

CASSAVA DEVELOPMENT IN NIGERIA

A Country Case Study towards a Global Strategy for Cassava Development

Prepared by

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1 ACKNOWLEDGEMENTS

Sincere gratitude is expressed to the Honourable Minister for Agriculture, the Director-General, Federal Ministry of Agriculture and Natural Resources and the Federal Director of Agriculture, Mr O.A. Edache, for their encouragement and support to undertake this case study. The financial support provided by the Federal Government for this study and the development of cassava in Nigeria, particularly the Cassava Multiplication Project (CMP) is acknowledged.

Thanks are also expressed to Mr Felix I. Nweke, Messrs O.M. Jimoh and Goke Oladapo, the staff of CMP and participants of the workshop at CMP, Ijebu Ife, for discussing this report and their invaluable contributions.

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2 EXECUTIVE SUMMARY

As part of the IFAD global strategy, Nigeria was selected to conduct a country case study along with other nations to analyse the past and present situation of cassava in Nigeria, with a view to describing the lessons learned from past development interventions and their implications for a strategy for future investment in cassava research and development.

The study was carried out using a combination of approaches, intensive use of literature review and quantitative secondary data and Rapid Rural Appraisal methodology.

The study revealed that cassava is one of the most important crops in Nigeria, playing a dominant role in the rural economy in the southern agro-ecological zones and is increasingly gaining importance in other parts of Nigeria.

Nigeria is currently the largest producer of cassava in the world with an annual output of over 34 million tonnes of tuberous roots. Cassava production has been increasing for the past 20 or more years in area cultivated and in yield per hectare. On average, the harvested land area was over 80 percent higher during 1990–1993 than during 1974–1977.

The growth in cassava production has been primarily due to rapid population growth, large internal market demand, complemented by the availability of high yielding improved varieties of cassava, a relatively well developed market access infrastructure, the existence of improved processing technology and a well-organized internal market structure.

Cassava is produced largely by small-scale farmers using rudimentary implements. The average land-holding is less than two hectares and for most farmers, land and family labour remain the essential inputs. Land is held on a communal basis, inherited or rented; cases of outright purchase of land are rare. Capital is a major limitation in agriculture; only few farmers have access to rural credit.

Almost all farmers in the main cassava belts of the southeastern, southwestern and central zones grow cassava, which is typically intercropped as a main or minor crop. Rotation and fallow systems are the traditional systems used by the farmers to maintain soil fertility but population pressure has resulted in reduced fallow, continuous cropping and reduced soil fertility. Farmers are generally aware of the benefit of inorganic fertilizer, but the commodity is scarce and a major constraint in cultivating improved varieties.

Almost all the cassava produced is used for human consumption and less than 5 percent is used in industries. As a food crop, cassava fits well into the farming systems of the smallholder farmers in Nigeria because it is available all year round, thus providing household food security. Compared to grains, cassava is more tolerant to low soil fertility and more resistant to drought, pests and diseases. Furthermore, its roots store well in the ground for months after maturity.

Cassava is important, not just as a food crop but even more so as a major source of cash income for producing households. As a cash crop, cassava generates cash income for the largest number of households, in comparison with other staples, contributing positively to poverty alleviation.

Cassava is usually consumed in processed forms. Cassava processing by traditional methods is labour-intensive but the application of improved processing technology has reduced processing time and labour and encouraged further production. Industrial utilization of cassava products is increasing but this accounts for less than 5 percent of the total production.

Women play a central role in cassava production, processing and marketing, contributing about 58 percent of the total agricultural labour in the southwest, 67 percent in the southeast and 58 percent in the central zones. They are almost entirely responsible for

processing cassava which provides them with additional income-earning opportunity and enhances their ability to contribute to household food security.

Government intervention and the efforts of non-governmental organizations in the cassava subsector have led to a number of measures that support the production, processing and marketing of cassava, dating back to the 1970s. These include government programmes such as the National Accelerated Food Production Programme (NAFPP), Operation Feed the Nation (OFN), the Agricultural Development Projects (ADPs), the development of the National Agricultural Research Systems and their close collaboration with the International Institute of Tropical Agriculture (IITA) and other international agricultural research centres and large-scale planting material multiplication and distribution facilitated by the IFAD-assisted Cassava Multiplication Programme (CMP) and activities of oil companies and church organizations.

Through these efforts, appreciable progress has been made in genetic improvement, agronomic practices, root storage and in the development of processing technology and rural infrastructure. Concerted efforts have also been made to introduce improved practices to farmers. Thus, improved varieties now occupy approximately 0.75 percent of cassava land area and several labour-intensive operations in processing, notably grating, dewatering and milling, have been mechanized. This has had a great effect on cassava land area expansion and production growth. Despite the rapid growth in cassava production, the cassava subsector in Nigeria is still constrained by a number of factors, namely pests and diseases, agronomic problems, shortage of planting materials, inconsistent policy measures, poor market access, limited diversification of processing options, inefficient extension delivery system and inadequate access to improved processing technology.

Consequently, future intervention strategies should include the following:

- development, rapid multiplication and dissemination of improved varieties to enhance the availability and diversity of improved planting materials;
- development and extension of improved agronomic practices for cassava production;
- deliberate efforts to support the development of cassava processing prototypes and identification of applicable and useful technologies and incentives for local entrepreneurs to fabricate them. This will save labour and improve the efficiency of processing, raise the quality and enhance marketability of products. The design of such machines should be gender-sensitive, bearing in mind the cardinal role of women in processing;
- strengthening of extension-farmer linkage with research to facilitate the ongoing spread of cultivars, management practice and processing techniques. This should lead to the mobilization of farmers through emphasis on a participatory development approach, family- or group-based extension and seed multiplication activities involving due recognition of the role of women in production, processing and marketing and assistance that would enable all farmers to take

- advantage of development programmes as far as possible; adequate and sustained research funding which must be timely released;
- development of new cassava products and packaging techniques for existing and new products;
 - promotion of industrial uses of cassava and diversification of processing options to encourage increased cassava production and enhance rural household income;
 - establishment of a sound macroeconomic policy that would promote sustained cassava development;
 - investment in rural infrastructure (especially feeder roads and water supply) to promote cassava production, processing and marketing; and
 - greater involvement of the private sector and non-governmental organizations in the use of research and technology in cassava production, processing and marketing and in the development of infrastructural facilities.

3 INTRODUCTION

3.1 NIGERIA: GENERAL COUNTRY BACKGROUND

Nigeria covers 924 000 km² on the west coast of Africa; vegetation ranges from tropical forest in the south to the sahel savannah in the north. The country comprises the Federal Capital Territory and thirty-six (36) states. The Federal Government is responsible for economic development policy while the states have jurisdiction over activities confined within their boundaries, including implementation of development projects.

Nigeria has a population of about 120 million people, of which 65 percent is rural-based and is growing at a rate of 2.83 percent per annum. Average population density is about 100 persons/km², ranging from 40/km² in the middle belt and northern states to over 400/km² in some southern states.

Prior to the discovery of oil in the 1970s, agriculture was the mainstay of the Nigerian economy, accounting for about two-thirds of the Gross Domestic Product (GDP). With the oil boom, agriculture's contribution to GDP declined to 25 percent by 1980 and Nigeria moved from being a large exporter to a major importer of agricultural products. Since the mid-1980s, as a result of a decline in oil revenue and policy measures implemented under a Structural Adjustment Programme (SAP), agriculture's contribution to GDP has risen to about 40 percent.

Nigeria's land stretches from latitude 4°N to 14°N and from longitude 3°E to 14°E. Of this area, 71 million ha (77 percent) are considered cultivable; about 32 million ha (45 percent of the total cultivable land area) are cultivated. Annual rainfall ranges from 2 500 mm in the coastal areas to about 500 mm in the far north.

A wide range of agro-ecological conditions allows for very diverse crop production. The northern part of the country is suitable for sorghum, millet, maize, cowpea, groundnut and cotton. The main food crops in the middle belt and the south are cassava, yam,

plantain and maize. Low-lying and seasonally flooded areas are increasingly being used for rice production.

Broadly speaking, the cassava-growing belt falls within three agro-ecological zones of the southeast, southwest and the central areas. The first two zones fall within the humid tropics. The predominant soil types are the ferralitic soils which are rich in free iron but low in mineral reserves and are consequently low in fertility. The central zone lies between the southern and the drier northern agro-ecological zones. The soils are poor, due to leaching from heavy and intense rainfall and so limited fertility is a constraint to agricultural production.

3.2 RATIONALE AND JUSTIFICATION FOR THE STUDY IN NIGERIA

As part of the IF AD global strategy for cassava development, Nigeria has been selected to conduct a country case study among other nations. The selection of Nigeria is largely based on the considerable level of experience in the development, multiplication and processing of cassava into various food, feed and raw material forms and the continued dominance in cassava production. These gains would need to be sustained, especially through a diversification of usage of cassava for industrial purposes, hence this case study would help in formulating a future strategy for the realization of this important goal. The report of this country case study which was carried out across the major cassava-producing states, would provide an easy reference for the various countries to share experiences which may be useful for future project interventions and development strategy in the cassava subsector.

3.3 TERMS OF REFERENCE

The purpose of this study was to analyse the past and present situation of cassava in Nigeria with a view to describing the lessons learned from past development interventions and their implications for a strategy for future investment in cassava research and development.

Specifically, the study investigated the following:

1. A description of the evolution of cassava development in Nigeria, which includes the identification of significant interventions that have influenced evolution. This includes:
 - a. trends in cassava production and utilization between 1987 and 1997 at the national level and by major cassava-producing states within the country;
 - b. major interventions, both at the national and state levels, that have influenced the evolution of the cassava sector, including:
 - changes in the development model adopted by the country (e.g. from a model of import substitution to a model of trade liberalization);
 - changes in import, pricing, of credit policies for cassava or competing commodities;

- investment in cassava research or development, including production, processing and marketing of the crop;
 - investment in infrastructure and services to promote rural development and/or the development of the crop both in service infrastructure (roads, storage facilities, etc.) and processing infrastructure.
2. An analysis of the successes and failures (or limitations) of the interventions identified above in removing the constraints to and/or realizing the opportunities for the development crop. Criteria used for analysing the relative success of each intervention include:
- total economic benefit;
 - return on investment;
 - impact on equity, including gender;
 - adoption or non-adoption of technology;
 - impact on the environment;
 - impact on the development of institutions and organizations associated with the cassava sector.
3. An enumeration of the lessons learned from past experiences.
4. A synthesis of the implications for a future strategy for cassava development in Nigeria.

3.4 METHODOLOGY

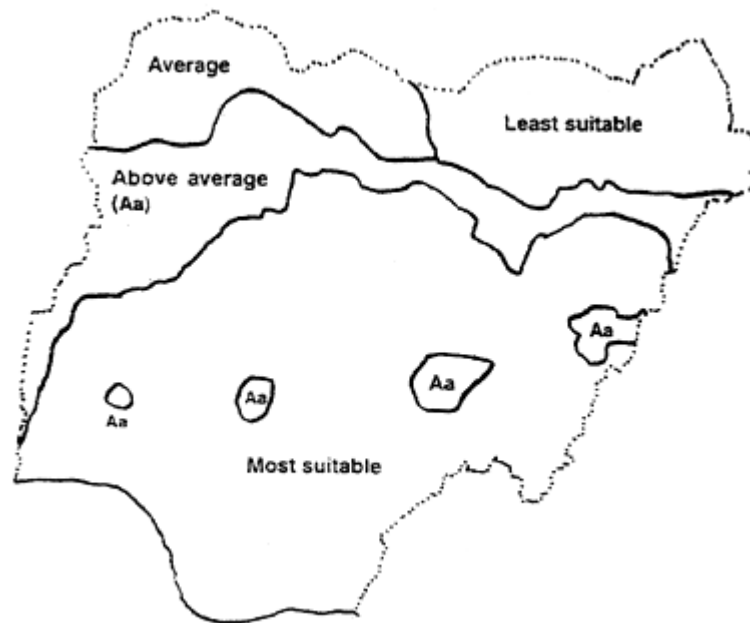
The case study was carried out using a combination of approaches. First, a comprehensive review of existing literature on the organization and management of cassava crop economy in Nigeria was undertaken. Secondly, quantitative information on the area, production, marketing, etc., of cassava was collected from the libraries of major institutions that are active in the cassava subsector as well as through visits and contacts.

To supplement these two approaches, the Rapid Rural Appraisal (RRA) methodology was adopted to provide information that the literature and personal interviews could not supply. This involved collecting information from selected key farmers and some major processors/marketers of cassava.

4 CASSAVA PRODUCTION IN NIGERIA

Cassava is one of the most important crops in Nigeria. It is the most widely cultivated crop in the southern part of the country in terms of area devoted to it and number of farmers growing it. Indeed, it is grown by almost every household. Cassava has also increased in importance in the Middle Belt in recent years. In all places, cassava has become very popular as a food and cash crop and is fast replacing yam and other traditional staples of the area. In all, over four-fifths of the cultivable land area is suitable for cassava growing (Figure 1).

Figure 1. Agro-ecological suitability zones for the cultivation of cassava, based on combined data for soils, mean rainfall, mean temperature, temperature range and the length of growing season in Nigeria



4.1 INTRODUCTION, SPREAD AND ECONOMIC IMPORTANCE

Cassava (*Manihot esculenta* Crantz) was introduced into central Africa from south America in the sixteenth century by the early Portuguese explorers (Jones, 1959). It was probably the emancipated slaves who introduced the cassava crop into southern Nigeria, as they returned to the country from South America via the islands of Sao Tome and Fernando Po. At that time there were Portuguese colonies off Nigeria's shores (Ekandem, 1962). Cassava, however, did not become important in the country until the end of the nineteenth century when processing techniques were introduced, as many more slaves returned home.

Cassava is important, not only as a food crop but even more so as a major source of income for rural households. Nigeria is currently the largest producer of cassava in the world with an annual production of over 34 million tonnes of tuberous roots. Cassava is largely consumed in many processed forms in Nigeria. Its use in the industry and livestock feed, is well known, but is gradually increasing, especially as import substitution becomes prominent in the industrial sector of the economy. As a cash crop, cassava generates cash income for the largest number of households in comparison with other staples (Table 1). It is produced with relevant purchased inputs as frequently as and in some cases more frequently than other staples. A large proportion of total production, probably larger than that of most staples, is planted annually for sale.

As a food crop, cassava has some inherent characteristics which make it attractive, especially to the smallholder farmers in Nigeria. First, it is rich in carbohydrates

especially starch and consequently has a multiplicity of end uses. Secondly, it is available all year round, making it preferable to other, more seasonal crops such as grains, peas and beans and other crops for food security. Compared to grains, cassava is more tolerant of low soil fertility and more resistant to drought, pests and diseases. Furthermore, its roots are storable in the ground for months after they mature. These attributes combined with other socioeconomic considerations are therefore what IFAD has recognized in the crop as lending itself to a commodity-based approach to poverty alleviation (FAO/IC, 1995).

Table 1. Percentage distribution of food crop cash income of households producing major crops

Food Crops	Cassava		Yam		Sweet potato		Plantain		Maize		Rice	
	N	%	N	%	N	%	N	%	N	%	N	%
Cassava	329	21	269	23	90	14	176	26	315	19	124	14
Yam	269	15	276	18	75	14	168	16	266	13	93	13
Sweet potato	90	1	75	1	95	1	43	1	94	0	59	0
Plantain	176	1	43	2	43	1	181	3	175	1	47	0
Maize	315	14	94	13	94	8	175	15	343	13	139	II
Rice	124	12	59	12	59	10	47	9	139	15	143	24
Others	-	34	-	31	-	52	-	30		39		38
Total	-	100	-	100	-	100	-	100	-	100	-	100

Source: Nweke *et al.*, 1997

N—Number of producers

Others include millets, sorghum, beans and peas

The socioeconomic importance of cassava and the accidental introduction of cassava mealybug which ravaged most cassava fields in the major producing areas led to the Government's direct intervention in the subsector, in the implementation of the IFAD-assisted Cassava Multiplication Project (CMP) between 1987 and 1996.

In the early 1980s, Nigerian cassava production fell drastically due to the combined effects of pests (mealybug and green spider mite) and diseases (mosaic virus and cassava bacterial blight), thereby posing a threat to national food security. In response, IFAD initiated the CMP as a parallel-financed part of the World Bank-assisted MSADP-L. The overall objective of the CMP was to multiply, promote and distribute improved varieties to farmers so as to improve productivity and income.

4.2 TRENDS IN CASSAVA PRODUCTION

Cassava production in the country has been increasing for the past 20 or more years. A recent survey of the cassava-growing areas shows that in more than 90 percent of the 65 representative villages, the farmer group respondents reported an increasing trend in cassava production over the 20 years prior to the interview in 1989 (Nweke *et al.*, 1997; Ugwu, 1996). Further analysis of the available production data shows that, on the average annual basis, the harvested land area was over 80 percent higher in 1990–1993 than in 1974–1977. Both the yield and of course, the overall production showed a similar trend.

Total production at present is estimated at over 34 million tonnes (Table 2). With this production level, Nigeria is the largest producer of cassava in the world.

Cassava production was reported to be increasing among villages where cassava, yam, rice, beans or peas, were the most important crops (based on farmers' ranking) in the cropping system (Ugwu, 1996). This implies that cassava was replacing these major crops, including fallow and pasture land in those villages.

Cassava production was reported to be declining in less than 10 percent of the representative villages for reasons connected with losses from livestock (mainly from cattle), pests and diseases and/or declining soil fertility. Unless fenced round, which is prohibitive considering the relatively low value of the crop, cassava fields could be destroyed by cattle, especially during the dry season when pasture is scarce. The villages with declining production trend were mostly located in the non-humid climate zone. Where soil fertility is low in this zone with short rainfall duration, farmers with a limited supply of fertilizer would prefer to grow short duration crops such as millet or sorghum.

Reasons adduced for the increasing trend by the farmer group respondents were rapid population growth and market demand. These two factors are related, since rapid population growth tends to increase market demand. The proportion of villages where cassava was increasing was significantly higher in the high population density zone (95 percent) than in the low population density zone (65 percent) (Ugwu, 1996). This agrees with the “contention that comparison between cassava growing environments and actual cassava distribution in Ghana and Nigeria demonstrates that the distribution of cassava could be primarily a function of population density rather than of agro-ecological considerations” (Stoorvogel and Fresco, 1991).

Table 2. Estimates of annual area cultivated, root yields and total output for cassava in Nigeria during 1986–1996

	1 000 ha cultivated	Yield tonne/ha	Output '000 tonne
1986	1 095	11.3	12 388
1987	1288	10.8	13 876
1988	1347	11.5	15 540
1989	1371	12.7	17 404
1990	1 472	12.9	19 043
1991	2 551	10.2	26 004
1992	2 755	10.6	29 184
1993	2 844	10.6	30 178
1994	2 927	10.6	31005
1995	2 944	10.7	31404
1996	2 546	10.7	31448

Source: FMANR (1997)

Other factors which were not quite evident to the group respondents but which could explain the increasing trend may include: (i) the availability of improved varieties of cassava; (ii) relatively well-developed market access infrastructure; (iii) existence of improved processing technology; (iv) participation of middleperson in cassava marketing; and (v) other market-related factors.

The positive relationship between the above-mentioned factors and the expansion in cassava production may be explained as follows:

- improved cassava varieties were bred for high yield (high dry matter content), pest disease resistance, good product quality and early maturity, among other desired qualities. Cassava root yield is significantly higher for improved than for local varieties (Nweke *et al.*, 1997). Higher root yield will result in larger total production per unit area;
- cassava processing by traditional methods is labour-intensive. Under this system, the relatively low field labour requirement contrasts with the high processing labour demand (Fresco, 1993). This implies that any cost-saving advantage of yield-increasing technology may not fully translate into expanded production if there is no matching cost-saving technology at the processing stage, since cost constraint is merely shifted to the processing stage (Nweke *et al.*, 1997). On the other hand, the application of improved processing technology results in reduced processing time and labour, which, in turn, encourages further production. Nweke (1994) observed that the relationship between the cassava production trend and whether cassava grating or mash pressing machines were available in the village was such that the relative frequency of villages which reported an increasing cassava production trend was high among villages where mash pressing and milling steps were mechanized and 100 percent among villages where mechanized grating had been adopted;
- well-developed market access infrastructure is crucial for cassava marketing. Cassava roots are bulky and with about 70 percent moisture content, are very perishable. It is therefore, expensive to transport cassava especially along poor access roads. Market access is said to be good among villages where farmers go to markets by motor vehicle or where they do so on foot for distances of 10 km or less and poor where they have to travel on foot over 10 km (Nweke, 1994). About 85 percent of the representative villages had good market access Ugwu, 1996.

Good market access also encourages the participation of middleperson in cassava marketing. By so doing, middlepersons relieve farmers of the marketing task, which gives them more time to grow more cassava. Cassava land area and root yield were found to be significantly higher among villages with good market access, but only the cassava land area showed a significant positive relationship with the participation of middlepersons (Ugwu, 1996). These observations imply that improvement in market access infrastructure and the participation of middlepersons in marketing cassava resulted in cassava production growth.

4.3 RESOURCE BASE OF THE FARMERS

4.3.1 Land

Under the Land Use Act of 1978, land is owned by the Government on behalf of the community. However, cultivated land is occupied by individuals and households under customary tenure where land is regarded as the property of the community or extended family, the head of the community acting as the primary trustee or custodian of the farming land. Under the communal system of land ownership, families and individuals acquired right of usage on a first come-first serve basis and such individual usage rights are heritable.

