3 CASSAVA PRODUCTION TRENDS

3.1 REGIONAL TRENDS IN CASSAVA PRODUCTION

Historic trends in the area planted to cassava and yields in sub-Saharan Africa are governed by climatic, technical, biological, economic and institutional or political factors. In this section the most significant trends are discussed and their implications analysed.

Figure 2 shows that total production of cassava increased from about 35 million tonnes in 1965 to over 80 million tonnes in 1995, an annual growth rate of 2.9 percent, which was the same as the population growth rate, so that average per capita production has not increased. However, per capita production has increased during the last decade as total production has grown faster (3.8 percent) than in the preceding decade (2.5 percent).

Figure 3 shows that the five largest producers of cassava in sub-Saharan Africa have increased their share from about 70 to 80 percent over the last two decades. The biggest increase has been in Nigeria which increased its share from 22 to 38 percent and Ghana which increased its share from 4 to 8 percent. The share of other producers has declined and Zaire has moved from being the largest to the second largest producer after Nigeria.

Figure 2. Trend in production of cassava in sub-Saharan Africa, 1965–95

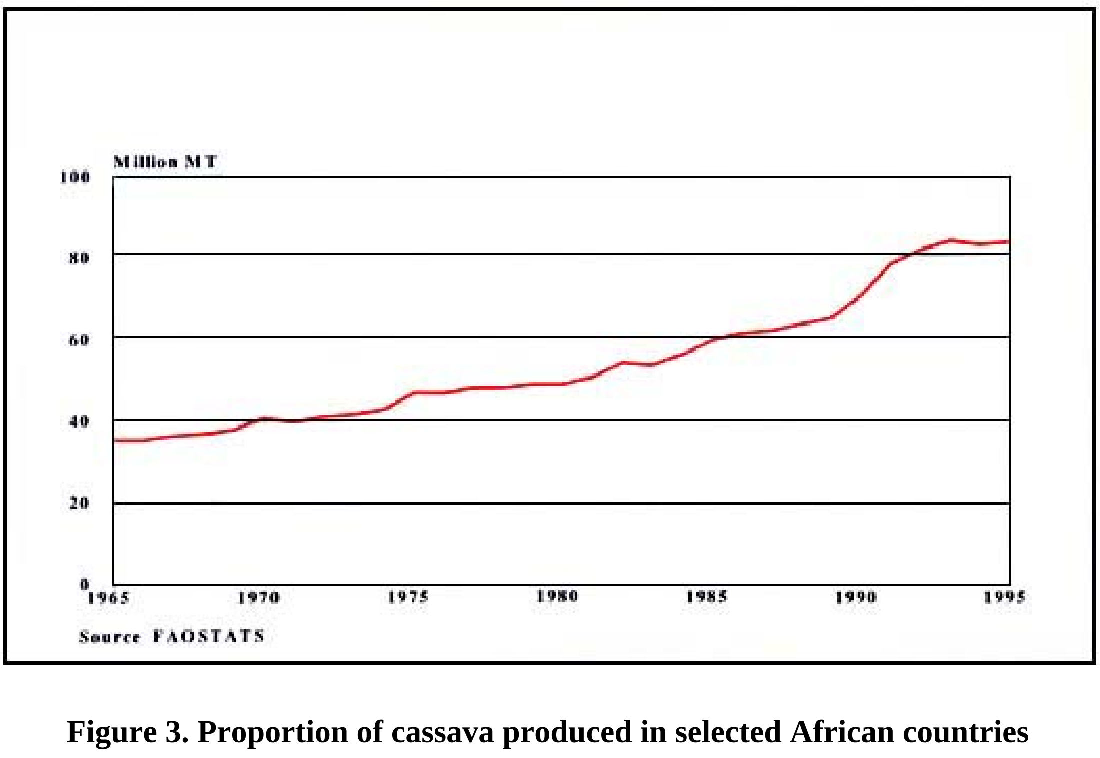
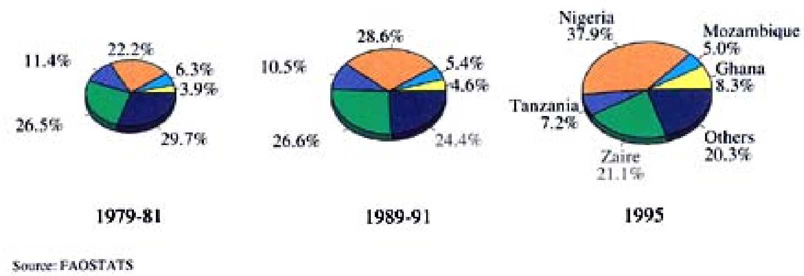


Figure 3. Proportion of cassava produced in selected African countries



Agro-ecological zones cut across regional boundaries. Consequently, data are not available in the FAO statistics that give production trends by agro-ecological zones. However, Spencer (in press) provides a breakdown of annual production of roots and tubers, about two-thirds of which is cassava, by the mandate agro-ecological zones of IITA. Figure 4 shows that over 60 percent of the total production of roots and tubers, is produced in the Moist Savannah zone, with virtually all the rest being produced in the Humid Forest Zone.

