for Agricultural Development (IFAD) is playing a leading role in the development of the strategy. A number of country case studies, regional reviews and cross-cutting thematic studies are being undertaken to provide the necessary building blocks for the global strategy. The International Institute of Tropical Agriculture (IITA) has the responsibility of preparing the regional review for sub-Saharan Africa (SSA).

1.1 OBJECTIVES OF THE REGIONAL REVIEW

The purpose of this review is to analyse the trends of cassava production and utilization and identify constraints to and opportunities for, the development of cassava in Africa. The study will identify and quantify the most significant trends in the region. It will provide a bridge between the country case studies and the thematic reviews. Building on existing data the review attempts to present a picture of how the crop is affected by policies and how it will develop in the future in terms of its contribution to poverty alleviation, equity, food security and environmental impact, with a view to developing a set of priorities for future action.

1.2 SOURCES OF DATA

The review uses a commodity production-consumption framework for its analysis. It is based solely on secondary data. Production and trade statistics are from the Food and Agriculture Organization of the United Nations (FAO), as contained in the World Agricultural Trade Indicators (WATI) and other databases. Although for some variables these statistics are not altogether reliable, they provide the only consistent global statistics for analyses of trends.

Most of the data used for analyses of characteristics of the commodity are from the Collaborative Study of Cassava in Africa (COSCA) database, in IITA, Ibadan, Nigeria and the Environmentally Sustainable Cassava Plant Protection (ESCaPP) database in IITA, Cotonou, Benin,. Published material from COSCA and regional cassava research and development networks have also provided useful information.

COSCA began in 1989 in six countries, namely Côte d'Ivoire, Ghana, Nigeria, Tanzania, Uganda and Zaire and later expanded to include Benin,, Burundi, Cameroon, Kenya, Malawi, Rwanda and Zambia. These countries include all the cassava growing agro-ecological zones, demographic and climatic conditions that influence cassava production and consumption in sub-Saharan Africa. The study was executed in three phases. The first was a broad characterization of the environment (physical, social, economic), production, processing, marketing and consumption situation. The second phase dealt in more detail with yield, land area, crop utilization (sale or home use, processed or fresh use) and input/output relationships, etc. The third phase involved detailed studies on post-harvest issues such as characterization of processing techniques, product quality assessment (nutrition, toxicity, quality), marketing, consumption and demand.

Villages in COSCA were statistically selected using a stratified random sampling technique of cassava growing areas (Carter and Jones, 1989), based on climate, human population density and market infrastructure. In Phase I, group interviews of farmers were conducted by national agricultural research scientists in each of the countries. In Phase II field surveys were conducted during which fields were measured and yields estimated using 20 m^2 or 40 m^2 plots. Phase III surveys were conducted at the household level. Male and female household members were interviewed using structured questionnaires.

ESCaPP data collection was carried out in four countries, namely Benin, Cameroon, Ghana and Nigeria. Data collection methodologies were similar to those of COSCA, although they focused more on plant health management issues.

1.3 OUTLINE OF THE REPORT

The next section of the review briefly describes the cassava production to consumption system, sketching out the main elements that should be covered in a review. In Section III cassava production trends are examined, focusing on changes in area under cultivation, yield, resources used by farmers and constraints that they face. In Section IV the role of cassava as a food security crop is examined, followed by an assessment of the environmental effects of the crop in Section V. The sixth section discusses infrastructure and product markets, focusing on access to markets and post-harvest technologies and processes. Section VII addresses the role and progress in research and extension systems. The final section presents the major conclusions for the future development of the crop, including the identification of research issues.

2 THE CASSAVA SYSTEM

Figure 1 presents a schematic representation of the cassava production to consumption system in sub-Saharan Africa. Over 90 percent of production takes place in small farms.

Inputs cover the whole spectrum for agricultural production in Africa. Imported inputs consist of small hand tools used by small-scale farmers, tractors, machinery, fertilizer and other agricultural chemicals, used mainly by medium- and large-scale farmers.

Large-scale agro-industries, which produce fertilizer, agricultural chemicals and farm production machinery (tractors, ploughs, etc.) are widespread in sub-Saharan Africa. Small-scale and artisan agro-industries that produce hand tools and processing machinery are more important in the cassava system and provide a link to the industrial sector.

Roots are transported by head load, as well a by trailers and small trucks, where the road network allows them to be used. Cassava roots are processed into a wide variety of products for human and industrial consumption, ranging from simple boiling, to fermented products and beverages. Most of the products are consumed domestically within the countries in which they are produced. However, there is a small but growing export trade in dried cassava chips and other industrial products.

Agricultural policies affect the cassava system at different stages and in different ways. The system contributes significantly to employment creation and income generation. It has an impact on the environment and its development will be affected by infrastructure constraints especially the state of the rural road network.

Each of the components of the systems and the processes that affect them are discussed in other sections of this report.

Figure 1. The cassava production to consumption system in sub-Saharan Africa