The basic qualification for land ownership is membership of a lineage. Any farmer who wants to farm outside his family land may get land on lease or rent. Payments for rented land range from token amounts to economic rates.

Outright sale of farm land is rare. For most households, ownership of farm land has been acquired through inheritance which is paternal, from father to son(s) or the nearest male relatives. This inheritance procedure and the customary concept of land ownership passes control over land to the household heads. However, in households where Muslim law is practiced, the son, daughter and wives are to share land in the ratio of 4:2:1. In most cases, women have access to land by virtue of their membership in the household as wives, daughters, or sisters. Their commonest access to land is through their husbands, fathers and brothers.

Less than half of available arable land in each agro-ecological zone of the cassava-growing area is put to use at any one time. Even though the area of land under fallow has been on the decreasing side, access to land *per se* is generally not seen as a serious constraint by the farmers. On average, the extent of land under fallow is greater than that under cultivation.

Generally, most of the farmers are smallholders with production primarily oriented towards meeting subsistence needs. They hold about 90 percent of the land and produce more than 90 percent of the agricultural commodities; large-scale farmers account for less than 10 percent of agricultural production. Average cultivated area per farming household ranges from 0.5 ha in the south to 2.5 ha in the central zone (Middle Belt). Traditionally, each farm had double or more of the cultivated area as fallow. However, increasing population pressure is reducing the fallow area and fallow period.

A common feature of the farming system is a subdivision of the farmers' holdings into a number of non-contiguous plots which they use interchangeably or simultaneously for the production of different crops. They usually grow their crops in varied mixtures because their aim is to produce all the crops required by the household and thereby spread the risk in doing so.

Land allocated to crops varies from zone to zone but the general pattern is that of allocating more land to crops of higher relative importance. Farm sizes are larger for cassava in the southern states while yam traditionally takes a larger share of farmland in

the Middle Belt, even here, the land allocated to cassava has been on the increase as cassava has become more popular.

Declining productivity of land is a major source of worry for the farmers. The soils are generally of poor quality, lacking in important nutrients and easily prone to erosion. Farmers have, over the years, through experience and knowledge of the crops and the associated location-specific agro-ecological characteristics, adopted systems of crop rotation and fallow they consider appropriate for their needs. This practice which requires abundant land area is being constrained by land shortage in the face of increasing population pressure on land, especially as the use of available land requires labour or capital and technology which are out of reach to the average farmer.

Generally, a rapidly, growing population has made land-population ratio less favourable in some areas and has led to shortened fallow periods or semi-permanent cultivation. This has made the use of inorganic fertilizers necessary, but most of the farmers do not have access to fertilizers because of distribution problems and inadequate supply.

4.3.2 Labour

Agricultural labour is mainly organized around the families. There is a clearly defined division of labour along gender lines. Agricultural labour is essentially manual and labour-intensive, involving the use of rudimentary equipment - mainly simple tools and equipment such as hoes and cutlasses. Governments at the national state and LGA levels, have attempted to ease the labour constraint problem and stimulate expansion of farms through tractor-hiring services but the tractors are either inaccessible to the poor who need them most or in a state of disrepair. In view of the high cost of tractors and their likely decline in availability, their use by poor farmers is almost out of the question. Moreover, mechanization of farming activities such as land clearing and preparation will be difficult in most of the cassava-producing areas because of heavy rainfall and the dominance of trees and shrubs. Similarly, use of work oxen is difficult because of tsetse fly infestation and the nature of the soil. Thus, considerable efforts in terms of family and hired labour are needed to clear land and prepare it for planting.

Availability of labour within families or capital to hire labour, governs the area of land that can be cultivated and the types of crops that can be grown. While family labour predominates, hired labour is employed during peak periods. Farm labour demand is highest during the period before the onset of the rains and for weeding. Family labour is mostly used as hired labour is expensive because of migration of able-bodied young men and women to the cities in search of other higher paid and attractive jobs or education, leaving an aging farm labour force.

4.3.3 Capital

In addition to the use of rudimentary implements, lack of cash capital is a major factor influencing adoption of improved technology. A common feature in the country is the difficult access to capital from government lending or credit institutions. Only about 1

percent of the farmers are known to have benefited from formal credit schemes. Farmers mainly rely on income from the farm and traditional sources of credit (relatives, friends, money-lenders and cooperative groups). The funds available at this level are limited and cannot meet the credit requirements of the farmers. Also, interest charged on credit obtained from money-lenders can be quite high. The low level of income of poor farmers prevents them from meeting the capital requirements of improved technology. On the whole, the farmers are generally poorly organized and poorly educated and find it difficult to gain access to agricultural support services. Virtually all the farmers interviewed during Rapid Rural Appraisals in Benue, Imo and Ogun States in 1993 and 1995 mentioned capital as a major constraint in their agricultural enterprises.

4.3.4 Production practices

Almost all farmers in the cassava-growing areas grow cassava. It is grown mainly as an intercrop and sometimes as a sole crop. It can be a main crop as well as a minor intercrop (Table 3). The cassava-based cropping systems include cassava/cowpea/vegetables, cassava/bambara nut/vegetables, cassava/cereals/vegetables, etc.

Table 3. Percentage distribution of crop fields by cropping pattern

Crop	No. of fields	Sole	Major	Minor	Total
Cassava	494	36	38	26	100
Yam	163	13	79	8	100
Maize	306	9	13	78	100
Rice	34	82	6	12	100
Sorghum/millet	100	19	41	40	100
Beans/peas	92	20	10	70	100
All crops	1 189	25	35	41	100

Source: Nweke et al. (1997)

Crop rotation and fallow systems are commonly used to maintain soil fertility. Wide variations exist between communities and households in the practice of these systems. However, cassava is usually the last crop in the rotation cycle.

Population pressure on land has reduced fallow periods, leading to greater intensive use of land and increasing problems of soil infertility. Meanwhile, fertilizer is scarce limiting the realization of the full potential of improved varieties. As capital utilization is low, land and labour remain the essential inputs for most farmers.

4.4 CONSTRAINTS IN CASSAVA PRODUCTION

Constraints in cassava production include a wide range of technical, institutional and socioeconomic factors. These include pests and diseases, agronomic problems, land degradation, shortage of planting materials, food policy changes, access to markets, limited processing options and inefficient/ ineffective extension delivery systems.

4.4.1 Pests and diseases

Cassava is plagued by various diseases and insect pests. Pests and diseases including the ACMD, CBB, the mealybug (which has been greatly controlled), green spider mite (GSM) and the large grain borer which attacks dry chips of cassava in storage.

In the 1997 season, the various diseases and pest considered to be most important in seven cassava-producing states were: mosaic disease, bacterial blight, leaf rollers, termites, anthracnose, root rot, mealybugs, spider mites, white flies, rodents and stem girdlers. In different areas of the cassava production zone, one or more pests and/or diseases are important.

White ants (termites) destroy stems that are planted before they sprout. Some areas appear to be very prone to this problem. A higher plant population (12–13 000 plants/ha) is used to compensate for those that would be lost. Various chemical control measures are recommended, but the need for safe use and high costs restricts their use among many small farmers who grow cassava in mixtures. Also the menace of rodents is a regular occurrence in the field.

4.4.2 Agronomic problems

Biotic constraints

- Use of low yielding varieties. The varieties in use by farmers often yield less than 10 tonnes/ha when there are new varieties that can give root yields of over 30–35 tonnes/ha. The local varieties are very susceptible to diseases and pests of cassava although consumers and processors still prefer them for specific uses and characteristics.
- Livestock damage of cassava farms have been widely reported. Thus, the community arrangements to protect farms are made to include as many crops as possible.

Abiotic constraints

- Low soil fertility affects many cassava-growing areas because the fallow periods are shorter as the pressure on arable land near homesteads is increasing. At the fresh tuberous root yield of 30 tonnes/ha (which is feasible under good field practice), the amount of major nutrients removed from the soil at harvest amounts to 164 kg of nitrogen, 31 kg of phosphorus, 200 kg of potassium, 80 kg of calcium and 31 kg of magnesium. Also needed are about 7 kg of a combination of several important microelements, e.g. iron (3.6 kg), manganese (1.4 kg), boron (0.5 kg) and copper (0.2kg) (Asher *et al.*, 1980).
- As the direct use of soil amendments in cassava cultivation is low, the yield potentials of the various varieties of the planted cassava crop are not often attained. The use of organic manure could improve soil properties, but this

technical fact seems not to be economically feasible under the circumstances of most cassava farmers.

4.4.3 Land degradation

The principal causes of land degradation include soil erosion, deforestation and soil spillage. Erosion is a general problem all over the country, especially in the southeastern zone. Desertification resulting from deforestation is peculiar to central, northeastern and northwestern zones, while oil spillage occurs essentially in the oil-producing zones. Each of these processes tends to reduce the productive potential of land and to impair the sustainability of soil fertility.

4.4.4 Shortage of planting materials

The cultivars released for cultivation in Nigeria have not all been extended to farmers. Although 17 have been released (Table 4) only about five of them have been made available to farmers. Out of these five, two varieties; TMS 30572 and 4(2)1425, continue to dominate. This seems to be related to the higher availability of the stems from distribution agencies of government and other partners. Many released varieties are yet to be multiplied on a large-scale and made available. Shortage of planting materials is also compounded by farmers' inability to preserve planting materials.

4.4.5 Food policy changes

In terms of food security and food production incentives there has been no policy consistency. Initially, the availability of oil revenue made it possible for the Government to respond, to food shortages with large-scale importation. The petroleum income also raised a demand for food as well as encouraging rural-urban migration which resulted in farm labour shortage.

The dramatic increases in prices of most tradable agricultural exports that accompanied the devaluation of the naira and the liberalization of exports were not applicable to cassava and cassava products to any significant extent because as a non-tradable staple food product, prices were not directly influenced by world market developments.

The main source of price increases for cassava products on account of SAP and market liberalization policies was indirect, through increases in the prices of substitute products such as rice, wheat and maize. The ban placed on the importation of these tradable products raised the domestic prices, hence reducing their demand, with the result that consumers switched over to the consumption of cassava and cassava products. This culminated in price increases. However, the increases were short-lived because of inconsistent government policies.

There is, thus, evidence of a lack of synergy between macroeconomic and sectorial policies; the macroeconomic policies have not been able to secure macroeconomic

stability, an external balance or a diversified economic base. Consequently, there is a serious inconsistency giving conflicting signals to the farmers.

Poor access also makes movement of goods and people difficult. This is more so during the rainy season when many parts of the rural area are inaccessible. The roads linking the major towns are usually quite good. Though the farmer market access food network is better in Nigeria than in other countries studied by COSCA (Nweke *et al.*, 1992) the rural feeder road networks are poorly developed and absent in some places. This has significant implications for marketing, cost of inputs, access to health facilities and other social services and may therefore have adverse effects on production and rural standards of living.

Table 4. Attributes of the seventeen cassava varieties released for cultivation in Nigeria

Cassava variety	Branching habit	Canopy development	Ecological adaptation	Pest and disease tolerance	Fresh root yield (tonnes/ha)	Dry matter yield (80 C24h)	Gari yield(%)	Starch yield (%)	HCN in products (mg 100g)
TMS 90257	profuse	moderate	wide	high	43	25	23	23	15.5
TMS 84537	moderate	sparse	wide	high	35	28	18	27	6.3
TMS 82/00058	profuse	moderate	wide	high	35	28	21	26	6.4
TMS 82/00661	profuse	moderate	wide	high	39	30		26	4.1
NR8212	profuse	moderate	wide	high	27	37	25	21	high
NR 8082	profuse	profuse	wide	high	32	32	22	19	high
TMS 50395	moderate	moderate	wide	moderate	36	29	24	12	high
TMS 30001	moderate	moderate	wide	moderate	16	28	23	22	low
NR 8208	profuse	moderate	wide	moderate	26	32	25	23	high
NR 8083	profuse	moderate	wide	high	31	43	36	25	high
NR 83107	profuse	moderate	wide	high	22	31	22	19	high
TMS 81/00110	profuse	moderate	wide	high	28	31	24	25	4.5
TMS 91934	moderate	sparse	wide	moderate	32	34	26	21	high
TMS 30572	profuse	profuse	wide	moderate	27	34	25	24	750
TMS 4(2)1425	moderate	profuse	savanna moderate		26	36	25	22	31

TMS 30555	moderate	profuse	wide	moderate	17	32	24	20	high
NR 41044	moderate	profuse	forest	moderate	37	34	25	23	high

The HCN content of the products was determined quantitatively by the enzymic method. Where this was not available, it was determined by the picrate leaf method and therefore reported as either high or low.

4.4.6 Access to markets

Marketing can be a problem for poor farmers who may not have resources to transport their commodities to the market, especially those living in villages with poor feeder roads. Typically farmers transport their farm produce to the market on heads as head loads, on bicycles or in lorries. With poor market access, marketing of cassava can be particularly problematic because of its bulky nature, especially if it is not processed.

4.4.7 Diversification of processing options

Compared with many countries of Africa, there is a wide range of cassava food products in Nigeria. However, industrial demand for cassava is relatively small, probably less than 5 percent of the total production. There is a potential market for cassava products in animal feed, flour and starch industries, but the size of the industrial market is small because of an inadequate supply of cassava products, a weak link between industrial processors and producers of cassava products and a preference for imported starch.

4.4.8 Extension delivery system to farmers

Discernible progress has accrued from the national agricultural research and extension systems. This is reflected in the adoption of some improved varieties of cassava, development of technologies for various farm operations, improved management practices and improved linkage between research, extension and farmers. However, there are still some constraints with the extension delivery strategy. The Unified Agricultural Extension System (UAES) which ensures a single line of command in the dissemination of technologies to the farmer has not been fully implemented for logistic reasons, especially with the cessation of most of the donor funds that were used for the take-off of this policy instrument. The implication of this, therefore, is that limited impact has been made in the non-crop subsectors.

Closely following from this is the shortage of human resources necessary to implement the Training and Visit extension management system. For most ADPs, the target ratio of EAs 1:1 000 farmers could not be realized. This had a negative impact on the effectiveness of the coverage of the various cells/circles in a given locality.

The operation of Research-Extension-Farmers-Linkage-System (REFILS) has been inadequately supplied with inputs such as seeds, fertilizers, etc. Extension mobility is also insufficient to enhance the attainment of the goals of REFILS.

There is the defectiveness in the use of contact farmers as recommended by Benor and Baxter (1986). In principle, contact farmers were expected to have multiplier effects on the adjacent farmers. However, there is insufficient formal feedback to the ADPs and limited spread of extension messages outside the contact farmers.

However, the contact farmers selectively adopt recommended practices and are often unrepresentative of the general farming population. They are usually better off and more able to afford the inputs to implement the new technologies. Only a few contact farmers are able to pass on the information to other farmers on a regular basis, which means that only a few farmers are being exposed to new technologies from research. Besides the occasional field day, there is no systematic way that other farmers in the cell have access to this information.

Furthermore, recent economic changes have caused input prices to rise more rapidly than product prices, reducing profit margins for small-scale processors of cassava products. To ensure that increases in yields bring some benefit to the women who are primary processors of cassava, alternate product markets need to be developed. Products that have a potential for improved market outlets include flour, starch and cassava chips for industry.

Another fundamental problem with extension strategy is the irrelevant nature of some of the recommendations. Quite often, the technological options offered by extension do not fit into the farming system and the socioeconomic conditions under which the rural people are operating. For instance, a broader range of new varieties that match different ecologies and end-user requirements should be developed and released to farmers.

5 CASSAVA UTILIZATION IN NIGERIA

5.1 TRENDS IN CASSAVA UTILIZATION

5.1.1 Contribution of cassava as household food security

The average Nigerian meets about 95 percent of the minimum energy requirements mainly from cereals and roots and tubers, followed by grain legumes. Cereals constitute the highest group of foods produced and consumed in the northern zones of the country while roots and tubers constitute the highest group in the south and central zones. Grain legumes feature more prominently in the food production system in the north and are prominent in both northern and southern food baskets.

Cassava food products are the most important staples of rural and urban households in southern Nigeria. Current estimates show that the dietary calorie equivalent of per capita consumption of cassava in the country amounts to about 238 kcal (Cock, 1985). This is derived from the consumption of *gari* (toasted granules), chips/flour, fermented pastes and/or fresh roots, the principal cassava food forms.

In the south, cassava followed by yam is the staple food. Yam consumption in most of the south is seasonal, being highest in the months of November to January, the period of harvest. Thereafter, cassava products and other supplementary foods take over.

In the Middle Belt yam is the preferred staple in most of the zone followed by cassava. These crops are grown primarily for food and consumed as such but substantial proportions are sold. About 60 percent of yam is consumed while about 40 percent may be sold while 40 percent of cassava is consumed and the rest (60 percent) sold. During the growing season or hungry period, as much as 50 percent of food intake is from cassava along with grains, as less yam is available. The importance of minor tubers (cocoyam and sweet potato) in the daily diet is far less than that of yam and cassava products.

In all locations, cassava has become a very popular crop and is fast replacing yam and other traditional staples of the area, gaining ground increasingly as an insurance crop against hunger. As shown earlier, cassava is also a major cash crop. A large proportion of cassava, probably larger than from most other staples, is planted purposely for sale. In comparison with other staples, cassava generates income for the largest number of households. Planting of high yielding varieties has resulted in higher cash income, especially in areas with access to improved technology and market in Benue Imo and Ogun RRAs suggest that income from the marketing of cassava produce generates up to 34 percent of the total household farm income in Imo and Ogun States and 20 percent in Benue State. Considerable income is also generated from cassava processing. As women are largely responsible for growing and processing cassava, it provides them with an income-earning opportunity, enabling them to purchase commodities which can contribute to household food security.

5.1.2 Industrial utilization of cassava roots

Processing of agricultural products in Nigeria is as old as farming itself. In Nigeria, traditional foods processed at home or in small-scale cottage operations constitute the principal mode of utilization of cassava. Commercial livestock producers are fast adopting the use of cassava processed by-products in livestock feeding, appreciating its great potential in feed formulations. Cassava is also useful in several other industries, such as baking and brewing but the domestic consumption of cassava products has resulted in a limited availability of cassava products for industrial use.

5.2 GENDER ROLES IN CASSAVA PRODUCTION, PROCESSING AND UTILIZATION

In most parts of rural Nigeria, division of labour within the household is gender-specific and according to age. Women play a prominent role in agricultural production. The extent of their involvement in agricultural production and their contribution to the household food basket varies from one ethnic group to another.

However, there are characteristics which are common throughout. They normally do weeding, planting and harvesting but the increased involvement of women in land clearing and preparation, traditionally performed by men, has been necessitated by the migration of men from home for off-farm employment or in part-time work off their farms. Also the reduction of the fallow period has made land clearing and preparation easier and increased women's involvement in such activities.

Overall, women play a central role in cassava production, contributing about 58 percent of the total agricultural labour in the southwest, 67 percent in the southeast and 58 percent in the central zones, with involvement in virtually all activities, hoeing, weeding, harvesting, transporting, storing, processing, marketing and domestic chores (IFAD, 1994).

They are almost entirely responsible for processing agricultural commodities. Women also play a dominant role in marketing of cassava produce. They assist their husbands in marketing cassava and other crops and also market their own crops. In many cases, women buy the agricultural produce from their husbands and other farmers and market this at a profit. At times, they buy cassava in the soil, harvest, process and market.

Small-scale cassava processing is the domain of women, although most of the mechanized equipment (graters and grinders) are owned and operated by men. It is necessary to ensure that the shift from manual to mechanical processing does not put them in a disadvantaged position in terms of employment and income earning opportunities. It is therefore important to consider gender issues in designing mechanized processing facilities.

6 INTERVENTIONS

6.1 CHANGES IN FOOD MARKET DEVELOPMENT

There is a strong demand for cheap food, especially cassava products within Nigeria. Since the mid-1980s, real producer prices have increased as a consequence of devaluation of the Naira abolition of the commodity boards and import restrictions on selected foodstuffs and animal feed. As a result, consumers have shifted from expensive foods such as meat, eggs, bread and rice, towards locally-produced staples such as cassava, maize, sorghum and yam; and farmers have responded by producing more of these crops. Despite this response, some people and some areas suffer from seasonal food deficits.

Cassava production has increased significantly, particularly in the last decade, partly through the adoption of higher yielding varieties, but mostly through an increase in the area cropped with cassava. As noted earlier, current estimates of cassava production are around 34 million tonnes per annum; over 90 percent of this is consumed and about 50 percent of total cassava production is marketed (Nweke *et al*, 1994).

6.2 MARKETING OF CASSAVA

The marketing system for traditional crops including cassava and its products is characterized by fluctuations in supply and the law of supply and demand determines product prices. The current marketing arrangements for cassava and cassava-based products are therefore devoid of government intervention, so the market as it were, operates without distortion. Marketing activities are carried out by private traders who operate in both rural and urban markets.

To forestall early deterioration and also due to its bulky nature, cassava is usually traded in some processed form, generally *gari* or chips/flour. In other words, there is a limited trade in fresh cassava roots.

The marketing channel of *gari*, the most commonly traded cassava product, consists mainly of five alternative flow channels. First there is the movement from the producer through the rural wholesale/assembler and rural market retailer to the rural consumers. The second channel is the movement from the producer through the processor to either the rural assembler or retailer. The third flow channel is the movement from the processor to the urban market wholesalers, retailers and even to the consumers, while the fourth possible channel is that arising directly from the producer to the rural or urban consumers. The fifth channel is from the producer directly to the rural retailers. Currently, the Federal Government has removed the ban on the exportation of yam and cassava products. This barrier has enhanced cross-border trade in cassava products.