Figure 5 shows that according to FAO statistics, most of the increase in production has been due to increases in area under cultivation, rather than increases in yields. While average yields have only increased by 33 percent over the last two decades, areas under production has increased by about 70 percent. What is even more worrying is that while the annual rate of growth in areas under production has increased to 3.2 from 1.3 percent during the previous decade, that of yield has declined from 1.2 to 0.6 percent. Figure 6 shows that it is only in Ghana that yield has increased significantly during the last five years.

Figure 4. Trend in annual production of roots and tuber Crops in the mandated agro-ecological zones of IITA, 1961–1991

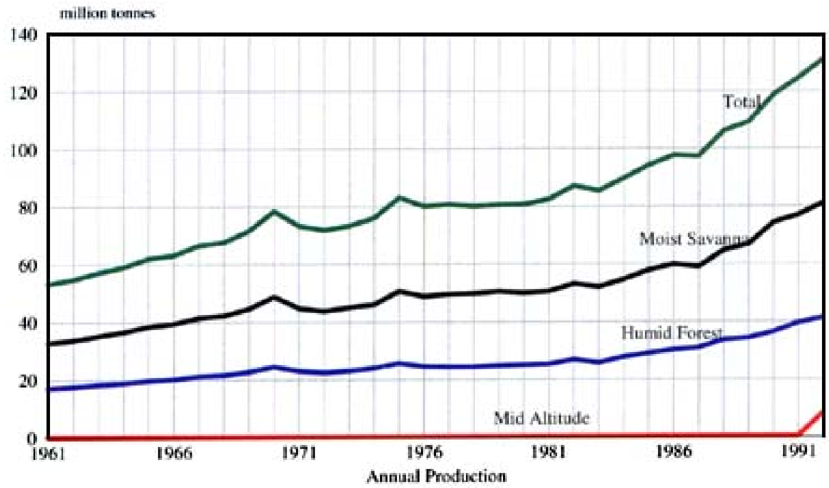


Figure 5. Cassava area and yield in Africa, 1961–1995

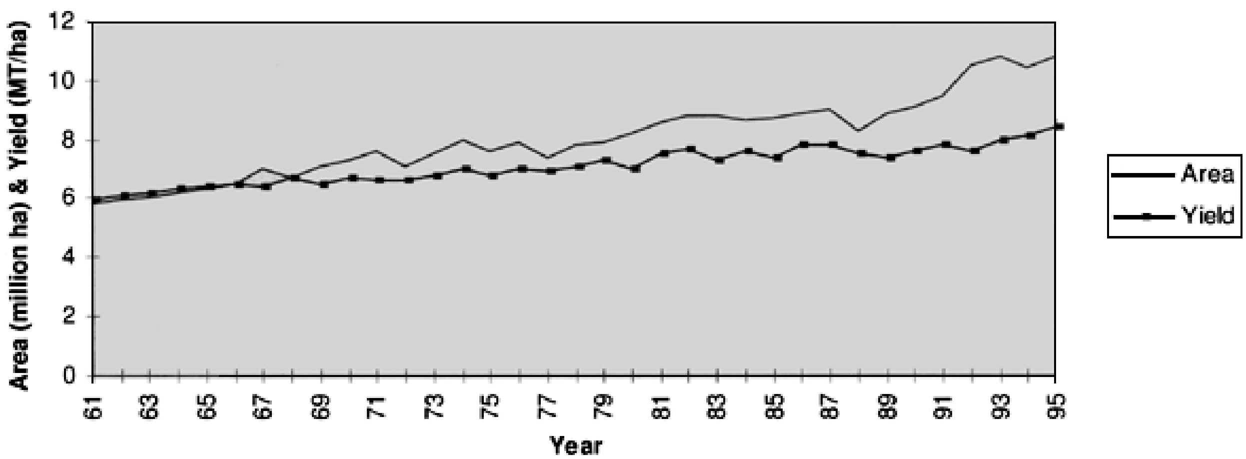
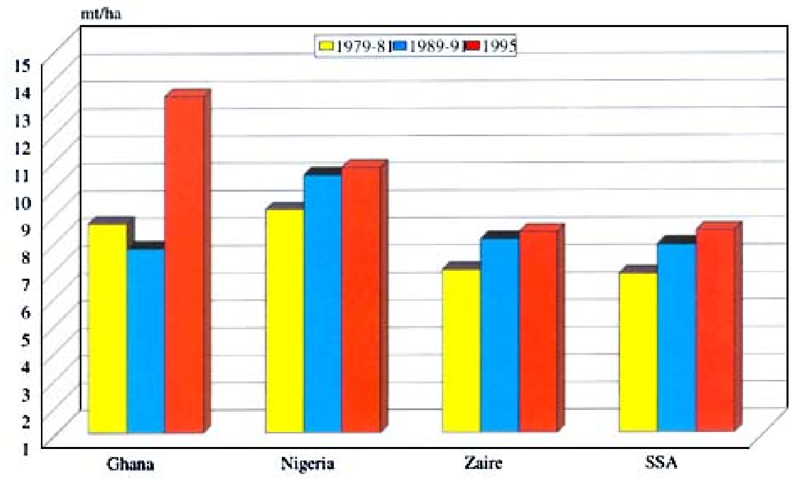