6.2.1 Fresh cassava roots

In parts of the north, raw roots of 'sweet types' of cassava are eaten as snacks (*rogo*). Otherwise, most harvested roots are processed. The marketing of fresh cassava roots is directly related to a number of factors. Due to their bulkiness, weight and high perishability, fresh cassava roots cannot be transported over a long distance. Usually tubers are sold, either unharvested in the ground, or harvested and sold in heaps at the farm gate or in rural markets.

6.2.2 Dry cassava chips

Traditionally, cassava chips are the intermediate products in one of the pathways of flour production. Currently, cassava chips are being industrially converted to alcohol in one of Nigeria's foremost alcohol manufacturing companies, the Nigerian Yeast and Alcohol Manufacturing Company (NIYAMCO), consuming 24 tonnes of cassava chips daily. This is an indication that the demand for cassava products as a raw material for the manufacturing industries is on the increase in Nigeria. This, of course, is one of the ways the current cassava production rate could be sustained.

There is no doubt that the cost of chip production is the lowest compared to other cassava products. This may explain the desire of many Nigerian entrepreneurs to export cassava chips to overseas countries to earn foreign exchange. Closer examination of the business of exporting cassava chips reveals that the viability of this venture is constrained by the pressure on cassava in Nigeria as a local main staple compared to other major exporters

of cassava chips such as Thailand where the commodity is not a major staple. Nigeria cannot benefit from the current international market price of cassava chips which sells at US\$175/tonne. A cost benefit analysis indicates an average of Naira 3 000/tonne of fresh roots and the requirement of 4 tonnes of roots for production of one tonne of chips, together with packaging and haulage costs. Nigeria may not be able to compete favourably with other countries.

6.2.3 Other cassava products

Cassava flour

The use of cassava flour as a raw material for the bakery, biscuit and pastries industries is fast gaining recognition as a viable partial substitute for wheat. Awareness of the potential of the product was created amongst rural cassava processors through training demonstrations. Both the industrial end-users and raw material processors were linked together. However, the payment pattern by industries which is usually not on a cash-and-carry basis seems to encourage the intervention of middlepersons in the cassava flour supply business as the rural processors are not in a position to tie down their meagre capital.

The cases of breaking into the industrial market by rural/local processors of potential raw materials for manufacturing industries in Nigeria present a different picture altogether compared with the marketing of local food products. Processors of local raw materials, alternatives to the imported materials, have to contend with stiff competition in terms of acceptability by the industrialists, even when the suitability of the local raw materials for the manufacturer's process had been well proven.

The cost of producing cassava products fluctuates with the season of the year. While harvesting of cassava is easier during the wet season, starch and flour yields are greatly reduced by the high water content of the tubers. This needs to be constantly monitored for price reviews. Care should, however, be taken to ensure that the price of cassava products is not higher than that of imported wheat.

Cassava starch

Traditionally, starch is made by soaking peeled, grated cassava roots in water to separate the starch from the fibre. This soaking, apart from causing a deterioration in the quality of the starch, may modify the starch structure itself and thereby reduce its acceptability for food or pharmaceutical use.

Unsanitary conditions at most small-scale processing facilities make the recovery of starch as a by-product of other processes difficult. Apart from starch production for domestic use and laundry purposes, there is limited production of cassava starch for industrial use. Attempts in the past to produce industrial starch recorded limited success, partly because of the marketing pattern and partly because of an inadequate supply of

cassava roots. To encourage the use of locally produced starch, it may be necessary to place some restrictions on the importation of starch.

6.3 PROGRESS IN CASSAVA RESEARCH AND DEVELOPMENT

At present, agricultural research is currently undertaken by 17 research institutes under the Federal Department of Agricultural Sciences and by Federal and State universities. The National Agricultural Extension Research Liaison Service is responsible for research and extension coordination. Each of the institutes has a mandate for breeding and genetic improvement of specific crops.

The key national institutions in the development and extension of improved cassava varieties are the National Root Crops Research Institute (NRCRI), the National Seed Service, Cassava Multiplication Programme Coordinating Unit (CMP-CU), Multi-State Agricultural Development Project (MSADP) and non-governmental organizations (NGOs) such as Shell BP Petroleum Development Company of Nigeria Ltd., Texaco Agro-Industries Nigeria Ltd. (Texagric), United Nations Children Emergency Fund (UNICEF), Agip Oil Company Limited and the Diocesan Development Service, etc. NRCRI in collaboration with IITA provided the base for the rapid spread of improved cassava varieties and other root crops. NRCRI has the national mandate for genetic and agronomic improvement of yam, cassava, cocoyam, Irish potato and ginger, as well as the farming systems research in southeastern agricultural zone (NRCRI, 1992).

Prior to the establishment of the National Agricultural Research Project (NARP) in 1991, funding for agricultural research in the country had not been adequate. Shaib *et al.* (1997) observed that while the National Agricultural Research Institutes (NARIS) have generated a number of technologies that have been successfully adopted by farmers, their capacity to meet future challenges is impaired by poor infrastructural facilities, inadequate and uncertain funding and (hence) by a lack of well-articulated long-term research plans.

NARP is now financing research, infrastructural improvements, capacity building and research extension linkage.

NARP has also formulated the National Agricultural Research Strategic Plan for the period 1996–2010.

6.3.1 Breeding and seed multiplication

In the pursuit of its breeding programme, NRCRI collaborates actively with IITA. The outcome of this collaboration culminated in the release of 15 elite varieties between 1987 and 1996. The varieties have fresh root yield potential of 30–35 tonnes/ha and they are tolerant of major pests (CMB and GSM) and diseases (CBB and ACMB) of cassava, among other desirable attributes. In addition to the tolerance trait in the bred varieties, NRCRI collaborated closely with the FGN Bio-control Programme and Plant Health Management Division of IITA (APMEU, 1997).

CMP-W played a major coordinating role in seed production. It liaised effectively with NRCRI for the production of BS and, in concert with a network of out growers, organized the production of the FS which was supplied to ADPs. The state ADPs played three key roles. First, they embarked on the extensive construction of rural feeder roads which resulted in a substantial improvement in market access infrastructure. Secondly, they supported the conduct of On-farm Adaptive Research (OFAR) by financing field costs for research institute and university scientists working in collaboration with their project extension officers. Between 1987 and 1997 a total of 6 658 cassava-based OFAR trials were conducted by the ADPs (APMEU, 1997). The thrusts of their extension programme were the monthly technology review meetings between workers and scientists and small plots of demonstrations of technologies in farmer fields (Nweke *et al.*, 1996). These arrangements helped immensely to provide a vital link between farmers, extension workers and research scientists. Finally, the ADPs multiplied and distributed a total of over two million bundles of TMS 30572, 30555, 30001, 50395 and 4(2)1425 to farmers (APMEU, 1997). This contributed immensely to the high output of cassava in the respective states (Table 5).

Concerted efforts have been made to generate technologies that were extended and adopted by farmers. Some of these efforts include forging strong collaboration with international research centres, especially IITA and sourcing for externally funded projects.

In order to mitigate the technical problems that constrain cassava production, NRCRI pursues the following objectives for its cassava programme:

- plant breeding for development of new varieties that are high yielding, have high dry matter and starch content and are resistant to pests/diseases, among other desired qualities;
- production of breeder stock for the National Seed Service (NSS) cassava multiplication programme;
- bio-control of cassava mealybug (CMB) and green spider mite (GSM); and
- agronomic research to evolve optimum management of new and existing cassava varieties.

6.3.2 Agronomy

The progress already made in genetic improvement is appreciable. There are nearly 24 varieties that give good yields of roots in 12–15 months of growth. Current trends in research are towards obtaining early types (six to nine months), pink flesh types, greater resistance to spider mites, mealybugs and various diseases especially African cassava mosaic disease and cassava bacteria blight. The use of biological control to tackle the damage by mites and bugs is ongoing and is supplemented by genetic enhancement.

Management of crop and soil has been well researched. The standard spacing in sole and mixed cropped plots of cassava is 1 m x 1 m. Various combinations with other arable

crops and vegetables have been tried and they show improved land usage when short season crops are intercropped with cassava.

The testing of soils before fertilizer is applied to the soil has shown that many cassava soils would need some amendments, but this should only be encouraged if the cost of the fertilizer or manure is less than the value of the incremental root yield. Only in intensive farms that are well managed farms and these are quite few, would that be likely to occur. Sound sanitary practices are now known but are not commonly practiced for various reason. The dipping of stems in insecticide solutions or suspensions to reduce missing stands in plots is effective, but its extension to farmers is as yet low.

6.3.3 Root storage

In Nigeria, several traditional methods are practiced to store fresh cassava tubers. The most common of them are:

- leaving the crop in the ground until needed;
- pit storage by re-burying roots after harvest;
- field clamp storage; and
- storing in the house as well as on platforms in the open.

So far the best recommended option to control microbial deterioration is the use of thiabendazole based produce (MERTECT or TECTO). It has been found to be of very low toxicity and in wide post-harvest use in many other crops.

Thus, a combination of rapid root curing and chemical prevention of microbial deterioration seems to be an improved method and feasible approach to obtaining acceptable stored tubers.

The Nigerian Stored Products Research Institute also introduced some improved methods of storage consisting of:

- packaging in boxes with a moist medium (saw dust);
- improved pit storage;
- packing roots in plastics or polyethylene bags;
- waxing; and
- storing in the house as well as on platforms in the open.

The use of plastic bags to maintain humidity and chemical treatment to control fungi should lead to the development of viable storage systems for commercial use. This however is yet to be adopted in Nigeria.

Table 5 Output (in '000 tonnes), area (in '000 hectares) and fresh root yield (tonnes/hectare) of cassava in states or Nigeria involved in the production of improved cassava cultivars

State	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Average
Akwa Ibom											
Output					452.50	447.70	468.20	791.90	794.90	986.86	656.94
Area					55.86	58.14	58.52	94.27	91.16	101.73	76.64
Yield					8.10	7.70	8.00	8.40	8.70	9.70	8.57
Abia											
Output						524.00	636.00	714.30	470.82	1 562.35	785.49
Area						3.240	37.50	40.38	26.25	93.43	45.99
Yield						1 620.00	1 740.00	17.60	17.90	16.70	17.08
Anambra											
Output					176.70	292.16	196.90	267.80	427.20	654.75	335.92
Area					19.20	17.75	21.20	29.20	35.60	48.50	28.58
Yield					9.20	16.46	9.30	9.10	12.00	13.50	11.57
Benue											
Output	840.50	832.20	865.60	996.70	1 214.40	1 662.70	2 504.80	2 896.86	2 859.72	3 853.58	1848.70
Area,	107.74	90.30	86.00	100.90	106.80	137.30	191.20	240.40	238.31	285.45	158.44
Yield-	7.80	9.20	10.10	9.80	11.4	12.10	13.10	11.90	12.00	13.50	11.66
Cross River											
Output	862.66	775.95	788.85	831.37	1 500.35	1 640.30	1 705.29	1 814.40	1 820.31	2 329.60	1416.81
Area	114.70	105.57	106.31	110.85	118.47	143.76	147.90	149.90	161.95	207.29	125.20
Yield	7.40	7.35	7-42	7.50	13.50	11.41	11.53	12.10	11.24	11.20	9.30
Delta											
Output						690.00	539.00	479.80	493.28	1 272.19	695.00
Area						38.90	38.90	41.70	61.43	98.86	65.92
Yield						17.70	17.70	11.50	13.92	12.87	14.74
Edo											
Output						456-00	411 00	67.80	321 .97	597.92	450.94

State	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Average
Area						70.00	64.60	64.10	35.66	50.08	56.88
Yield						6.50	6.30	7.30	9.00	11.90	7.73
Enugu											
Output	1 766.70	2 215.50	1 916.20	2 714.40	2 821.10	3 001.60	3 321.00	2 848.10	2 295.41	2 978.04	2537.79
Area	254.87	234.90	198.80	274.90	276.90	293.00	312.10	302.50	277.09	299.34	272.44
Yield	6.90	9.40	9.60	9.80	10.12	10.24	10.64	7.76	8.28	9.90	9.31
Kogi											
Output						51.90	238.64	678.90	1 635.66	2328.90	986.80
Area						6.54	22.90	67.00	128.19	182.66	81.46
Yield						7.90	10.40	10.10	12.70	12.70	12.11
IM0											
Output	722.00	968.00	1 204.00	1 124.00	1 266.00	1 391.00	1 560.00	1 881.23	1 387.23	2125.17	1362.89
Area	97.72	75.20	85.20	82.90	84.30	58.30	60.00	78.20	72.38	164.73	86.41
Yield	7.40	12.80	14.10	13.50	15.00	14.80	1 500.00	14.90	11.80	12.90	15.77
Ogun											
output	934.40	321.10	1 051.12	1 217.20	2 124.10	2 089.10	1 387.80	1 631.90	1 614.02	1572.61	1434.36
Area	116.06	102.50	107.20	124.75	183.10	188.20	112.40	109.90	111.30	110.63	126.60
Yield	8.01	8.00	7.81	MO	11.60	11.10	12.30	13.92	14.50	14.20	15.42
Plateau											
Output	578.70	601.18	267.34	678.70	698.55	763.00	867.60	807.80	832.06	1379.00	707.91
Area	64.50	68.00	73.90	74.70	76.40	83.10	74.30	68.10	90.76	102.20	76.13
Yield	8.90	8.80	9.00	9.00	9.10	9.10	9.20	9.10	9.10	13.50	9.25
Total											
Output	5704.06	6 152.38	2 751.75	7 646.70	3 567.35	12 116.40	13 104.40	20 641.00	14 052.20	21561.40	13217.61
Area	758.62	690.50	678.00	737.30	834.01	1 067.03	1 102.72	1 305.65	1 335.24	1796.70	1200.99
Yield	7.52	9.30	10.00	9.90	13.02	11.15	11.96	15.81	11.98	12.20	11.88

6.3.4 Processing

In Nigeria, virtually all the processing steps in the production of *gari* are mechanized, thereby removing the drudgery of the most female rural cassava processors. The Federal Institute of Industrial Research (FIRO), Lagos, successfully improved the technology, splitting the process into definite steps and optimizing each step with respect to time, product quality and unit cost. Notable areas of improvement include the use of a mechanical grater, mechanical or hydraulic press or centrifuge to replace the stone and milling to a uniform particle size. With the application of these modern operations, the quality of the product is adequately guaranteed.

FIRO has also gone a step further to fortify *gari* with soybean, thereby improving its nutritional content with the protein rich soyflour. The extension outreach of the ADPs through the activities of WIA has brought this protein enriched *gari* to the household level. This was achieved through practical demonstrations in schools, health centres and clinics as well as to organized women groups.

6.4 INVESTMENT IN INFRASTRUCTURE AND SERVICES

6.4.1 Extension services

The ADPs are the extension arm of the State Ministry of Agriculture. With the assistance of the World Bank, pilot enclave integrated projects, Agricultural Development (ADPs), were established in Gusau, Gombe and Funtua in the 1970s. Subsequently, ADPs have been established in every state and the Federal Capital Territory. The main aim of the ADP is to increase production and farm income through adaptive research and transfer of improved farming technology based on the Training and Visit System. The ADP has responsibility for all aspects of agriculture, crops, livestock, fisheries and forestry.

Extension messages being disseminated by the ADPs cover improved cassava varieties and cassava cropping mixtures, with or without fertilizer. The technologies being promoted in the cropping mixtures are spacing and crop geometry, planting date and others, some of which are complicated and rarely adopted.

During the rapid rural appraisal survey of the Collaborative Study of Cassava in Africa (COSCA), the farmer group respondents were asked to indicate the relative number (none, few, many or most) of farmers in the village who were growing improved cassava varieties.

Analysis of that information showed that in 1989, improved cassava was available in nearly 90 percent of the 65 villages representing the cassava-growing areas of Nigeria, while many or most farmers grew these varieties in nearly 60 percent of the 65 villages (Nweke *et al.*, 1996). The adoption rate determined through this method, compared favourably with the village adoption rate of 55 percent obtained during the detailed field level survey which involved determination of field size.

Rapid Rural Appraisals conducted in Imo, Ogun and Benue States suggested that most farmers are aware of the improved cassava varieties and have to some extent adopted them (IFAD, 1994). In Imo (southeast), almost all respondents (92 percent) were aware of them and 66 percent had partially adopted them. Furthermore, 73 percent of the farmers reported that they had adopted the recommended spacing, about 30 percent followed recommendations on weeding, but few farmers used insecticides (14 percent) and herbicides (2 percent).

In Ogun (southwest) about 85 percent of the respondents was aware of the improved varieties and about 82 percent had adopted them. Time of planting, spacing and weeding was adopted at the same level of 40 percent. Fertilizer adoption for cassava production was about 25 percent while adoption level of herbicide was less than 1 percent.

In Benue (Middle Belt), the vast majority of farmers (86 percent) was aware of improved varieties and half of these (45 percent) had to some extent adopted them. The adoption of improved cultural practices was moderate-to-low, moderate in cases where purchased inputs were not required (e.g. planting time, spacing, weeding and harvesting). However, adoption of purchased inputs (fertilizer, herbicides and insecticides) was low due to difficult access to inputs, non-availability, high and unaffordable costs and lack of knowledge about their use.

In general, awareness and adoption of improved cassava varieties were higher in Imo and Ogun where cassava is the traditional and main staple than in Benue where cassava is relatively new in the farming systems.

Of the improved cassava being promoted under the IFAD-CMP (TMS 30572, TMS 4(2)1425 and TMS 30555), TMS 30572 seems to be the most preferred and widely adopted. Reasons provided for this preference include high yield, early maturity, pest resistance and weed suppressing qualities and suitability for intercropping.

However, some of the farmers who have adopted or are using improved varieties of cassava still retain some of their local varieties mainly because of food habits and preferences or the varying uses to which cassava is put. For example, for those who like boiled and pounded cassava, there is hardly any improved substitute. The major obstacle to the rapid spread of improved varieties in all zones is unavailability of suitable planting materials.

Improved varieties occupy above 40 percent of cassava land area. The level of spread is wider in the southeast and southwest than in the Middle Belt (Nweke et. al., 1992). The spread was made possible by improved planting material multiplication and distribution and large-scale government and non-governmental extension programmes.

Although the ADPs marked the beginning of a practical approach to rural development, the NAFPP was another intervention that brought together three interrelated components research, extension and Agroservice to create a powerful effect and enable farmers to increase their productivity. The project was launched in 1973 to arrest the downward

trends in food production. Cassava was given adequate attention by the project with the establishment of National Cassava Centre at Umudike.

6.4.2 Agricultural inputs

Awareness has been created in Nigeria on the use of modern agro-input fertilizers, improved seeds and agro-chemicals. During the implementation period of Cassava Multiplication, the uptake of fertilizer by the participating states and on a national scale increased tremendously. For instance, the total consumption of fertilizer rose from 186 000 tonnes in 1977 to well over 1 million tonnes in 1993. In terms of the rate per hectare the Nigerian farmer is estimated to use about 12 kg/ha of fertilizer nutrient which is higher when compared to the Sub-Saharan Africa average of 8.9 kg/ha.

The establishment of National Fertilizer Procurement and Distribution Division (FPDD), the National Fertilizer Company (NAFCON) at Onne and the various agricultural input/farmers supply companies have all increased the pace of the production of major crops in Nigeria, including cassava. The Federal Government is also committed to the sustenance of these investments. For instance, over Naira 4.9 billion were spent for the operation of the National Fertilizer Company (NAFCON) in 1996 alone.

However, improved agricultural practices and inputs are not widely in use because of availability, costs and inappropriateness. For example, the need for fertilizer is unmatched by availability due to the combined effects of insufficient supply and inefficient distribution system. Meanwhile, with the decline in soil fertility, farmers now realize they cannot get good yields without the use of fertilizer.

Farmers are beginning to use improved planting materials but they still mainly use their own materials which even though well adapted to the environment, are basically low in yield potential. Farmers rely mostly on their local planting materials when the improved variety is not available or they are not convinced about its superiority. Thus, given adequate supply and appropriate information, adoption of improved varieties would be high. Improved cassava varieties are already in use to a significant degree in the country.

Also, the farmers hardly use herbicides and other agro-chemicals. Though some rich farmers have begun to apply herbicides for weed control, most farmers lack the required capital and knowledge on the safe use of the chemicals. Their production is therefore often hampered by labour constraints and weeds. Interest in pest management and disease control appears to be increasing, especially for grain legumes where the benefits of spraying are recognized, but these chemicals are too costly and set beyond the reach of most farmers.

Access of the poor to the available fertilizer and other essential inputs tends to be limited because they lack organization and/or resources to acquire them because the extension messages are dependent on these inputs, extension is handicapped by their unavailability. To circumvent this obstacle, extension has to pay more attention to low-input technology.

6.4.3 Processing facilities

Cassava roots are perishable, spoiling within three to four days after harvest. They are also heavy, containing 70 percent moisture by weight. In addition, they contain cyanogenic glucosides which breakdown to form hydrocyanic acid (HCN), a toxic compound. Processing is necessary to reduce the moisture content and weight, improve product storage, enhance flavour and reduce the HCN potential. Traditional processing methods are very effective in reducing the HCN potential to safe levels, if properly carried out. The most important processes for reducing cyanide levels are the mechanical breaking of the cell walls followed by mixing and exposure to temperatures above 25.7°C at which HCN volatilizes.

In a bid to overcome the inherent problems of traditional cassava processing, giant strides have been made towards mechanizing several labour-intensive operations, notably grating, water expressing and milling. Various agro-engineering centres such as Rural Agro-Industrial Development Scheme (RAIDS), Product Development Agency (PRODA), Federal Institute of Industrial Research (FIIRO) NRCRI and IITA, as well as the agricultural engineering departments in several universities in the country, have developed many mechanized units designed to remove the constraints that processors face at the household level. Thus, several models and variations of mechanical cassava graters are available on the market. Odurukwe *et al.* (1997) observed that since the later 1960s stationary or pushcart-mounted graters powered by petrol or diesel engines have been in general use. Mechanized techniques for milling cassava chips and grains are also available on the market.

Not much success has, however been recorded towards mechanizing cassava peeling and *gari* frying (labour intensive operations) at the household level. However, industrial *gari* fryers have been developed by RAIDS, PRODA, FIIRO and IITA but these are more suitable for use in large-scale commercial enterprises or cooperative organizations, than at the household level.

Attempts at mechanizing the peeling step have achieved very limited success, owing mainly to non-uniformity in root geometry. Several hand-held tools that are more efficient have, however, been developed by NCAM and the Federal University of Technology, Owerri. These tools need to be commercialized and promoted through WIA.

Not much effort was made towards extending post-harvest technology to farmers before the IFAD-assisted CMP loan in 1989. The IF AD project had an agroprocessing component, with the objectives of removing those constraints faced by processors at the household level, promoting improved and appropriate mechanized food processing and supporting research on cassava processing.

According to APMEU (1997) substantial progress was made towards achieving the above-mentioned objectives. The recorded progress was in the form of:

- establishment of 35 demonstration processing centres;

- identification and formation for about 10 608 processing groups. About 3 936 processing and utilization demonstration/training workshops were conducted for such groups and other individuals and some women groups received credit from NGOs to establish processing centres; and
- identification of about 300 local manufacturers of cassava processing equipment. In some cases, the identified manufacturers were encouraged through direct training and assistance in procuring capital equipment.

Table 6 shows that mechanized techniques for grating and milling were available in more than half of the representative villages. Field observations also showed that cassava grating by traditional methods was rare. This implies that processors in those villages where the grating step was not mechanized, grated their cassava in nearby villages with such facilities, or where applicable, had this done in their homes by itinerant operators of pushcart-mounted graters.

More wide-spread adoption of the post-harvest technology seems to be hampered by its energy requirement. Most available cassava processing machines are driven by petrol, diesel, or electrical energy and for most rural households, these are scarce and expensive energy sources (Ugwu, 1996).

Table 6. Distribution of mechanized processing in Nigerian villages

Type of equipment	Percentage Of villages in 1989		Total
	Present	Absent	
Grater	52	48	100
Press	22	78	100
Mill	55	45	100

Source: Adapted from Ugwu (1996), p.149

A cassava processing study by FAO/IC in November 1994 concluded that the returns to small-scale production of *gari* are low, especially for those who buy roots, making it difficult to justify investment in expensive processing equipment. Nevertheless, in most villages and towns, there is limited demand for manual processing equipment because there is already a large number of mechanized processing facilities.

To ensure that increases in root yields will be absorbed and to enhance the returns to the women who are the primary processors of cassava, alternative product markets need to be developed. Products that have the potential to provide small-scale processors with improved market outlets include flour, starch and to a less extent, cassava chips for the animal feed industry. IITA has begun a pilot programme with groups of women cassava processors in Oyo State to assist them to produce high quality cassava flour that is suitable for biscuit and bread manufacturers. Roots of the most suitable varieties for bread-making are peeled, washed, pressed, sun dried and then ground into flour using a hammer mill. A biscuit manufacturer in Ibadan would like to purchase 40 tonnes of flour per week but this volume cannot currently be met by processors. Good quality cassava flour sells for one and half times the price of *gari* and costs the bakers less than half the

price of wheat flour. Similarly, starch is a high value product made by washing peeled and grated cassava in water to separate the starch from the fibre. In Nigeria, wet starch which is easier for village-scale processors to produce than dry starch, sells for Naira 18 000/tonne (US\$220), while food grade starch fetches Naira 40 000/tonne (US\$490). Imported starch costs Naira 210 000/tonne (US\$2 560/tonne). Starch is more difficult to produce than flour because the process requires an adequate supply of clean water.

The RAIDS under the Federal Department of Agriculture is the principal government institution charged with the responsibility for the development of agroprocessing technologies to suit the needs of the village or small-scale entrepreneur. RAIDS is underfunded, understaffed and poorly equipped to fulfil its role. The RAIDS staff organigram shows that of the 29 professional positions, 12 are vacant. Seven of these are at the zonal offices and five are at the headquarters in Ibadan. RAIDS has no computers, few vehicles, inadequate facilities for producing publications no testing facilities for equipment and little office equipment. Among the professional staff, only the Assistant Coordinator for Monitoring is a woman. Given the predominance of women in small-scale processing of agricultural crops, women should be better-represented in RAIDS (RAIDS, 1997).

The ADPs have promoted cassava processing through the establishment of demonstration units and the provision of training for farmers and processors. They also provided packaged processing units through the CMP. Apart from a single agroprocessing specialist at the state level and the Women-in-Agriculture (WIA) units, at both headquarters and zonal level, the most important field agents working with rural women on processing are the Block Extension Agents (BEAs) who are the female extension staff based in the rural areas. A BEA devotes 30 percent of the work time to crop processing and utilization. Under the present system, women are not adequately consulted to determine their priorities in processing. Often a package of equipment is provided that does not meet their needs as individuals or as a group. Many groups are weak and loosely organized. Some of those that are focused around equipment tend to be dependent on a patron or on the BEA. Sometimes a few powerful women or husbands take over and ordinary group members do not have the opportunity to learn how to set up and run activities themselves. The WIA staff recognize that they require additional skills to equip women's groups to plan and manage their own processing activities. They also recognize that they lack the basic business management and to manage their business operations, both the agroprocessing and WIA staff understand the need to cooperate closely and clarify their different roles to ensure that appropriate equipment goes to the most needy people and women are trained in the skills needed to set up and run their processing activities.

IITA has been working to develop new market outlets for cassava products. They are currently using a commodity system approach that integrates cassava production, processing and marketing. The approach reflects the belief that strong market demand is the best incentive for farmers to adopt productivity-enhancing and resource-conserving technologies. To retain as high a proportion of the value-added from processing the rural

areas, the approach focuses on processing methods geared to small groups of women or farmers, or small rural entrepreneurs.

Market niches for high quality cassava products have been identified and processing methods developed to meet the quality requirements of these markets. Currently, the main effort is directed toward the production and marketing of high quality flour for the baking industry and the response from the industry indicates a high level of demand.

Other research institutions in Nigeria that have studied aspects of cassava processing and marketing are: FIIRO, Oshodi; PRODA, Enugu; NRCRI, Umudike; RMRDC, AbuJa; University of Ibadan; Obafemi Awolowo University, Ile-Ife; University of Agriculture, Abeokuta; and the University of Nigeria, Nsukka. Other institutes that have worked on crop drying and may have an impact on cassava chip, starch, or flour production are the Crop Storage Unit, Ibadan and the Institute for Agricultural Research, Zaria. There is much overlap of operations and inadequate mechanisms to disseminate research results, where these are relevant, to those who need them. Inadequate funding reduces the ability of these institutions to conduct research programmes and the publication of results on problems identified by small-scale processors.

6.4.4 Storage infrastructure

The National Stored Products Research Institute (NSPRI), Ilorin, has developed some cassava related equipment and facilities for improving the shelf-life of dried cassava products. The use of some safe agrochemicals for maintaining products has also been recommended.

6.4.5 Accessibility to markets

Apart from the access infrastructure investments that were introduced with the advent of the oil boom, the Government of Nigeria, through its collaborative development efforts with the World Bank, instituted quite a number of integrated approaches to agricultural developments such as IBRI/IDA financed Multi-State Agricultural Development Projects (MSADP-I, MSADP-II, MSADP-III). These projects incorporated such features as agricultural research, agricultural extension activities, input commercial services and a heavy dose of rural infrastructural development effort.

The rural infrastructural component of these projects was charged with the rehabilitation and maintenance of feeder roads and associated equipment and village-level water supply through a programme of borehole construction and deep wells fitted with hand pumps. As regards MSADP-I, which was implemented in tandem with the IFAD-assisted CMP, the rural infrastructure component rehabilitated over 5 000 km of roads and maintained over 17 000 km. In addition, a total of 1 558 open wells were constructed to improve the availability of portable water in the villages.

In monetary terms, the MSADP-I was implemented with a sum of US\$244.45 million (representing US\$166.08 million as the World Bank contribution, US\$22.5 million as

FGN contribution and US\$43.87 million as the by states). About 31 percent of the base cost of the project was expended on rural infrastructure.

The implication of this on the cassava subsector was the relative ease of evacuation of cassava produce from the farmers as a result of the investment on road development that enhanced rural mobility. The implementation of DFRRRI along with the various MSADPs (with Naira 5 billion = US\$162.5 million) also facilitated the rapid distribution of cassava planting materials and the attendant increase in cropped area and production levels. It would be noted that the infrastructural development level has the potential of improving on the expansion of the production possibility frontiers of the agricultural sector in general and cassava subsector in particular. This implies that new intervention measures have a good base to build on.

7 SUCCESSES, FAILURES AND LIMITATIONS OF INTERVENTIONS

7.1 MARKETING MODELS

Prior to the implementation of SAP in 1986, the marketing of cassava and its products had limited government intervention. Except for less than one year in 1977 when cassava marketing came under the now defunct Nigeria Roots Crops Marketing Board, the marketing system has remained in the hands of private traders.

The dramatic increases in prices of most tradable agricultural exports that accompanied the devaluation of the Naira and the liberalization of exports were not applicable to cassava and cassava products to any significant extent because as an internationally non-tradable staple food product, prices were not directly influenced by world market development.

The main sources of price increase for cassava and its products on account of SAP and market liberalization policies was indirect, through the increase in the prices of substitute products such as rice, wheat and maize. The ban placed on the importation of these tradable products raised the domestic prices hence reducing their demands, such that consumers switched over to the consumption of cassava and its products. This culminated in price increases, but the increases were short-lived because of inconsistent government policies. It can be concluded that market liberalization has not had the desired positive effect on prices of cassava and its product (FACU, 1993).

7.2 PRODUCTION AND CONSUMPTION TREND OF CASSAVA IN NIGERIA

There is a high positive correlation between the increase of cassava production and the estimated demand for the commodity. Over the years, cassava has been transformed into a number of products both for domestic and industrial uses. The household consumption of cassava has been on the increase, even in the northern states, where cereals are the staple foods of the people. Although figures of the estimated demand for cassava and its products are not readily available, there are strong indications of the positive increase in

the demand for the commodity. There are indications that the domestic demand for cassava, particularly as a staple food, tends to outweigh the demands of the industrial sector. As farmers are unable to meet their demand, some industries are now engaging in direct production of their cassava requirements. The conclusion here is that cassava output is increasingly being demanded for both domestic and industrial uses. There is therefore, further room for improvement in production.

7.3 ECONOMIC BENEFITS AND RETURN TO INVESTMENT

There are many ways to describe the importance of cassava to Nigeria's socioeconomic life. It provides employment to producers, transporters, processors, marketers, food vendors and is a food of great preference to rich and poor in urban and rural areas alike. In quantitative economic terms, the value of all cassava produced in Nigeria annually can be estimated as follows:

- converting all roots produced into *gari* equivalents as 25 percent of fresh root yield;
- costing *gari* at an average price of Naira 28/kg throughout the year;
- converting value mentioned above to US\$ at Naira 83/US\$ as at May 1998.

From this estimate, it was calculated that: [33 000 000 tonnes x 1 000 kg x 0.25 *gari* conversion x Naira 28/kg at Naira 83/US\$] which comes to about US\$2.8 billion worth of *gari*.

If the fresh roots were sold directly as Naira 1 200–2 800/tonne throughout the year or at an average of Naira 2 000/tonne for an annual output of 33 000 000/tonne at Naira 83/US\$, the value was about US\$795 million worth of fresh roots.

The APMEU-ICR report on CMP also revealed that gross returns to the farmers from one hectare of cassava farm increased in nominal terms from about Naira 11 000 in 1987 to Naira 77 000 in 1997. To the whole economy, it was estimated that CMP resulted in over 35 percent economic rate of return.

7.4 COMPARATIVE ADVANTAGE OF CASSAVA PRODUCTION

Nigeria, by and large, has a lot of factors working in its favour as far as cassava production is concerned. Quite a number of comparative indices tend to put Nigeria in the forefront of cassava production. Firstly, cassava as a crop can thrive well in most parts of Nigeria. Secondly, cassava which is normally consumed in processed forms is a major staple crop in Nigeria. This country has a projected population of over 120 million people and therefore constitutes a large internal market for cassava and its products. Thirdly, the local market for cassava is well organized and highly competitive.

Added to these is the fact that a large number of improved varieties exist from which farmers can obtain stems for planting. These are available from private farmers who grow cassava and sell stems. The trade on the stems of improved varieties of cassava has been

a most helpful development in the spread of new varieties at a faster pace than through the usual farmer-to-farmer gift system of small amounts of free stems. Furthermore, the extension strategy currently in place in Nigeria also facilitates the ease of dissemination of proven technology.

The Government has a number of fertilizer blending plants although the demand for fertilizer far outstrips the output from these companies. The Government also set up a Fertilizer Procurement and Distribution Department (FPDD) but government policy on fertilizer importation has not been consistent.

7.5 AGRICULTURAL POLICY

Nigeria's cassava production is believed to have more than doubled from about 14 million tonnes in 1987 to the present level of about 34 million tonnes from around 2 million ha. The main reason for the scale of increased production has been an increased demand for locally produced, low cost staple food. This is in itself a consequence of the devaluation of the Naira, declining real incomes and the import ban on cereals. These favourable conditions were attributed to macro and micro-economic policy under SAP. Cassava products, therefore, became the 'life-saver' or the 'poverty-alleviation crop'.

Also the policy direction of Nigeria in terms of cassava development has led to a new orientation in research-extension-farmers' linkage, especially in the IFAD-assisted CMP. Increase in cassava production and productivity was largely attributed to the rapid spread of improved varieties. The adoption level of improved varieties by June 1996 was 75 percent on average. In furtherance of this policy thrust, the variety release in combating mealybug through biological means contributed significantly to cassava production. The SPATs and farmer-to-farmer exchange of cuttings also contributed to cassava development.

Apart from general marketing and price policies, there have never been direct marketing and price policies on cassava. Cassava is a highly perishable and bulky crop and if these attributes are considered along with a relatively poor transportation system, farmers have no choice than to sell at farm gate price. Apart from very low prices, cassava has been one crop that is greatly affected by price fluctuation, hence there is the need to further pursue a policy that will encourage storage and processing to ensure that the producers enjoy reasonable and stable prices.

As part of a government policy instrument, RAIDS was established to coordinate the processing components of the CMP. However, this vital sector in cassava development could not keep pace with the level of production. An elaborate plan to strengthen cassava processing would therefore be needed for a follow-on project. Cassava processing would have to be diversified into such options as chips, pellets, flour and starch for use by households, industries and for export.

Generally, policy thrusts in some aspects have not been consistent. For some years, cassava products enjoyed trade liberation while in other years, it would be included

among prohibited exportable commodities. This inconsistency does not encourage sustainable development of the crop. It is hoped that a more stable socio-policy environment would become available for future interventions.

7.6 FULFILMENT OF OBJECTIVES AND SCIENTIFIC ADVANCES

A cursory look at the achievements of some of the major intervention strategies would give a clearer perspective of the need for further intervention in the cassava subsector.

7.6.1 Germplasm development

The germplasm of cassava in Nigeria is vast. There are two groups of germplasm: cultivars in the domain of farmers cultivation and genotypes that researchers are holding whilst in the process of assembling favourable genes into cultivars that would be released to farmers for cultivation. In the 1989–91 season, some 151 cultivars were-being cultivated in the 63 representative villages spread across the major cassava-growing areas of Nigeria found within areas south of latitude 10°N (Nweke *et al.*, 1997). The cultivation of the crop is extending into areas north of that latitude mainly as an insurance crop against the frequent occurrence of drought-induced failures of cereal crops. The large number of cultivars grown by farmers in each local government area of the country shows that the farmers keep several cultivars for uses in different ways as they wish. Some for food, some for sale, each having some characteristics that are preferred by the consumers and users.

At NRCRI, Umudike and IITA Ibadan, there are cassava genetic improvement programmes. These include aspects for the collection, conservation, evaluation and continuous assessment of numerous genotypes so as to characterize them. This process helps researchers to know more about genotypes before they can be further used for crosses towards the creation of new and better genotypes. The hybrids are sown as seeds and cuttings are obtained from the stems of that original plant from the hybrid seed. The stems are repeatedly cloned to provide planting materials for the trials and assessment that would be made in the field and laboratory as well as in screen and greenhouses.

The promising genotypes are included in nationwide field trials of the nationally coordinated research projects at 15 sites. At several locations across the cassava-growing areas of the country, field trials are established in replicated plots. Based on these multiplication trials, the root yields and disease/pest tolerance and suitability of the different varieties are also ascertained before they are eventually recommended for release to farmers to cultivate. The issue of adequate multiplication of the stems of the selected varieties is crucial to the effective conduct of on-farm trials, acceptance of the varieties and their adoption by farmers. This widespread is essential for capturing the climatic and other agro-ecological influences that affect the performance of cassava genotypes as regards root yield and their reactions to pests and diseases across the seasons.

The cultivars now being grown by farmers are conserved at the major research institutes with a mandate for cassava: NRCRI Umudike, Umuahia and IITA at Ibadan. Both institutions through their substations and in collaboration with NSS-CMP, ADPs and other units, of the Ministry of Agriculture located in many states in the cassava-growing areas maintain collections of elite genetic materials from which foundation and certified planting materials are generated.

Currently, there are very many cassava clones that have proved their superiority to local cultivars that are available for multiplication and use by farmers in Nigeria, after multiplication trials. Table 7 provides important features of such clones in the savanna agro-ecologies of Nigeria.

The various genotypes produced from the breeding work of both NRCRI Umudike and IITA Ibadan have to be tested across the country before their stability of yields and overall performance can be evaluated. The relative performance of selected varieties in the locations reflect the suitability of such locations for the field cultivation of cassava.

7.6.2 Improvement of cropping system with cassava

Arable land use in Nigeria is mainly rain-fed. Thus, most of the cropping system is dependent on the optimum use of adequate rainfall. The use of manures and fertilizers for improving the fertility of the soil is not widespread in the cassava-growing belt because of unavailability and cost. The mixed cropping of various species so as to utilize land and weather conditions is a prominent practice. The improvement of the cropping system would therefore relate to:

- spatial arrangement of crops in the same field;
- timing of the planting of the different crops in the same field plot;
- fertilizer use for target crops and its residual effect on associated crops; and
- mulch and cover crop management in fallows to control erosion.

A 1995 survey of 1 268 cells in the southern Guinea savanna (covering Abuja Federal Capital Territory, as well as Benue, Kogi, Niger, Plateau and Kwara States) showed yam to be the dominant crop followed by sorghum, maize, rice, cassava, etc. However, cassava was the number one crop that was expanding in 43 percent of the cells and as the number two crop in 20 percent of the cells (Manyong *et al.*, 1995).

Table 7. Characteristics of improved clones adapted to the savanna of Nigeria under native soil fertility without the application of inorganic fertilizers after 12 months growth

Cassava clone (best local)	CMD	CBB	CGM	Products for which the tuberous roots are most suited	CNP	Drought	Yield range (tonnes/ha)
Derived Savanna							25
TMS 30572	R	R	S	Fufu, Starch, <i>Gari</i>	Medium	Tol	
TMS 91/02324	HR	MR	R	Fufu, Starch, <i>Gari</i>	Medium	R	
TMS 91/02327	HR	MR	R	Fufu, Starch, <i>Gari</i>	Medium	R	
TMS 91/02322	HR	MR	R	Fufu, Starch, <i>Gari</i>	Medium	R	
TMS 92/0326	R	R	HR	Starch, Boil/Eat, Starch	Low	R	
TMS 92/0427	HR	MR	R	Starch, Flour	Low	R	
TMS 94/0239	HR	HR	R	Starch, Flour	Medium	R	
*TME I (Antiotia)	R	S	R	Fufu, <i>Gari</i>	Low	Tol	15–20
Southern Guinea Savanna							20–40
TMS 4(2)1425	MR	MR	MR	Boil/Eat, Starch	Low	Tol	
TMS 92/0325	HR	MR	R	Boil/Eat	Low	R	
TMS 91/02327	HR	MR	R	Fufu, Starch, <i>Gari</i>	Medium	R	
TMS 91/02324	HR	MR	R	Fufu, Starch, <i>Gari</i>	Medium	R	
TMS 92/0427	HR	MR	R	Starch, Flour	Low	R	
TMS 92/0326	R	R	HR	Starch, Boil/Eat	Low	R	
TMS 92/036	HR	MR	HR	Boil/Eat, Flour	Low	R	
TMS 92B/00061	R	MR	R	Starch, Flour	Medium	R	
TMS 92/0057	R	MR	R	Boil/Eat, Starch	Low	R	
TMS 91/02322	R	MR	R	Starch, Flour	Low	R	

Cassava clone (best local)	CMD	CBB	CGM	Products for which the tuberous roots are most suited	CNP	Drought	Yield range (tonnes/ha)
*Oko Iyawo	MR	MR	MR	Starch, Gari, Boil/Eat	Medium	R	12–15
Northern Guinea Savanna							15–30
TMS 4(2)1425	MR	MR	MR	Boil/Eat, Starch	Low	Tol	
TMS 92/0057	HR	MR	R	Boil/Eat, Starch	Low	R	
TMS Z92/0250	R	MR	R	Gari, Flour	Low	R	
TMS 92/0326	R	R	HR	Boil/Eat, Starch	Low	R	
TMS 92/0427	HR	MR	HR	Starch, Flour	Low	R	
TMS 92/0398	HR	MR	HR	Boil/Eat, Tapioca	Low	R	
TMS 92/0401	HR	MR	R	Starch, Gari, Boil/Eat	Low	R	
*Danduala	S	S	S	Oil/Eat	Low	R	
Sudan Savanna							15–25
TMS 4(2)1425	MR	MR	MR	Boil/Eat, Starch	Low	Tol	
TMS 92/0326	R	R	R	Boil/Eat, Starch	Low	R	
TMS Z92/0250	R	MR	R	Gari, Flour, Starch	Low	R	
TMS Z93/0194	R	MR	R	Starch, Flour	Medium	R	
TMS K94/0327	R	MR	R	Tapioca, Flour	Medium	R	
*Dailkata Wariya	S	S	S	Boil/Eat, Flour	Low	S	7.5–10

CNP = Cyanogenic potential of storage roots

HR = highly resistant

MR = moderately resistant

R = resistant

Tol = tolerant

S = susceptible

In commercial farms, the practice for cassava root production is to prepare the land and plant well selected stems of one desired variety or a few varieties after disinfecting the cut stems with an insecticidal suspension. A spacing of about 1 m x 1 m is commonly adopted. The field is weeded or sprayed with herbicide (e.g. Primextra). The crop grows for 12–15 months before tuberous roots are harvested. The general attitude among

farmers is to fertilize short duration crops with which cassava is intercropped. The pattern in commercial farms of cassava is shifting to that of minimal application of fertilizers and manures.

In a 1996/1997 trial of 25 improved clones, the fresh root yields of the clones after 12 months of crop growth averaged 34.37 tonnes/ha in fertilized plots compared to 32.64 tonnes/ha for the unfertilized plots at Mokwa (Dixon, IITA, 1998). In this trial, the dry root yields were 11.11 tonnes/ha for fertilized plots and 10.39 tonnes/ha for unfertilized plots. It is important to note that yields in experimental fields are not unattainable in commercial plots where high standards of agronomic practice are not normal or expected.

In trials conducted under the Nationally Coordinated Research Programme (NCRP), 12 elite clones grown with fertilizer had an average fresh root yield after 12 months of 25.54 tonnes/ha with a dry root yield of 8.72 tonnes/ha, compared with 24.12 tonnes/ha with a dry root yield of 8.34 tonnes/ha in unfertilized plots. In a repeat of this trial, fresh root yield was 20.32 tonnes/ha (fertilized) and 19.63 tonnes/ha (unfertilized).

The lesson from these examples is that root yields vary with the various timings for planting, weed control, fertilizer application, harvest, the type and mode of fertilizer incorporation into the soil, the choice of varieties planted as well as the level of other agronomic operations on the commercial farm. Thus, a wide range of fresh root yields is possible with dry matter content of 20–40 percent and an average of about 33 percent.

For two seasons in 1992–1994 ten improved clones of cassava were tested in eight locations across the cassava zone of Nigeria. Some plots had fertilizer applied in a varied rate according to the soil test values of nutrient content to obtain 0.15–0.2 percent $^{\circ}\text{N}$ 1 520 mg P/kg soil and 46 million K/kg soil. In all, the fresh root yields after 12 months were 173 tonnes/ha in unfertilized plots and 22.4 tonnes/ha in plots with adequate fertilizer application (NRCRI, 1996).

7.6.3 Reduction of pest and disease incidence

Most of the released varieties are tolerant to most of the known diseases. In the 1970–1980s, the mealybug and green spider mite were the most serious pests. The mealybug has been successfully controlled with the release of its natural enemy *Epidinocarsis lopezi* through the combined efforts of NRCRI and IITA. With the start of CMP, the main thrust of protection shifted to the control of spider mite through the release of neotropical mites (*Typhlodrarnalus linonicus*, *Neoselleus ideaus* and later *T. aripo*). *T. aripo* established well in field and from the first releases in 1995 and at about 20 locations across the country between 1995 and 1996. It became established within 18 months over 200 000 km² covering the rain forest, the rain forest savanna transition and moist savanna zones of Nigeria.

Research towards the use of chemicals to control the menace of rodents in the field has slowed down and the use of integrated pest management systems is preferred. The

efficacy of the biological control of cassava green spider mite has been reported by NRCRI (1997).

7.6.4 Improvement of cassava post-harvest handling techniques and product diversification

The traditional cassava processing methods tend to be laborious and concerted efforts have been made to mechanize the various operations, notable grating, mash pressing and milling. While remarkable successes have been recorded in the mechanization of grating, especially through the use of petrol/diesel engines, not much has been achieved in the mechanization of root peeling and *gari* frying at the household level.

More widespread adoption of the post-harvest technology seems to be hampered by its energy requirement. Most available cassava processing machines are driven by petrol, diesel, or electrical energy and for most rural households, these are scarce and expensive energy sources (Ugwu, 1996). Moreover, available machines are not gender-sensitive and are owned and operated largely by men.

8 LESSONS LEARNED FROM PAST EXPERIENCES: FUTURE STRATEGIES

8.1 LABOUR

In the absence of labour-saving technology, agricultural production and processing are arduous and time consuming, putting a heavy burden on the rural people, especially women. Labour is particularly a problem among small-sized households and women may depend on men for certain vital tasks such as land clearing and preparation. Communal labour exchange and hired labour are some of the devices that farmers use to ease the labour shortage problem but this source of labour is not always available. In general, poor farmers have no resources to hire labour and have limited labour and income to make effective or optimal use of their lands.

Although the CMP intervention had facilitated growth in the production of cassava, there is a need for further research interventions in the area of labour-saving devices in order to eliminate the drudgery associated with cassava production and processing.

8.2 ROLE OF WOMEN IN CASSAVA ECONOMY

Women play an important role in cassava production, processing and marketing. The extent of their involvement in cassava production and their contribution to household food basket vary from one ethnic group to another. Until recently, the role of women was underestimated. This misconception together with cultural prejudices limits the access of women to extension services and other resources.

With growing recognition of the role of women in agricultural production, a number of programmes have been initiated recently, namely, Women in Agriculture (WIA), Better

Life Programme (BLP), Family Economic Advancement Programme (FEAP) and Family Support Programme (FSP).

These serve as mechanisms for giving women better, cheaper or more reliable access to land, credit, agricultural inputs, extension information and other resources. For example, the WIA programme in the ADPs formed several cassava processing and utilization groups and is promoting the use of improved technologies, working with the RAIDS to improve awareness of existing processing facilities. The WIA units also attempt to secure and to make available to women's groups improved cassava processing machines to increase processing efficiency.

Concerted effort must, therefore, be made to ensure that women have better, cheaper and reliable access to land, credit, agricultural inputs, extension information and other resources. The existing women-focused development programmes and other programmes aimed at the rural households in general, should be streamlined and strengthened to achieve this objective. Women also need to be properly organized to gain better access to these services and resources.

Furthermore, for some villages, the existing processing facilities are too far away. This increases the cost of processing and reduces quality of product and income. Studies have shown that returns to small-scale processing are low making it difficult to justify investment in expensive processing equipment.

To increase processing efficiency, save labour and improve the margin of profit for women who are the primary processors of cassava, there is a need for improved access to processing facilities and improved processing technology to remove drudgery and produce higher value cassava products, such as flour and starch. This underscores the need to design machines that are gender specific for women who play a major role in cassava production and processing.

There is also a need to strengthen the capacity of the ADPs, to involve women in cassava-based on-farm adaptive research trials, SPATs and processing demonstrations. This would involve integrating support for the WIA units into OFAR/extension and marketing and processing programmes.

8.3 CASSAVA RESEARCH CAPACITY BUILDING

Capacity building through training and skill development was successfully implemented under the CMP. Local and overseas training courses in cassava breeding and agronomy, seed multiplication, quality control, biotechnology, agroprocessing and monitoring and evaluation were organized for the staff of research institutes, NSS and the ADPs.

In general, given the high cost of farm inputs and unfavourable credit conditions, future interventions should focus on available low cost technologies easily adoptable by poor farmers: a combination of improved varieties and improved cultural practices. The aim is to expose farmers to and encourage feedback on a range of improved technology options

designed to fit in the existing tuber and root-based farming system. The scarcity and high cost of fertilizer also implies a need to develop alternative approaches to maintain soil fertility; for example, increasing the proportion of legumes in the cropping system, promoting alley cropping and improved fertility regeneration in the fallow period through planting legumes in the fallow. Genotype evaluation and matching of varieties with different farmers' and end-users' requirements should be an ongoing activity.

To address the risk of men displacing women in cassava processing as more profitable outlets are developed, future strategy will support women's groups to help them to become involved in the production of higher value products. This will involve assisting groups, especially women to form direct linkages with markets for higher value cassava products and to source credits from end-users.

8.4 DIVERSIFICATION OF PROCESSING OPTIONS

The experience gained in the implementation of CMP points to the fact that there is the need for further diversification in the use of cassava and its products, especially in industrial uses as chips are basics for pharmaceutical, baking and brewery industries. Future strategy should concentrate more on this with the hope of turning cassava products into internationally traded commodities. Further research into utilization is being perfected by FIIRO but needs to be further encouraged. Specific research in utilization may also be considered under the ongoing NARP.

8.5 SPECIFIC RECOMMENDATIONS

To sustain cassava production in Nigeria, there must be a will to do so. That will involve various aspects of research and the provision of stems of acceptable quality of improved high yielding varieties. Wider usage of roots and improved post-harvest interventions will be needed for better income to accrue to producers and processors as well as transporters and marketers. Specific main aspects of recommendation are outlined by subtitles below:

Cultivars: The use of existing and new cultivars should be made popular through an extended or expanded cassava multiplication programme. Generating more varieties while not extending those already available to farmers is not good enough.

Agronomy: Better production of cassava involves the use of manures and fertilizers, crop rotations and appropriate cropping patterns to enhance fertility levels of the soil on which the crop is grown. As most cropping systems are mixed cropping, there is the need to specify dominant cropping systems in each local government area and to identify the most probable package of agronomy operations that will best suit the growing of each particular set of crops in a mixture of species.

Extension: The extension linkage with research should be strengthened so as to facilitate the spread of improved cultivars and management practices to farmers. The involvement of more cooperative societies in the multiplication and sales of stems should be

encouraged. Integration of information and supply of various inputs is necessary. A group approach to extension delivery should be further promoted.

Research: The major constraints to poor farmers in cassava production are limited availability and lack of diversity in improved planting materials. Processing constraints are also a major concern. Many parts of the cassava-producing belt are beset with problems of land degradation, mainly through soil erosion. Furthermore, the uptake of existing technologies is limited. Based on these problems, a broad area of intervention should be identified. Such programmes should centre on activities that would contribute significantly towards alleviating the production, utilization, processing and marketing constraints of small-scale producers and thereby enhance their productivity, income and nutritional status.

There is also the need to develop a system for the sustainable intensification of the production of cassava through a combination of increased availability of improved planting materials, cultural practices and pests and disease control so as to improve the income of the rural poor and enhance their food security.

The soils of the area are generally of poor quality, lacking in important nutrients and easily prone to erosion. While fertilizers are very expensive there should be a deliberate effort to promote low cost land conservation measures and soil management techniques to allow for sustainable crop production.

Supporting the development of cassava processing prototypes, identification of applicable and useful technologies and incentives for local entrepreneurs to fabricate them should be encouraged. The aim would be to save labour, improve the efficiency of production, improve the quality of products and diversify to enhance marketability of products.

The objectives of increasing production and the remunerative process of cassava products would be taken as interdependent. Thus, promotion of industrial uses of cassava would be undertaken, based on the supply and demand structure for various cassava products, ensuring that cassava products are not put out of reach of the poor, making them food insecure.

Farmer mobilization should be encouraged through emphasis on a participatory development approach, family or group-based extension and seed multiplication activities involving due recognition for the role of women in production, processing and marketing and providing assistance that would enable all farmers to take advantage of development programmes as far as possible.

Institution building and strengthening and support for federal and state level agencies to ensure effective implementation of the programme are also being proposed. Funding support for various levels of research at the NRCRI and among other scientists working on cassava should be substantially increased so as to close gaps in the knowledge of the crop. Continuous understanding of the system from planting to complete use of all

products from cassava is necessary for the efficient management of the cassava production system in Nigeria.

Marketing: The growing trend in the production and use of cassava has been established. What is required for sustenance and further growth is to put into place an appropriate enabling environment that would facilitate the further industrial use of cassava. This is with the hope of making the products exportable to other countries. Such traded products that could be derived from cassava are glucose, starch, pellets and bases for pharmaceutical products, alcohol and other products.

Government should, therefore, synchronize agricultural sector policies within the broad macropolicies and avoid sporadic banning and lifting of bans on importation of cassava substitute products.

Middlepersons should be encouraged to actively participate in marketing cassava by improving market access. If properly “energized”, ADPs can build feeder roads and substantially improve access to markets. The participation of middlepersons in marketing is often decried but they perform an important marketing function by bridging the gap between the producer and the consumer. All that farmers need to do to avoid possible exploitation is to group together and assist one another to present a more united front to middlepersons or traders.

Export markets for well processed cassava products which can be offered to customers in attractive forms and those which are competitive to similar grain products need to be developed and exploited especially, in neighbouring countries.

Post-harvest technology: The storage of cassava roots in a processed form (*gari*, *lafun* and flour) should be further researched and pilot studies made to enable cottage industries to adopt them.

Transportation of inputs and evacuation of products are dependent on road conditions as well as transport costs. Storage of *gari* in special sacks that will prolong shelf life is also needed to preserve the output.

More research is needed to develop appropriate post-harvest technologies that are cost-effective, easy to fabricate at roadside mechanical workshops, have appropriate designs and are easy to operate and maintain at the farm level. Above all, as much as possible, such technologies should not be based on electrical or petroleum sources of energy.

There is a need for research also to develop new processed cassava products as well as appropriate drying and packaging techniques for new and existing products.

The use of cassava as composite flour in the bread making industry and for confectioneries has not been totally perfected. Cassava-based bread is still considered inferior to wheat-based bread in terms of taste and quality. There is therefore the need for further research development along this line. Similarly, the domestic use of cassava in the

replacement of grain-based meals would require the fortification of food to increase protein content.

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CASSAVA DEVELOPMENT IN GHANA

A Country Case Study of Cassava Development in Ghana

Prepared by

*Ministry of Food and Agriculture
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1 FOREWORD

Cassava is a major crop in the farming systems of Ghana. It is a main source of carbohydrates to meet the dietary requirement needs and a regular source of income for most rural dwellers and contributes substantially (22 percent) to the Agricultural Gross Domestic Product (AGDP).

Despite the introduction of cassava to Ghana in the 16th century and its substantial contributions to the livelihood of the populace, the crop has remained in obscurity and neglect. Burgeoning interest in the crop in recent times results from the realization of the potential of cassava as a food security and emergence crop which could generate employment for the rural poor and foreign exchange for the country. Since 1990, the Government of Ghana, through the Ministry of Food and Agriculture, has demonstrated its determination and commitment to promote cassava for the alleviation of poverty particularly in rural households and communities.

Apart from hosting the Ninth Symposium of the International Society for Tropical Root Crops (ISTRC) in Accra in 1991 and national workshops held on the crop in 1992 and 1993, the Government ensured that modest support was always allocated for the promotion of the production, processing and marketing of cassava under various relevant projects and programmes being implemented under the Medium-Term Agricultural Programme (MTADP). A National Cassava Working Group and a Cassava Task Force were inaugurated in 1995/96. These were followed by the participation of the Ministry of Food and Agriculture (MOFA), in conjunction with the private sector, in the recent Industry and Technology Fair dubbed “INDUTECH 97” held in Accra in March/April 1997 with the exhibition on cassava being adjudged the best stand at the fair. Related to these official initiatives, there has been research and development focus on cassava from several NGOs and bilateral partners in Ghana.

IFAD's initiative regarding a Global Cassava Development Strategy offers a unique opportunity for Ghana to develop the production, processing and marketing of cassava as a food security crop and a commercial crop for rural employment generation for the improvement of income for resource poor farmers and the national economy.

The IFAD guidelines for the preparation of country case studies for the formulation and execution of the Global Cassava Development Strategy specified a four-member team from each participating country. However, in view of time constraint, the following persons who have been associated with the cassava industry of Ghana were invited to contribute information for the preparation of the Ghana Cassava Case Study: Mr E.V. Doku and Mr (Mrs) Ramatu Al-Hassan, University of Ghana, Legon; Mr J.J. Afuakwa, Crops Research Institute, Kumasi, Mr D. Pessey, Transport and Commodity General, Donkokrom; Mr R.K. Noamesi, Glucosett Ghana Ltd., Accra and Mr W. Amoa-Awuah, Food Research Institute, Accra. The contributions of these colleagues for the preparation of the case study and their responsiveness to meetings at short notice is appreciated. The technical and secretarial support offered by Messrs N. Neequaye and J. Osei-Wusu and

Ms Nada Dwomoh of the Department of Crop Services, MOFA, Accra, is also appreciated.

It is hoped that the Ghana Cassava Case Study would contribute immensely to the Global Cassava Development Strategy initiated by IF AD.

Mr Francis Ofori
Director of Crop Services
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Accra

2 TERMS OF REFERENCE

The terms of reference (TOR) of the Ghana Cassava Cast Study were:

“To analyse the past and present situation of cassava in Ghana, with a view to describing the lessons learned from past development interventions and their implications for a strategy for future investment in cassava research and development”.

The following were the key elements of the TOR:

1. A description of the evolution of cassava development in Ghana, which includes the identification of significant interventions that have influenced evolution, including;
 - a. Trends in cassava production and utilization from 1986 to date in Ghana and by major cassava producing regions within Ghana.
 - b. Major interventions, both at national and regional level, that have influenced the evolution of the cassava sector, including, for example;
 - i. Changes in the development model adopted by the country (e.g. from a model of import substitution to a model of trade liberalization);
 - ii. Changes in import, pricing or credit policies for cassava or competing commodities;
 - iii. Investment in infrastructure and services to promote rural development and/or the development of the crop (both service infrastructure, roads, storage facilities, etc. and processing infrastructure).
2. An analysis of the success and failures (or limitations) of the interventions identified above in removing the constraints to and/or realizing the opportunities for the development of the crop. Criteria for analysing the relative success of each intervention might, depending on the information available, include:
 - a. total economic benefit;

- b. return on investment;
- c. impact on equity, including gender;
- d. adoption or non-adoption of technology;
- e. impact on the environment;
- f. impact on the development of institutions and organizations associated with the cassava sector.
- Derived from the above-mentioned analysis, an enumeration of the lessons learned from past experiences.
- A synthesis of the implications for a future strategy for cassava development in Ghana.

3 EXECUTIVE SUMMARY

The Government of Ghana, through the Ministry of Food and Agriculture (MOFA), accepted the invitation from the International Fund for Agricultural Development (IFAD) to prepare a case study on cassava as part of IFAD's initiative regarding the development of the Global Cassava Development Strategy. This case study on cassava was prepared in eight weeks, by a cross-section of Ghanaians who are currently engaged in the crop and were supported with information from relevant institutions/organizations, the private sector, farmers and NGOs that are contributing to the development of the crop as food security and commercial crop with many industrial applications in the country.

The case study recognizes cassava as an important crop in Ghana. Although attempts were made to develop cassava in the 1930s after its introduction from Brazil in the 16th century, past government policies marginalized the crop in favour of export crops and maize. Earlier research efforts focused attention on the selection for high yields, low HCN content and excellent cooking qualities and subsequently breeding for improved pest and disease resistance. There was limited information on husbandry practices for the realization of high yields of selected varieties. However, effective programmes were put into place to check the spread of diseases including the Cassava Mosaic Virus Disease (CMVD), Cassava Bacterial Blight (CBB) and pests such as cassava mealybug and cassava green spider mite. Since 1984, a biological control programme has been established by MOFA for the control of major pests of cassava. The remarkable achievements of the biological control programme being implemented by a multidisciplinary team is developing, testing and adapting sustainable cassava plant protection technologies in Ghana under the ESCaPP (Ecologically Sustainable Cassava Plant Protection) project.

In 1988, the National Root and Tuber Crops Improvement Project (NTRCIP) was launched as a component of the IFAD sponsored Ghana Smallholder Rehabilitation and Development Programme (SRDP) and in collaboration with IITA, three improved cassava varieties were released to farmers in 1993. This effort is being complemented by the implementation of various activities on cassava under the National Agricultural Research Project (NARP) including; crop improvement, agronomy, integrated pest management, post-harvest management, processing and socio-economic studies by several research institutions and universities.

The study also covers post-production aspects of cassava such as processing into various forms, utilization and interventions that had been introduced for processing of cassava into marketable and acceptable forms. It is clearly evident that cassava has not received adequate support for the realization of its potential as a food security and commercial crop with many industrial applications in Ghana.

The launching of the Medium-Term Agricultural Development Project (MTADP) in 1991 by MOFA and government policies thereafter have contributed to the realization of the importance of cassava in Ghana. Some of the programmes and projects being implemented under the MTADP provide modest support for research on the development of high yielding and pest and disease resistant varieties. Since launching of the NARP, the production, processing and socio-economic aspects are being investigated by relevant research institutions.

The establishment of an export led industry in cassava chips for export and the local livestock industry by a private company, Transport and Commodity General, has also increased interest in the crop in most parts of Ghana in recent times.

Finally, the study reveals positive impact of cassava on equity (including gender) with women mainly responsible for processing and marketing, with minimum damage to the environment. It is clearly evident that the provision of the adequate support for the development of improved varieties for the varied agro-ecological zones, the supply of adequate planting materials, research and extension support, improvement in the traditional method of harvesting, promotion of processing into various forms such as chips, pellets, starches, flours and for industrial applications and elimination of constraints to market development would expand the current output of cassava. This would accord cassava the recognition of contributing adequately to the economy of Ghana through food security, poverty alleviation and application for several uses.

4 EVOLUTION OF CASSAVA DEVELOPMENT IN GHANA

4.1 INTRODUCTION

Cassava (*Manihot esculenta* Crantz) was introduced from Brazil, its country of origin, to the tropical areas of Africa, the Far East and the Caribbean Islands by the Portuguese during the 16th and 17th centuries (Jones, 1959). In the Gold Coast (now Ghana), the Portuguese grew the crop around their trading ports, forts and castles and it was a principal food eaten by both Portuguese and slaves. By the second half of the 18th century, cassava had become the most widely grown and used crop of the people of the coastal plains (Adams, 1957). The Akan name for cassava 'Bankye' could most probably be a contraction of 'Aban Kye' - Gift from the Castle.

The spread of cassava from the coast into the hinterland was very slow. It reached Ashanti (and Brong Ahafo) and northern Ghana, mainly around Tamale in 1930. Until the early 1980s, the Akans of the forest belt preferred plantain and cocoyams and sorghum and millet in the north. Cassava became firmly established in most areas after

the serious drought of 1982/83 when all other crops failed completely (Korang-Amoakoh, Cudjoe and Adams, 1987). Cassava and its various preparations including fufu, *gari* and *konkonte* are now very popular foods throughout Ghana and not only in the coastal regions, as was the case some 20 years ago.

Prior to 1981, declining trends in agricultural production largely accounted for the downward economic situation experienced at different times in the country. During the period, food crop production and marketing, including cassava, were marginalized relative to the production of export crops and food imports. The occasional government interventions in the production and marketing of agricultural commodities under crash programmes were geared to respond to specific demands and situations.

Recognizing the low growth in the national economy, an Economic Recovery Programme (ERP) was initiated in 1983 to reverse the declining trends in major contributors to the economy such as agriculture. The bold policies initiated under the ERP resulted in the reversal of the downward decline in the production of major food crops including cassava. Under the ERP, an Agricultural Services Rehabilitation Project (ASRP) was launched in 1987 to strengthen the capacity of the public sector to support research, extension services, irrigation, policy planning, monitoring and coordination and to make the required investments for expanded agricultural production.

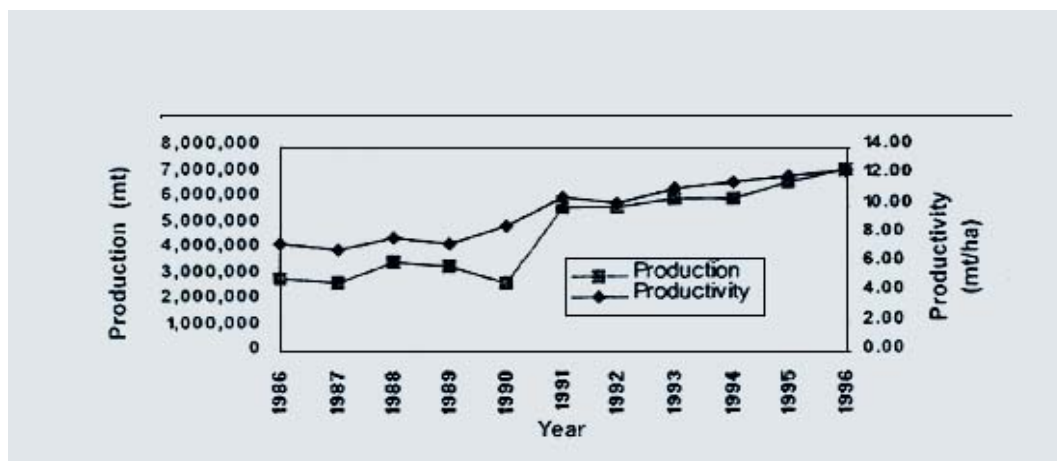
In order to consolidate and sustain the gains of the agricultural sector under the ERP, a rolling ten-year Medium-Term Agricultural Development Programme (MTADP) was launched in 1991 with emphasis *inter alia* on efficient resource allocation, the attainment of food security and abundant food supply for the people at affordable prices. For the attainment of the objectives of MTADP, various projects and programmes are being implemented with donor support for improvement of the food crop subsector; these include, the National Agricultural Research Project (NARP), the National Agricultural Extension Project (NAEP), the Agricultural Diversification Project (AGDIV) and the Agricultural Sector Investments Project (ASIP). As part of the measures towards sustainable development, the Vision 2020 was launched in 1996 as the Government's blue print for long-term sustainable development of various sectors of the economy based on science and technology.

4.2 IMPORTANCE OF CASSAVA IN GHANA

The importance of cassava is confirmed in terms of crop area, total production, contribution to Agricultural Gross Domestic Product (AGDP) and food expenditure shares (Alderman and Higgins, 1992). The average area planted to cassava which was about 387 000 ha in 1986 increased to 590 000 ha in 1996. During the same periods, cassava production also increased from about 2.9 million tonnes to 7.11 million tonnes (Figure 1 and Appendices 1 and 2). Cassava is by far the largest agricultural commodity produced in Ghana and represents 22 percent of AGDP compared to 5 percent for maize, 2 percent for rice, sorghum and millet, 14 percent for cocoa, 11 percent for forestry, 7 percent for fisheries and 5 percent for livestock (Al-Hassan, 1989; Dapaah, 1996).

The number of households engaged in cassava production also measures its importance. According to the 1987/88 Ghana Living Standards Surveys (GLSS), 1.73 million sampled households (83 percent) were engaged in cassava production compared to 1.74 million (86 percent) in maize production. By 1988/89, the GLSS recorded a one percent decline in the number of sampled households engaged in cassava production, with a corresponding one percent increase in maize producing households. The presentation of data from the 1991/92 GLSS III survey differs slightly from the report of the earlier surveys so it is not possible to track the trends in numbers of households engaged in the production of cassava and maize. The GLSS surveys, however, appear to be recording a declining percentage, albeit small, of households growing cassava relative to those growing maize.

Figure 1. Trends in cassava production and productivity



Nevertheless, according to the GLSS report, cassava is grown extensively in all the ecological zones represented in the sample. Earlier data sources however indicated negligible cassava production in the two Upper Regions (Al-Hassan, 1989). The apparent spread of cassava into the Upper Regions, especially Upper West, is a reflection of the growing trend in cassava production through area expansion. The MTADP reports of a rapid spread of cassava in the Guinea Savannah zone since the famine of 1983 (MOA, 1990).

In addition, survey data on farmers' perception of trends in cassava production in their villages presented in Prudencio and Al-Hassan (1994) show a growing trend in cassava production in 93 percent of the 30 villages in the survey. The most common reasons given for the increasing production are population growth (50 percent) and famine (21 percent) (COSCA, 1990, unpublished data). This suggests that farmers are using cassava to improve long-term food security as well as hedge against intermittent food shortages.

The village surveys also suggest that prior to 1989/90, when the survey was conducted, cassava production increased more through area planted to the crop (by displacing fallow land or other crops) than by increasing yields (Table 1).

Table 1. Sources of cassava area expansion

Crops	Displaced	Percent of Villages
Fallow		27
Cocoyam		23
Yam		13
Plantain		13
Cereals		11
Other		13

Source: Collaborative Study of Cassava in Africa (1990).

4.2.1 Crop related factors

- farmers' activities leading to the accumulation of numerous local varieties and developing cultivation and processing methods;
- government interventions (direct and donor-assisted), through the Ministry of Agriculture (MOFA) and researchers of the Council for Scientific and Industrial Research (CSIR) and the universities and MOFA staff in developing and extending to farmers improved varieties and proven production and processing technologies;
- recent activities by NGOs and entrepreneurs in facilitating production of *gari* and other food preparations for the local market and chips for export.

4.2.2 Farmers' local varieties

In the traditional bush-fallow system, some cassava plants are always left to grow with the fallow which is long enough to enable the cassava to flower and set seed. The natural out crossing habit of cassava leads to the production of numerous new hybrid combinations from self-sown seed from which farmers select and propagate desirable types. By this process, pools of new local varieties are continuously created which are adapted to the different agro-ecological zones of the country. In 1930, there were over 30 such named local varieties and by 1960 the number had increased to over 90 (Doku, 1969). As these selections are made on account of their excellent cooking qualities, low HCN content and high yields, they are used as parents in breeding programmes mainly to improve pest and disease resistance. To help identify these local varieties readily, Doku (1996) provided detailed descriptions of 91 varieties based on branching habit, height, petiole colour and inner skin colour of tuber, amongst others. Cassava varieties are not easily identified in the field and it is not clear to what extent the Doku's classification has been applied in identifying varieties. The possibility that varieties planted by farmers are still very mixed is very high indeed and there is an urgent need to develop rigorous but easily applicable procedures of varietal identification in the field.

Farmers' cropping systems

In addition to the selection of suitable varieties, farmers also evolved cropping systems in the form of rotations and crop mixtures suitable for the various agro-ecological zones in which they operate, generally in the following sequence: maize - legume (cowpea) maize/cassava - fallow (Doku, 1967). With fallow periods drastically decreasing in the wake of population pressure on farm land, agronomic investigations are urgently needed to develop appropriate systems of soil fertility maintenance. Farmers do not apply fertilizers owing to the high cost and cassava yields vary from 5 tonnes/ha to 25 tonnes/ha or more, depending on soil fertility.

Development of improved varieties

Between 1928 and 1962, the Department of Agriculture was responsible for cassava research and extension in Ghana. Since 1962, research institutions under the CSIR and the universities have been responsible for cassava research. In contrast to the unconscious selection by farmers, systematic breeding and selection which started in 1930 have been carried out mainly to improve pest and disease resistance and yields of the local varieties.

The Cassava Mosaic Virus Disease (CMVD) was first observed around 1930 and was considered serious enough to merit attention, as all existing local varieties were severely affected. This first government intervention involved the introduction of varieties from other West African countries, East Africa, the Caribbean and the Far East. Several crosses were made between the locals and these introductions followed by selections for desirable types. Four outstanding varieties namely Queen, *Gari*, Williams and Ankrah were released in 1935. These were high yielding (7–10 tonnes/ha), of good taste, highly resistant to CMVD and were grown widely throughout the country. However, by the late 1950s either due to increased virulence of the virus, a breakdown in varietal resistance or purity, all the newly released varieties except Ankrah became highly susceptible, necessitating a second breeding intervention for CMVD resistance.

The second intervention involved crosses between the local varieties and four other species closely related to *M. esculenta*, since it has been shown that no resistance could be found in any *M. esculenta* variety. Work with the interspecific crosses went on throughout the mid 1950s to mid 1960, out of which four selections K357, K162, K680 and K491 were released to farmers. The best K680, yielded around 19 tonnes/ha, had moderate resistance to CMVD with good palatability and cooking quality. These varieties were widely cultivated and maintained their good characteristics until the late 1970s and the beginning of the 1980s when a third intervention had to be sought to obtain varieties resistant to two new pests (cassava mealybug and cassava green spider mite) and a new disease, Cassava Bacterial Blight (CBB), in addition to CMVD.

Biological control of cassava pests and introduction of improved varieties from IITA

The third intervention was triggered by the drought of 1982/83 which aggravated the effects of the cassava pests and diseases. Government requested assistance from FAO which came in the form of a consultancy provided by IITA. The objectives of the consultancy included:

- release of available beneficial agents from IITA to evaluate their effectiveness under Ghanaian conditions;
- evaluation of IITA and Ghana local cassava varieties for yields and resistance/tonne to the pests and disease (Korang-Amoakoh, Cudjoe and Adams, 1989).

Biological control of the cassava pests - mealybug and green spider mite started in March 1984 with the introduction of a parasitoid wasp (*Epidinocarsis lopezi*) and predatory insects (*Diomus* sp. and two *Hyperdpsis* spp). In March 1985, a second batch of the natural enemies together with one more predatory lacewing insect (*Symphorobius* sp) and predatory mites *Neoseiulus idaeus* and *N. anonyms* were introduced.

Mechanization trials

For large-scale farms, mechanization of planting and harvesting are very necessary but there have not been any major interventions. Field trials in early 1960 at Pokuase Agricultural Station of semi-mechanized planting (persons sitting on low platform behind a tractor doing the planting) which could ridge and plant six rows at a time, showed that an acre could be ridged and planted in one operation in 2 hours 10 minutes instead of 5 days for planting alone. A mid-mounted disc terracer could also harvest one acre in two and a half hours for which five person-days were normally required (Doku, 1969). The preponderance of small farms has no doubt been responsible for the lack of interest so far shown in the mechanization of cassava planting and harvesting. However, with the appearance of export-driven large-scale farms, interest is bound to arise in the mechanization of planting and harvesting of cassava.

Fertilizer trials

Quite a number of fertilizer trials has been carried out mainly at the Soil Research Institute, but the results have yet to be developed into definite recommendations (Ofori, 1970, 1973, 1976; Takyi, 1972, 1974; Cobbina and Thompson, 1987). However, as cassava is usually intercropped or is the last crop in the rotation before the fallow, the crop most likely benefit from the residuals of fertilizers applied to the companion or preceding crops. Farmers also generally believe that fertilizers reduce the quality of cassava tubers, cooking quality and storage. The late start of agronomic research particularly on rotations and chemical fertilizer applications can have serious implications for fertility maintenance, resulting in soil degradation if recommendations and their adoption are delayed for too long. It is apparent that more work should be done on the effects of fertilizers in order to arrive at firm recommendations, especially for large-scale farms.

The National Root and Tuber Crops Improvement Project (NRTCIP)

The increasing importance of root crops, cassava in particular, in the economy of Ghana led government to enter into a bilateral agreement with IF AD leading to the implementation of the Ghana Smallholder Rehabilitation and Development Programme

(SRDP). The SRDP was to ensure food security by providing the needed inputs, resuscitating essential infrastructure and strengthening institutional capacity for research and delivery of essential production services. The National Root and Tuber Crops Improvement Project (NRTCIP) which took off in 1988 was a component of SRDP (Kissiedu and Okoli, 1988). Its aims were to:

- support root crop adaptive trials and root crop based farming systems research;
- introduce pest and disease tolerant varieties of cassava from IITA from 1989 to 1995 and their evaluation for adaptability and acceptability;
- start a programme of biological control of cassava mealybug and cassava green mite;
- conduct a survey of root crop processing technologies at the village level; and
- support human resources development for root and tuber crops research and biological control of pests.

For cassava, work carried out included continuation of the biological control programme for the mealybug and green spider mite [carried out by the Plant Protection and Regulatory Services Department of MOFA, in collaboration with IITA and later from 1989, a multi-disciplinary effort involving Benin, Cameroon and Nigeria]. Collection and testing of local germplasm alongside improved IITA varieties [carried out by Crop Research Institute, CSIR]. The SRDP project ended in 1995 but the NRTCIP continues to receive some funding under the succeeding project, the Smallholder Agricultural Development Project (SADEP) born out of SRDP.

The National Agricultural Research Project (HARP)

In 1991, the Government launched a National Agricultural Research Project (HARP), with the assistance of the World Bank, as a long-term process to strengthen Ghana's agricultural research system. The project is generating improved technologies to contribute to national development objectives and growth in the agricultural sector. Emphasis is being given to the development of processes and institutional arrangements to ensure that research priorities accord with national development priority, the needs of farmers and the sustainable use of the country's natural resource base. Among components of the NARP is support for the National Agricultural Research Plan and selected research programmes. The Root and Tuber Crops Research Programme of the NARP is being coordinated by the Crops Research Institute (CRI) and currently undertaking the following activities on cassava:

Crop improvement

- germplasm acquisition (local collection and introduction) characterization and preservation;
- evaluation of both local and introduced germplasm for desirable agronomic and end-user qualities;
- proposed to embark on hybridization programme.,

Agronomy

- cassava - fertilizer studies using N, P, K and Bo. on the yield and quality of cassava;
- plant population studies;
- intercropping studies.

Integrated pest management

- production of healthy planting material using tissue culture;
- studies on cassava anthracnose disease;
- evaluation of cassava germplasm for tolerance/resistance to ACMD and CBB;
- control of speargrass, a major cassava weed;
- survey of storage pest in dried cassava;
- post-harvest Management.

Product development

- pasta production;
- other food products.

Socioeconomic

- baseline studies of cassava production and marketing;
- adoption and impact studies of using improved varieties and technologies.

Collaborating institutions of the Root and Tuber Crops Research Programme of the NARP are:

- Crops Research Institute, Kumasi;
- Soil Research Institute, Kumasi;
- Savannah Agricultural Research Institute, Nyankpala via Tamale;
- Plant Genetic Resources Centre, Bunso;
- Food Research Institute, Accra;
- Biotechnology and Nuclear Agricultural Research Institute, Kwabenya, Accra;
- Kwame Nkrumah University of Science and Technology, Kumasi;
- University of Ghana, Legon, Accra;
- University of Cape Coast, Cape Coast.
- University of Development Studies, Tamale.

The programme also collaborates with the International Institute of Tropical Agriculture (IITA), in the exchange of germplasm and training of research and technical staff.

Funding for the NRTCIP has been as follows: SRDP: 1988–1994 - US\$222 897; NARP: 1993–1996; US\$550 000 budgeted for a three-year root crop-based farming systems

research. Out of the budget, US\$90 000 has so far been released for various research activities under the Root and Tuber Crops Research of the NARP.

4.2.3 Post-harvest issues

Cassava tubers are highly perishable and begin to deteriorate two to three days after harvesting. Unfortunately apart from delayed harvesting there are no effective methods available for prolonged storage of the tubers. Therefore, post-harvest handling of the root crop is extremely important. Approximately, 30 percent of cassava produced is consumed by the producers, whilst the rest is sold on markets and a large proportion of this is processed into various indigenous products such as *gari*, agbelima and kokonte.

Processing

Processing of cassava into various shelf-stable and semi-stable products is a widespread activity carried out by traditional cassava processors and small-scale commercial processing units. The traditional methods for processing cassava involve combinations of different unit processes including peeling, grating, dehydration, dewatering, sifting, fermentation, milling and roasting. The major products are agbelima, *gari* and kokonte. During processing, the cassava tuber is transformed from a highly perishable root crop into a convenient, easily marketable, shelf-stable product which meets consumer demand for a staple food. Processing may improve the palatability of the product and also reduce the level of cyanogenic glucosides in the tuber thereby detoxifying the product. Products fermented by some species of lactic acid bacteria such as agbelima and *gari* may attain anti-microbial properties.

Several problems are encountered during traditional processing which have created an urgent need for mechanization and upgrading of processing. Operations are often uneconomical because the product is not properly costed; for instance, there is heavy reliance on family labour which is not perceived as cost. Operations are carried out on a very small-scale and the areas of manufacture may be unorganized and scattered. The processing procedures are labour intensive and time consuming and mostly carried out manually. Operations are not adequately mechanized because processors cannot afford equipment and do not have access to capital. Processing is often carried out under unhygienic conditions and some unsanitary practices such as improper effluent disposal during the dewatering of cassava mash have adverse effect on the environment. Some operations such as the roasting of *gari* on open fires present a risk to the health of the processors. Products may be of inconsistent organoleptic and microbiological quality because no formal quality system is applied during processing to assure the quality of the product. There is rudimentary packaging of products.

Utilization

The role of cassava in the Ghanaian *diet also* confirms the importance of the root crop. Cassava is extensively consumed as food either in the processed or unprocessed form and is a major source of dietary carbohydrate constituting 19 percent of dietary energy intake

averaging 380 Kal/day per person (Dosoo and Amoa-Awua, 1992). Out of a total of 5 775 million tonnes of cassava produced in 1993, 1 798 million tonnes, representing 29.92 percent, were consumed by farmers whilst 4.84 percent was sold in the village and 36.89 percent outside the village (Antwi, 1994). In that year, cassava produced and processed into *gari* was 0.1611 million tonnes representing 12.74 percent, 0.163 million tonnes representing 9.89 percent were processed into agbelima, 1.07 percent into kokonte and 0.6 percent into cassava chips.

Interventions for processing

The major intervention in cassava processing was the introduction of a medium-scale motorized cassava grater by the Agricultural Engineers Ltd in 1966. The cassava grater presented a great innovation in cassava processing since grating is central to traditional processing of cassava in Ghana. Since then, several equipment manufactures including engineering firms, research institutes, university departments, small-scale artisanal shops, blacksmiths and mechanics have developed and produce various types of cassava processing equipment. Cassava processing machinery manufactured locally are drum graters, horizontal disc graters, cassava chippers, screw presses, hydraulic presses, cassava dough disintegrators, sieving machines, grading machines, plate mills, hammer mills and mechanical dryers.

Over the past three decades there has been a gradual but steady increase in the adoption of cassava processing equipment in the cassava processing industry. The adoption of mechanized cassava processing appears to have escalated in recent years through assistance provided by non-governmental organizations to various local communities.

In the last few years, the export of cassava chips has been introduced into the country through the activities of a private company, the Transport and Commodity General Ltd. This activity which is promoted by the Government is being explored actively by several potential exporters and it is envisaged in the foreseeable future that cassava may be considered as a cash crop rather than as a food crop.

The processing of cassava is a widespread and important activity in the informal sector of the Ghanaian economy. Strides have been made in recent years towards upgrading and adopting a mechanized approach to cassava processing but there are constraints to the adoption of the technologies which need to be addressed. The export of cassava chips is offering new opportunities to the cassava processing industry.

4.2.4 Socioeconomic policy evolution and interventions

Development strategies and policy changes

Development strategies and policy changes in Ghana and their influences on the development of cassava are indicated below.

- *Immediate post-independence period*

The development strategy adopted by Ghana after independence in 1957 was that of rapid industrialization with a strong bias for import substitution. The rapid industrialization policy aimed to shift employment away from agriculture. This was to be achieved by raising the productivity of farming to such levels that larger numbers of farmers could be released to work in other occupations (GoG, 1964). As the productivity of those who remained in agriculture increased, their earnings would also increase leading to further growth of the industrial sector through consumption linkages. Within this strategy, Government was to maintain a high level of participation in production to support its socialist policies with respect to distribution and utilization of national income.

The policy for the agricultural sector was to concentrate on a limited number of commodities and apply to them all available agricultural knowledge and technology. The development of research of human resources was also to be specific to the development of these commodities. The selected commodities were cereals and fish to fill the nutritional requirements, cocoa to improve the balance of payment situation and rice and sugar for both domestic consumption and export. Clearly, the development strategy at that time had no role for cassava as a crop; neither did the crop benefit from a general intervention in relevant farming systems because of lack of support to the small farm sector.

The period 1966 to the early 1980s was marked by political instability and therefore lack of continuity of policies. Changes in government often meant a redefinition of policies to address pressing issues of the time. Hence, the period 1966 to 1970 was characterized by austerity measures to stabilize the economy as well as re-orient governance away from a command system, and the development strategy away from rapid industrialization and public participation in production. Incentives were given for private enterprise development. To further encourage foreign investment, the Cedi was devalued by about 43 percent (Stryker, 1990); imports were liberalized with a reduction of import duties on a number of essential commodities.

- *Five-year development plan (1975–76 – 1979–80)*

By the mid 1970s, there was concern over the 'openness of the economy' because of a high marginal propensity to import as expressed in the Five-year Development Plan (GoG, 1977). Other issues of concern in the Five-year Development Plan were the high rates of unemployment and inflation. The thrust of policy at the time was the management of the balance of payments. The strategy was to cut back on imports of raw materials and capital inputs (GoG, 1977). This resulted in the birth of the Operation Feed Yourself and Operation Feed Your Industries programmes, which placed agriculture in the centre of the development strategy.

The following cassava programme was specified under the Five-year Development Plan (GoG, 1977):

- 93 600 ha of land was to be cultivated by the end of 1980;

- total cassava production was to increase through the small-scale farmer and area expansion, with a gradual increase in yield with the introduction of new varieties;
- Ghana community farms were expected to cultivate 1 600 ha by 1977 and the state farms, 800 ha annually;
- the state farms and Ghana community farms were each to establish processing plants for *gari*, tapioca and cassava chips.

This was probably the first official expression of recognition of a role for cassava in the Ghanaian economy. Unfortunately, the plans did not materialize because of the economic crisis of the late 1970s and political instability. Agricultural policies on the food crops subsector have tended to favour grains to the neglect of non-grain starch staples. For example, Government intervened in grain marketing and pricing with parastatals such as Grains Marketing Board and Food Distribution Corporation to operate guaranteed minimum prices. Government also sought to encourage production through the provision of subsidized inputs, machinery and credit. The subsidy on compound fertilizer increased from 49 percent in 1970 to a peak of 86 percent in 1975. It then declined to 58 percent in 1977 and increased again to 68 percent in 1984. These subsidies favoured large-scale cereal-based farmers (Stryker, 1990).

- *Economic recovery programme and structural adjustment programme (1983 to date)*

More recent changes in Ghana's economic and agricultural policies have favoured the development of the cassava subsector. The Economic Recovery Programme (ERP) followed by the Structural Adjustment Programme (SAP) which were initiated in 1983 and 1986, respectively, introduced macroeconomic policies to favour trade and private enterprise. A flexible exchange rate system and trade liberalization are the major macroeconomic policies that have affected the development of the cassava subsector. The depreciation of the cedi under the flexible exchange rate policy has made exports of commodities in which Ghana has comparative advantage more competitive. Trade liberalization, while encouraging exports has also opened the economy to an influx of foreign goods. Uncontrolled food imports could pose a threat to domestic production by causing a shift in tastes away from local foods such as cassava.

The advantages of the trade and exchange rate reforms for cassava have been the entry of Ghana into the cassava chip export market, particularly to the European Union. The timing of reforms has coincided with a decrease in export supplies of chips from Thailand and other East Asian countries which have traditionally dominated the cassava export trade. Ghana's exports of chips have increased from less than 3 000 tonnes in 1994 to about 20 000 tonnes in 1996 (Table 2). Until its entry into the cassava chip export market, formal trade in cassava was only of *gari* to Europe and North America. The average recorded trade volume was about 50 tonnes over the period 1985 to 1988 (Al Hassan, 1989). However, there has always been an unrecorded informal cross-border trade of cassava between Ghana and its neighbours. A recent study of the effect of the CFA devaluation on cassava in Ghana shows that the flexible exchange policy of Ghana limited the competitiveness of cassava products from Togo even with the CFA

devaluation, thereby resulting in increased exports of *gari* and cassava dough by traders (Al-Hassan *et al.* 1996).

Table 2. Exports of cassava chip by T&CG

Year	1994	1995	1996
Volume (tonnes)	2 423	3 322	20 000
Value (US\$)	242 300	332 200	2 000 000

Source: Transport and Commodity General, Accra

Under the MTADP, agricultural growth is expected to have a significant impact on poverty alleviation and food security by increasing the level of incomes of smallholders through higher productivity and employment as well as lowering food costs through improvements in marketing efficiency. The strategy for agricultural development includes, among others, expansion in demand by accessing export markets and diversifying exports, which could lead to both expansion and import substitution. The strategy for the crop sector is to increase production through productivity increases and area expansion.

The development of the cassava trade is therefore in line with this medium-term goal. Apart from the foreign exchange earnings, cassava chip processing has provided additional employment opportunities, especially during the off-farming season, for farmers in the buying areas. It is estimated that the processing of one tonne of chips generates 20 person days of labour (Ms Atenka, Processing Equipment Manufacturer, Accra, pers. comm.).

The strategy to increase productivity has led to a modest improvement in research funding under the National Agricultural Research Programme (HARP). Under this programme, allocation of research funds to roots and tubers, including cassava has increased to US\$550 000 (for three years). To support the dissemination of research findings, a National Agricultural Extension Project is also being implemented as an off shoot of the MTADP. The reform in extension services is to improve efficiency in delivery and relevance of extension services. A major thrust to improve infrastructure supporting agriculture has also been launched under the ASIP. Under the project, the following investments have been made since 1993: Processing - US\$49 560; Road Development - US\$1.64 million; and Market Development US\$6.4 million.

A Village Infrastructure Project (VIP) will be launched in 1997 to complement ASIR. The VIP would support the effort of the Government to reduce poverty and increase the quality of life of the rural poor through increased transfer of technical and financial resources to develop basic and sustainable village-level infrastructure. The components of the project include rural transport infrastructure which would *inter alia* support improvement of existing feeder roads and the development of arterial village roads and tracks linking farms to villages for the improvement of transport of agricultural produce including cassava. It would also support the development of on-farm and village level

drying facilities to reduce post-harvest losses, on-farm storage and appropriate facilities for processing of crops such as cassava.

This account of policy changes and interventions shows that until the late 1980s there was little, if any, policy intervention in support of the cassava subsector. Whatever attention the crop received was through individual research and private entrepreneurs. Yet the crop has spread across the country to all but the Sudan Savannah Zone of the Upper East Region. The factors causing this spread are related to the adaptability of the crop and its integration into the food and farming systems (Appendix 3).

Although the food security role of cassava is widely attributed to its availability during times of food shortages, the crop has increasingly become an important source of cash income. Results of the 1992/93 Ghana Living Standards Survey show that out of the 1.7 million households who reported harvesting cassava two weeks prior to the interview day, 16 percent reported selling the crop over the same period. It is interesting to note that the estimated value of cassava sold by the 16 percent of households was US\$32.2 million cedis, which compares well with the US\$41.4 million realized by 55 percent of maize producing households who sold the crop. It should also be noted that since cassava can be processed for sale, households harvesting but not selling fresh roots may be processing the harvests and not necessarily consuming it.

The main reasons for expansion of cassava are population growth, famines or seasonal hunger and market availability. The COSCA data also show that cassava production is increasing almost everywhere in Ghana and the factors causing this spread in different areas are demographic pressure, good market demand, commercialization of agriculture and improved cassava processing technology.

The cassava subsector has enjoyed significant yield increases since the late 1980s. The national average yield of about 8 tonnes/ha in 1988 has increased to about 12 tonnes/ha. Average yields recorded in 1991 during the COSCA surveys was already 12 tonnes/ha with a range between 6 tonnes and 37 tonnes/ha. It is expected that current yields will far exceed the 12 tonnes/ha as a result of interventions such as the release of improved cassava varieties research institutions and the universities and the intensive biological control of the cassava mealy bug and cassava green mite by MOFA. The high yields of the 1990s are still below the potential yields of most cassava varieties.

The determinants of cassava yields at the farm level are presented in Appendix 4. It is important to note that apart from the climate and agronomic factors (plant density and plant age at harvest), socioeconomic factors such as population density, sales level and use of hired labour in farming, affect the yields of cassava. The negative relationship between population density and cassava root yield is also an important result considering the fact that growing population density is also one of the reasons for the spread of cassava.

5 EVALUATION OF INTERVENTIONS

5.1 POLICY

Although the many excellent attributes of cassava (such as tolerance to drought and poor soils, easy-to-grow famine reserve/food security crop, poverty alleviation in rural communities) have been recognized for several decades in Ghana, there have been limited government interventions to guide the development of the crop until very recently. Even in the early 1980s when the Government started to address the agricultural sector more seriously, policy still favoured the cereals - maize and rice, the old time favourites, in the form of guaranteed minimum prices, subsidies on fertilizers and agro-chemicals. However, after the very severe drought during 1982/83 when the superiority of cassava over the cereals was glaringly demonstrated, the Government started taking action through a series of bilateral and World Bank agreements in agricultural development as a vehicle for economic growth. The agricultural development policies filtered down through root crops to cassava.

In 1988, the Government sought financial assistance from IFAD to support root and tuber crops research as a component of MOFA's Smallholder Rehabilitation and Development Programme (SRDP) based at Tamale. The National Root and Tuber Crops Improvement project (NRTCIP) that resulted as a component of SRDP, was executed by the Crops Research Institute (CRI) from 1988 to 1996. As the MAD funding was inadequate to cover all root crop activities, attention was given to cassava improvement and biological control of cassava pest. Currently, the World Bank sponsored NARP project is funding cassava research as part of the NRTCIP and the biological control is being handled under ESCaPP.

5.2 ADOPTION OF TECHNOLOGIES

5.2.1 Improved variety

- disease resistant varieties were released between 1930 and the 1980s;
- three (3) high yielding, pest and disease resistant varieties have been released by NRTCIP - 1993. These varieties, namely; Afisiafi, Gblemo Duade and Abasa Fitaa yield in excess of 200 percent of local varieties;
- the two (2) non-poundable varieties have high adoption in areas where cassava is processed before cooking. In the fufu-eating areas, the one (1) poundable variety is being adopted but at a slow rate, due to availability of farmers' varieties;
- adoption rate would be high if high yielding and poundable varieties are released.

5.2.2 Crop production

Three improved clones of cassava were selected as higher yielding than local varieties and tolerant to local pests and disease as well as having acceptable food qualities released to farmers as varieties. These clones are being multiplied throughout Ghana. Local germplasm accessions are being collected for characterization, evaluation and

maintenance. A programme has been put into place for evaluating and selecting on a continuing basis, superior introduced IITA clones to replace lower yielding varieties that might succumb to new pests and diseases. Several clones are currently being evaluated under this programme. Packages of technology for producing cassava have been tested. These include, intercropping, fertilization, harvesting age and plant population studies.

5.2.3 Agronomic practices

Although extensive research has been carried out on the agronomy of cassava, impact on production has been low and farmers continue to use traditional methods of production and obtain low yields (NARP, 1994). It is envisaged that the organization of research on cassava on a multidisciplinary basis under the NARP would result in the generation of agronomic technologies for the improvement of cassava production in the next three to four years.

5.2.4 Biological control

Biological control of cassava green spider mite and cassava mealybug was successfully carried out by the Plant Protection and Regulatory Services Department of MOFA, in collaboration with IITA, Ibadan, Nigeria. A new pest (Aleuroid spp.) of equal importance as the mealybug which is causing severe damage on the coastal plains is receiving serious biological control assistance.

5.2.5 Mechanization

Research information on mechanization of planting and harvesting of cassava is very low. Apart from earlier trials conducted in the 1960s (see section 3.1.5), the mechanized cassava harvester developed at the University of Leipzig, Germany is being tested for adaptation in Ghana by the Department of Agricultural Engineering of the Kwame Nkrumah University of Science and Technology, Kumasi. Research on manual and mechanized processing of cassava including power operated graters, manual screw presses and solar driers is ongoing; some of which has been widely adopted by processors in the country (NARP, 1994).

5.3 POST HARVEST ISSUES

5.3.1 Processing

Mechanized cassava processing is now a fairly well established activity and there are several cassava processing plants in the country. Despite the steady increase in the rate of adoption of mechanized cassava processing there are factors which mitigate against the adoption of the technology. Mechanized cassava processing is often not a viable venture because the products have to compete with traditional products which are underpriced because traditional processors rely on family labour which is not perceived as cost. To process cassava profitably the plant has to be sited at very high cassava producing areas

where raw material costs are low and production has to be at a very high capacity which is difficult to maintain.

Cassava processors usually have neither capital or access to capital to enable them to afford cassava processing equipment. Most operators in traditional and small-scale cassava processing plants also have limited managerial capabilities and training due to little formal education and this mitigates against the successful management of a cassava processing enterprise.

5.3.2 Utilization

A modest start has been made by the Food Research Institute and other private entrepreneurs in the production of various new convenience/instant foods from cassava such as fufu flours, agbelima and unfermented cassava flours. These products are steadily gaining popularity with the Ghanaian public however, their prices are not yet competitive.

5.3.3 Marketing

Inadequate infrastructure in the farming areas has adversely affected marketing of cassava and other food staples. Poor roads in rural areas mainly account for the rot of cassava in the hinterlands. The lack of a communication system has also not helped in effective marketing of cassava. In some areas, farmers are not encouraged to harvest all their cassava and sell them at once. Cassava which contains about 70 percent water must be dehydrated to reduce the cost of transporting the product from the rural areas to urban cities.

Marketing of products made from cassava have not been aggressive enough. Products such as kokonte, cassava flour which are well packaged and produced by the Food Research Institute and other industrialists are not well patronized relative to those produced locally and sold on the local markets. Prices offered for the same products on the local markets are cheaper than the industrially produced products. The cost of production of processed cassava products by industry are high and need to be made competitive, these measures are being addressed by the various processing companies. Intensive education is required to convince the populace to change its attitudes towards packaged food products such as powered fufu.

5.4 IMPACT ON EQUITY INCLUDING GENDER

Prior to 1993 when three improved cassava varieties were released to farmers, various local varieties were cultivated in the country. The yields of the improved cassava varieties were about two to three times higher than the local varieties. With the establishment of organized markets for cassava in some parts of the country, there has been intensification of cultivation of the crop for the improvement of rural incomes in recent times. Whilst cultivation of the crop from land preparation and planting may be dominated by men, women play a major role in the production, processing and marketing

of cassava in Ghana. The inadequacy of post-harvest technology (poor storage, marketing and processing facilities), poor market infrastructure and poor access of women farmers to formal credit continue to constrain investment in the agroprocessing of cassava.

5.5 IMPACT ON THE ENVIRONMENT

Cassava is generally cultivated on smallholdings in association with crops such as maize, groundnut, cowpea, plantain and cocoyam depending on the agro-ecological zone and relies on residual soil nutrients when intercropped with maize which has been fertilized or as following crop in rotation with legumes. Cassava is grown mainly on impoverished soils with no soil amendments such as fertilizers. Continuous cropping of cassava particularly the high yielding varieties without adequate maintenance of soil fertility could lead to soil and environmental degradation. As an efficient soil nutrients miner, cassava removes large quantities of N and K and also of P and Mg. For instance, a harvest of 25 tonnes/ha of cassava removes about 60 kg/ha of N, 40 kg/ha of P₂O₅ and 136 kg/ha of K₂O (NARP Roots and Tubers Research Programme, 1996).

Currently, cassava-based farms are low-input systems which require little or low agrochemicals and are therefore environmentally friendly. With the introduction of high yielding varieties and the promotion of cassava production for both food security and export, most technologies being tested lean towards agricultural intensification leaving more land available for environmental conservation and biodiversity preservation. This is particularly peculiar to cassava in the forest and transition zones of the country. Increased cassava production from land already under cultivation will reduce the need to encroach on forests and other ecologically fragile areas.

The successful results of the biological control of the pest programme of cassava clearly indicate that recourse to external chemical inputs which are harmful to the environment will be avoided as much as possible through the use of limited amounts of chemical fertilizers where no other alternatives are available. Integrated pest management for cassava and other crops is being promoted in the country to minimize damage of the environment.

5.6 IMPACT ON INSTITUTIONAL DEVELOPMENT

Root and tuber crops research is being coordinated by CRI. This has enabled research work on the crops to attract local and international recognition and funding. Cooperation in work on root crops in Ghana has been forged between workers in research institutions, universities, extension workers and farmers. It is anticipated that the established extension-research linkage would benefit farmers immensely.

In consonance with government policy of increasing agricultural production for export, MOFA has taken the following initiatives:

- two National Root and Tuber Crops and Plantain Workshops were held in 1992 and 1993;

- the 9th Symposium of the International Society for Tropical Root Crops (ISTRC) was hosted on behalf of the Government by MOFA in 1991 (Ofori and Hahn, 1994);
- it declared 1994 as Cassava Year. That year and subsequent years were to be devoted to the promotion of cassava and its products;
- a National Cassava Working Group was convened in 1995 to act as an advisory body for formulation policy guidelines for the development of the cassava industry;
- a National Cassava Task Force (CTF) was convened in 1996 to study all aspects of cassava production, processing and export potential and make recommendations for immediate implementation. The CTF submitted recommendations to MOFA ranging from policy issues through production, research, extension and processing to marketing in October 1996;
- a major drawback to the take off of cassava was the long delay on the part of Government in setting policy guidelines and creating an enabling environment to stimulate production;
- the NRTCIP and the Biological Control Programme were of short duration and inadequately funded, crop improvement and pest and disease control programmes are long term and should be accorded permanent ongoing status to enable problems to be anticipated and tackled on a continuing basis. The current NARP and ESCaPP successor projects should therefore take the long-term nature of the problems into consideration. Already a potentially serious white fly (*Aleuroid sp*) has appeared, causing serious damage to cassava in the southeastern section of the country.

The original SRDP and ESCaPP projects developed in long collaboration between Ghana and IITA in cassava development. These projects, especially ESCaPP, were a unique multidisciplinary and multi-institutional effort to develop, test and adapt sustainable cassava plant protection technologies for major production constraints in western Africa. Multidisciplinary teams of national plant protection experts joined with international experts to share expertise and pool efforts across ecozones. The African component is a collaborative effort between IITA, national plant protection staff, extension workers and farmers in Benin, Cameroon, Ghana and Nigeria. ESCaPP activities included diagnostic surveys of cassava pests in targeted ecozones, development and testing of appropriate intervention technologies with farmer participation, training of researchers, extensionists and farmers and special postgraduate training through Winrock International for African women scientists. Unique features of this approach included national teams of seconded multi-disciplinary scientists, shared local expertise and R&D activities based on local diagnoses and priorities.

The research, training, implementation and evaluation paradigm created is a model for appropriate crop management. Major accomplishments of ESCaPP Project at the close of Phase I include:

Cassava R&D Coordination

1. Establishment of multidisciplinary national teams. This model has been adapted for other R&D activities in participating countries.
2. Set research and implementation of priorities for specific ecozones based on diagnostic surveys.

Information Resources

CD-ROM of hyper-linked cassava information resources (personnel, institution and project directories, bibliographies, field guides and handbooks, general references, grey literature and databases for cassava plant protection decision-making).

Human Resource Development

1. A curriculum for sustainable cassava plant protection based on needs of farmers, extensionists and researchers;
2. 194 trainers, 1 800 extensionists and 2 400 farmer groups trained in sustainable cassava plant protection;
3. Specialized training of 24 national researchers; post-graduate training of 12 women.

Intervention Development, Testing and Dissemination

1. Regional diagnosis of major cassava pests and a digitized database of survey results;
2. Collaborative research with existing institutional capacities to broaden the scope and impact of the project in the region;
3. Classical biological control of the cassava green mite in the forest and transition zones. Pest populations have declined an average two-thirds and yields have increased by a third where the exotic natural enemies are established;
4. A new disease of cassava has been discovered in Ghana (Bud Necrosis).

In the areas where an exporter of cassava chips has concentrated its activities, farmers' response has been overwhelming. Sale of chips is seen strictly as an income generating activity from surpluses of cassava that cannot otherwise be sold particularly in areas that have had problems of access to the traditional fresh root markets. Some 15 000 farming households have so far benefited. For 1996, expected average earnings from cassava chips sales were estimated at US\$2 000 000 and this was reflected in improved life styles of the farmers as witnessed by improvements or expansion to their houses, purchases of bicycles, sewing machine, etc. (Pessey, 1997).

The Food Research Institute has identified 15 manufacturers of cassava processing machinery all of which together with the relevant research institutes, university departments, extension services of MOFA and various NGOs have been involved in the promotion of mechanized cassava processing. The efforts of the relevant national research institutes such as the Food Research Institute (FRI) and Institute of Industrial

Research (IRI) of the CSIR towards the development of the cassava processing industry are indicated below.

The FRI has played an active role in the development of cassava processing technology in Ghana. In addition to fabrication of cassava processing equipment, including the introduction of mechanical and solar dryers, the FRI has developed improved technologies for processing cassava into traditional and non-traditional products. These include the processing of agbelima and akyeke into more convenient shelf-stable dehydrated products, the production of kokonte using solar and mechanical drying to yield very high quality products, the production of unfermented cassava flour and the production of fufu flour using cassava and other root crops. Some of these technologies such as the production of agbelima and fufu flours have been adopted by industry and are being commercially produced. To facilitate the dissemination of improved cassava processing technology and adoption of mechanized cassava processing in the country, the FRI in collaboration with the IRI established the Cassava Processing Demonstration Unit (CPDU) at Pokuase in a joint project with the African Regional Centre for Technology based in Dakar in 1987. The project was funded by the UNDP through the Economic Commission of Africa to serve as a focal point for accelerating the dissemination and training of entrepreneurs, traditional cassava processors and technicians engaged in the fabrication of food processing equipment. The CPDU has a full range of pilot scale cassava processing equipment and machinery, runs training programmes and assists entrepreneurs to set up cassava processing units and routinely produces cassava products for sale to the general public as a means of familiarizing them with upgraded products. The FRI is demonstrating and promoting the implementation of the Hazard Analysis Critical Control Point into traditional food processing to assure the microbiological quality of cassava and other indigenous products and to help improve their image in the eyes of local consumers.

5.7 Socio-economic impact

The success of each of the interventions in the cassava subsector outlined in Section 2 will manifest in increased yields and production and ultimately of food availability (food security) and incomes. Unfortunately, there have been no evaluation studies to assess these impacts neither is the data available for such evaluation.

However, it can be deduced that the fast spread of the crop in both the production and food systems is partly due to these projects and partly to the response of farmers to higher demand (commercial and subsistence) arising from a growing population. Together, these projects and farmer responses have resulted in the high contribution of 22 percent share to agricultural GDP from cassava. Other indicators of impact are contribution of cassava to per capita caloric intake and improved income from processing. The Ministry of Food and Agriculture estimates change in per capita consumption of cassava from 146 kg in 1985 to nearly 150 kg in 1995. Over the same period Yam consumption actually declined from 44 kg to just under 43 kg (Table 3).

The percentage of cassava processed and marketed also seems to be growing; US\$32.2 million worth of cassava was sold by 16 percent of cassava growing households who sold the crop, compared to US\$41.4 million earned by 55 percent of maize growing households who sold the maize further emphasize the high commercial value of cassava. In addition, the estimated total value of *gari* and cassava flour estimated by the GLSS survey was US\$10.7 million compared to the next highest value of US\$6.1 million for processed fish (Ghana Statistical Service, 1995). These values indicate a growing importance of the crop in cash income generation and more generally a probable shift from a subsistence crop to a cash crop.

The following provides a more specific assessment of the impact of cassava chip exports on employment and income. It is estimated that in 1996, 10 000 farming households were involved in the production of cassava chips for exports, earning an average of US\$150 per household.

Table 3. Estimated levels of per capita consumption of starchy staples of (kg)

Commodity	1985	1990	1995
Cassava	146.3	148.0	149.7
Yam	43.8	43.3	42.8
Cocoyam	NA	54.0	55.0
Plantain	82.5	83.0	83.5

Source: Ministry of Food and Agriculture (1995)

The introduction of this activity has also seen the entry of more men into cassava processing. The effects of these positive impacts on employment and income generation on living standards will require further analysis on the distribution of the benefits within the households and in the local economies at large.

The traditional methods of cassava processing have seen the introduction of the mechanical grater and pressor, which have helped to reduce the drudgery and labour intensity of the processing methods. The mechanized subprocess has created opportunities for a higher rate of processing and turnover. Major beneficiaries of the mechanization are women who dominate in traditional cassava processing.

It is important that any future interventions including research and extension should not only include a monitoring component, but also an evaluation component to track progress, identify implementation problems and assess impact.

5.7.1 Constraints to further development of cassava

- lack of planting material (or effective distribution system), especially of improved varieties;
- high transport costs (Asuming-Brempong, 1992; Dadson et., 1994). - Inadequate transport systems and inappropriate handling at ports (Pessey, 1996);

- limited utilization in non-traditional products (feed, composite flours, starch and starch derivatives);
- low uptake of new/improved products from research;
- low profitability of *gari* processing (Asuming-Brempong, 1992);
- poor packaging of products.

6 LESSONS LEARNED FROM PAST EXPERIENCES

Up to the early 1980s, government policies were more favourable to cereals. Non-cereal staples like cassava were almost completely neglected. Since the 1982/83 drought cassava has emerged as the most drought tolerant crop that could be relied upon in attaining food security.

Its contribution to agricultural GDP has remained the highest (22 percent) since 1989. In spite of these attributes it took the Government nearly ten years through several short-term, donor-assisted projects to arrive at a definite project (NARP) that only partially provided the much needed support (research, extension) commensurate with the importance of the crop. Priority should have been given to cassava in view of its versatility adaptation to a wide range of ecologies and extent of cultivation throughout the country. More would have been achieved for cassava with only a fraction of the inputs given to the cereals. The fallout from this achievement would then serve as a catalyst for increased food production countrywide.

There is an urgent need for a clear and dynamic cassava policy that will provide adequate support for the development of the crop from production right through to marketing including product development and export.

Due to the slow start, it is only during the past three years or so, that processing particularly for export was started by a few private entrepreneurs without government encouragement or assistance. In view of the current short falls in production to meet export quotas (for chips and pellets), Government should play a more active role by coordinating the activities of all those connected with exports to (farmers, processors, port facilities, etc.) in order to facilitate their activities and maximize their output. Breakdown in varietal resistance/tonne to pests and disease has been the base of cassava improvement. In cooperation with the International Research Institutes (IITA, CIAT), researchers should be trained in modern biotechnology techniques to enable them to study and understand the plant mechanisms that bestow resistance/tolerance. By this approach, new resistant varieties can be bred in anticipation of future pests and disease outbreaks.

Data collection for compilation of statistics for cassava is not adequate for evaluating the impact of new varieties and technologies for the guidance of policy formulation, there is a need for a strong monitoring and evaluation unit for the cassava programme.

Under NARP, several institutions/organizations handle definite aspects of the cassava programme, the current coordinator is CRI, there is a need to look far ahead into the

future and start planning now against the time when World Bank funding for NARP will end and the Government will be the sole provider of funds.

7 A SYNTHESIS OF THE IMPLICATIONS FOR A FUTURE STRATEGY FOR CASSAVA DEVELOPMENT IN GHANA

7.1 PRODUCTION

With the clear demonstration that the various interventions to promote increase in cassava production are yielding the desired results (increase of total production of 170 percent within the past ten years), it is suggested that the following measures should be adopted to increase productivity.

7.1.1 Planting material

Planting material should be made available to farmers at all times. To complement the efforts of MOFA in the multiplication of improved planting material for farmers, a programme should be initiated to identify and select three to five farms in each of the agro-ecological zones with the potential to take part in this exercise. A conscious effort should be made to provide inputs and logistics through a special fund to make this workable. This should form part of an overall national action plan for the industry. As a corollary, these farms should serve as secondary multiplication sites.

7.1.2 Research and extension

In order to make cassava attractive for use in industry, there is the need to substantially reduce the price of cassava roots to outdo the cereals, its closest substitute. To achieve this, the following should be considered:

- support for research to develop high yielding varieties that would yield in excess of 40 tonnes per hectare. These varieties should have low cyanogenic potential;
- support research and extension to develop and disseminate information on improved agronomic practices such as optimum plant population, use of healthy planting materials, development of sustainable production systems to maintain soil fertility such as intercropping, rotation and manuring, efficient pest and disease management practices;
- support research and extension to develop methods of preserving planting material when cassava is harvested during the dry season;
- use of high value compatible intercrops like soybean, cowpea that would share in the cost of production, increase productivity per unit area and contribute to revenue;
- production credit programmes should be put into place to provide credit facilities to farmers. Arrangements involving banks, organized producers and associated marketing companies (who provide guarantees of payment on behalf of producers) could be arranged;

- efforts should be made to encourage the private sector to enter into the large-scale production of cassava. Modern farming estates with outgrower schemes should be encouraged and supported. This would enable the use of machinery and the employment of modern farming techniques to improve efficiency and profitability. To encourage investors to enter into the development of farming estates, a number of potential growing areas should be identified and provided with good access to roads and other infrastructural facilities; and
- small-scale cassava farmers should also be organized into farmers groups to facilitate the sharing of facilities and dissemination of technical information.

7.1.3 Harvesting

A. Labour/drudgery in harvesting could be reduced through testing and adoption of simple manual lifting/digging devices (Thai lifting pole); b. The use of appropriate harvesting equipment to cut down on cost of harvesting. The new simple hand lifter used by peasant farmers in Thailand and adapted by the Post-harvest Unit of the Agricultural Engineering Department of the Ministry of Food and Agriculture should be adopted for harvesting smallholder cassava farms; c. For commercial and large-scale farmers, the Leipzig University cassava harvester which was developed in Germany and currently being tested at Kwame Nkrumah University of Science and Technology could be adopted if found to be practical. The harvester harvests 2–3 hectares of cassava in eight hours, an operation which would require about 75 person hours. The equipment designers are ready to enter into agreement with local manufacturers for assembling the harvesters locally.

7.2 POTENTIAL FOR COMMERCIAL AND INDUSTRIAL UTILIZATION OF CASSAVA

7.2.1 Processing

- processing plants should be sited at vantage points in the cassava producing areas. The plants should be within reach in order to reduce the cost of transportation to processing centres. Various agencies are already working with the traditional processors to improve on the equipment, for processing cassava into *gari*, dough and flour. These agencies should be identified and supported;
- commercial production of cassava chips calls for processing equipment that has high efficiency. Mechanization of a chipping programme through identification, procurement and testing of motorized and manual chipping/slicing machines (local/foreign). There are hand operated chipping machines being produced locally at affordable costs. On the other hand at a larger scale of processing, motor operated chipping machines are available. There are various drying methods from solar drying to mechanically heated aeration drying which can be adopted; and
- pelleting machinery using chips as raw material are also available and when processing in bulk at 12 000 to 25 000 tonnes pellets per annum, these pelleting machines are economically viable and are more environmentally acceptable with higher value than chips.

Further increases in production can only be realized through market-driven strategies. To underscore this suggestion, it has been shown that high yields (30 tonnes/ha) are obtained as a result of existing organized wholesale market in cassava producing areas. In addition to organized markets for the fresh roots, the establishment of processing facilities around production centres could encourage increased production, stabilize prices, enhance value-added processing into flours and instant/convenience and export market as well as increased production of chips and pellets in the country. In this respect, it is necessary to assess market-driven parameters and compare the relative comparative advantages that Ghana possess and their possible return on investment.

7.2.2 Cassava chips

The development of cassava chips is moving cassava from a situation of relative obscurity and neglect to the centre stage in national awareness and to the attention of the policy-makers, NGOs and bilateral partners (Antwi, 1994). Following the pioneering activity by a private company in developing an export led industry in cassava chips in 1993, there has been improvement in the contributions of cassava to employment generation, additional income, the livelihood of participating rural producers, export diversification and foreign exchange earnings for the country. At the level of rural producers, there has been tremendous interest and response to the new industry. Other private interests have become active in the marketing of cassava chips and working to access the export market and exploring the utilization of cassava chips in livestock feed and in alcohol production.

Though in general decline, the European Union (EU) livestock feed market for cassava chips of about 6 million tonnes per annum gives Ghana great export opportunities. This follows the continuing reductions in exports by the traditional market leaders namely; China, Indonesia and Thailand. Currently, Ghana has access to the 145 000 tonnes annual quota of cassava chips for the members of GATT set by the EU. This quota has never been fully utilized in the past. The best performance of nearly 57 000 tonnes was achieved in 1995 (Macambro pers. comm., 1996). Ghana's export performance of cassava chips of about 20 000 tonnes in 1996 accounted for about 75 percent of the performance under the GATT quota in that year (Tanoh pers. comm., 1997). Apart from the export, other potential markets for cassava chips currently being developed include: the local livestock feed market which is using about 100 000 tonnes of cereals per annum and the industrial production of alcohol.

7.2.3 Cassava-based flours for bakery and industrial uses

A study has indicated that there is a significant market potential for unfermented cassava flours as partial or total replacement for wheat in food and for the manufacturing of plywood and paperboard in industry (Day *et al.*, 1996). In industry, the application of cassava flour could replace wheat flour which is used by the plywood industry as glue extender and possibly the industrial starch used in paper board. Presently the demand for industrial starch is estimated at about 2 500 tonnes per annum and could increase to about 5 000 tonnes per annum.

The largest market potential for cassava flour in the medium-to long-term in Ghana lies in food applications (Day *et al.*, 1996). Cassava flour could potentially substitute large amounts of wheat flour currently used in bread, snacks and other food items. The market of wheat flour imported into the country is estimated at between 250 000 to 300 000 tonnes per annum. The possibility of replacing up to 20 percent or more of imported wheat flour with cassava flour is very attractive. A marketing sample survey conducted at the recent Industry and Technology Fair dubbed INDUTECH '97 held in Accra from 28 February to 10 March 1997, clearly showed that a composite flour of 20 percent cassava inclusion rate was widely accepted by the public as comparable to 100 percent wheat flour.

In spite of considerable research on bread making and the use of composite flours, there has been little impact on commercial practice (except where government controls wheat imports as in Nigeria). Cyanogenic glucosides contents, microbial contamination and inadequate drying have precluded uptake of cassava flour by large-scale food processors. With the informal producers of snack foods, cassava flour may prove popular as they have lower quality requirements compared to large-scale food processors. The most promising food products for cassava flour substitution on account of simplicity are pies/pastries, cakes, biscuits and doughnuts.

There is inadequate data on the size of the non-bread wheat flour market in Ghana (Day *et al.*, 1996). Factors likely to expand the market with the possibilities for inclusion of cassava flours are urbanization, population growth and rising incomes. On the evidence of public response to snacks made from cassava composite flour presented at the INDUTECH '97 Fair, the prospects look good.

7.2.4 Cassava pellets

Although there is no export-based pelleting project in the country, it would be relevant to remark that over 90 percent of cassava chips that are exported to the EU enter as pellets. Hence as the export of cassava chips increases, this should be kept in view. Thailand started cassava chips export as raw chips but because of environmental concerns, most of the chips are now exported as pellets. Presently, GAFCO is the only company which has pelleting facilities and uses it for internal consumption requirements. Arrangements are far advanced to build for the first pelleting factory in the country to produce 25 000 tonnes of pellets annually for exports to the EU.

7.2.5 Cassava starch

The local market for starch is about 5 000 tonnes per annum. In the context of annual cassava production of about 7 million tonnes, the industrial starch market offers relatively little potential to expand the market for cassava (Day *et al.*, 1996). Although the starch market in Ghana is very small, major opportunities for starch lie in the regional and subregional exports. Significant markets exist in Nigeria and South Africa (KB Consultants, 1995). In South Africa, the annual consumption of starch is about 300 000 tonnes per annum with an annual growth rate of 12 000 tonnes. Keen interest is currently

being shown by investors from South Africa to invest in starch production in Ghana. A local company, GLUCOSET, which plans to produce high quality starch for both domestic and export markets is sufficiently large to attract potential investment (Noamesi, pers. comm.).

7.3 CONSTRAINTS TO MARKET DEVELOPMENT AND EXPANSION OF CASSAVA

Research and Development (R&D) of expanded markets for cassava has been identified as a major bottleneck in the promotion of cassava as a food security and industrial crop. Available data suggests that Ghana has a comparative advantage at the farm gate for cassava. However, this advantage is quickly to slow down the marketing chain. This is mainly attributed to poor road and transport infrastructure and the associated high transport costs, as well as the comparative inefficiency of marketing systems (Day *et al.*, 1996). The improvement for competitiveness of Ghana in the cassava export markets. It is worth pointing out that the problem of the inefficiency of market systems is not peculiar to cassava. In addition to problems and constraints listed in the National Cassava Task Force Report (NCTF, 1996), the following are some of the constraints to market development of cassava which are to be addressed to raise cassava as a major agricultural commodity in Ghana:

- there should be a scheme of government guarantees to support private companies in the acquisition of low interest credits from financial institutions. The credits could be long-term for the procurement of capital items such as transport vehicles and storage facilities. There should also be short- and medium-term credit for working capitals;
- there should be a targeted programme of access and feeder road rehabilitation to link up high potential areas for cassava production with the private sector (entrepreneurs and processors);
- export handling procedures and tariffs of the Ghana Ports and Harbours Authority, private stevedoring companies, the Ghana Shoppers Council and Customs, Excise and Preventive Service should be reviewed to improve efficiency and minimize costs;
- further investments are required to upgrade port facilities (i.e. export wharf and handling of additional bulk exports).

In conclusion, enhancing the marketing opportunity for cassava and its products calls for government intervention in the promotion of investments in the development of cassava products by guaranteeing loans for the private investor, the use of legislation to protect investors in the development of cassava, intensive education of consumers and encouragement for schools of manufacturers in the food industry to use cassava products.

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APPENDIX I

Best cassava-producing districts in each region of Ghana

Region	District	Production (tonnes)	Acre (ha)	Yield (tonnes)
Eastern	Birim South	259 720 (2)	17 200 (1)	5.1 (10)
	Asuogyaman	182 000 (4)	10 000 (7)	- 18.2 (6)
	West Akim	171 000 (5)	15 000 (2)	11.4 (12)
	Manya Krobo	153 720 (7)	8 400 (10)	18.3 (5)
G/Accra	Tema	46 084 (21)	11 200 (6)	4.1
	East Dangbe	20 500 (24)	5 000	4.1
	Ga		5 000	4.1
Volta	Nkwanta	234 000 (3)	13 000 (5)	18.0 (7)
	Kete Krachi	144 000 (8)	8 000	18.0 (7)
	Hohoe/Jasikan	68 400 (15)	3 800	18.0 (7)
Northern	Bimbila	31 500 (22)	4 200	6.5
	Bole	28 500 (23)	3 000	9.5
	Tolon Kumbungu	17 000 (25)	2 000	8.5
	Damongo	-		
Brong Ahafo	Techiman	270 560 (1)	8 900 (9)	30.4 (1)
	Atebubu	132 540 (9)	14 100 (4)	9.4
	Wenchi	116 100 (10)	5 400	21.5 (3)
	Sunyani	107 730 (11)	5 700	18.9 (4)
	Nkoranza	112 739	4 070	27.70 (2)
Ashanti	Atwima	157 300 (6)	14 300 (3)	11.0 (13)
	Amansie West	102 000 (12)	10 000 (7)	10.2 (17)
	Amansie East	83 200 (13)	8 000 (11)	10.4 (15)
	Offinso	73 200 (14)	6 100	12.0 (11)
Western	Juabeso-Bia	59 129 (15)	5 797	10.2 (17)
	Wassa Amenfi	58 181 (18)	6 256	9.3
	Aowin Suaman	55 558 (20)	5 974	9.3
Central	Mfantseman	64 459 (14)	6 081	10.6 (14)
	Agona	59 384 (17)	5 710	10.4 (15)
	Upper Denkyira	55 876 (19)	5 478	10.2 (17)

Best three districts in each region with high potential for cassava production

- Figures in brackets are ranked

** Districts with high yields*

APPENDIX II

Estimates of determinants of village level mean cassava root yield (kg)

Explanatory variables	Minimum set model	Population cassava/ sales Model	Population purchased input model
Intercept	4 288.96	4 006 580	-3 755.976
	(2.316)	(2.410)	(-2.259)
Climate Zone	2 221.553	1 414 663	3 046.419
(1 if subhumid)	(2.877)	(2.053)	(4.863)
Village mean plant density (stds/ha)	0.323	0.760	0.583
	(4.353)	(1.730)	(6.038)
Village mean plant Age (months after planting)	480.989	276.204	-59.906
	(2.908)	(1.730)	(-4.297)
Village population	-110.895		
Density	(-6.984)		
Village mean proportion of cassava		68.610	3 402.002
Marketed (percent)			(10.295)
Hired labour used in village (1 if yes)			
Statistics: R ²	0.19	0.39	0.54
F-value	18.122	28.400	50.715

Source: Unpublished COSCA data 1990/91