Figure 6. Average cassava yields in selected African countries and in sub-Saharan Africa



However, data available from the farm level COSCA surveys and other observations would indicate that the yields reported in the FAO statistics underestimate current yields in Africa. The overall mean of fresh root yield in 1991 is estimated at 11.9 tonnes per ha from the COSCA database (Table 1). During the same year FAO statistics report an average yield of 7.9 tonnes per ha. The COSCA yields are skewed to the lower side of 8 tonnes, with a range from less than one tonne to over 60 tonnes per ha.

Table 1. Yield Components for cassava in sub-Saharan Africa, 1991

Yield Component	Mean	Minimum	Maximum	Standard deviation	Number of fields
Fresh root (tonnes/ha	11.90	0.40	67.10	8.39	501
Plant density (stands/ha	1 774.00	500.00	41 250.00	5 280.00	500
No. of roots per plant	6.00	1.00	36.00	4.33	500
Average root wt. (kg/root)	0.40	0.05	5.18	0.32	500
Harvest index	0.50	0.03	0.89	0.13	497

Source: COSCA

Data from COSCA and ESCaPP show that farmers recognize that there has been an increase in cassava production in all the agro-ecological zones in sub-Saharan Africa. From the ESCaPP database 74 percent of the respondents claim that there has been an increasing trend in the dynamics of cassava production. Reasons for the trend from both the COSCA and ESCaPP studies, vary across the zones. The six most important reasons are shown in Table 2.

Table 2. Percentage distribution of reasons given by farmers for increased cassava production by agro-ecological zone in sub-Saharan Africa, 1991

Reason	Humid	Sub humid	Non-humid	Highland-humid	Weighted average
Drought	4.75	5.20	2.88	0.00	3.21
Famine/hunger	17.32	29.48	17.63	13.83	19.57
Population growth	18.16	6.65	6.41	3.19	8.60
Higher prices and market access	12.85	11.56	4.49	8.57	9.38
Pests and diseases	10.06	15.61	15.71	12.77	13.54
High yields	9.78	2.31	3.21	18.69	8.5
Others [1]	27.08	29.14	49.67	42.95	37.21

Source: COSCA

[1] *Comprises 29 other reasons from poor soil fertility to government price policy*

Across all zones, farmers indicate that the most important reason why cassava production is increasing is in response to famine, hunger and drought. The second most important reason is the crops resistance to pests and diseases. This confirms that cassava is planted as a food security crop, an issue discussed in more detail later. Increases in production due to population growth, higher prices and increased market access, as well as increasing yield of cassava, are more important in the humid than other zones (except for high yield in the highland-humid zone), pointing to the importance of these market related factors in driving farmers to increase cassava production. This is significant, as such factors are expected to increase in intensity over the next two decades, as a result of urbanization of humid West Africa.

Table 3 shows that as cassava production is expanding in Africa, the crop is to a large extent replacing fallow, confirming that most of the production increase has been due to increase in crop area. The fact that COSCA data also show that cassava is often planted just before land is allowed to go into fallow indicates that the crop is also being used to increase land use intensity. Cassava is also replacing other root crops, especially yam in the humid zone, maize in the non-humid zone and other food crops in the subhumid zone at important rates. The potential impact of these phenomena is discussed later.

Table 3. Percentage of farmers reporting that cassava is replacing alternative crops by agro-ecological zone in sub-Saharan Africa, 1991

Crop replaced	Humid	Subhumid	Non-humid	Highland humid
Yams	16	16	6	0
Cocoyams	11	4	0	0
Potato	4	2	6	0
Plantain	5	0	2	0
Banana	2	0	0	0
Maize	1	9	21	0

Crop replaced	Humid	Subhumid	Non-humid	Highland humid
Rice	2	4	0	0
Other food crops	8	20	21	12
Cash crops	11	6	3	2
Fallow	40	39	42	43

Source: COSCA and ESCaPP

3.2 RESOURCE USE IN FARM PRODUCTION

Mixed cropping. In cassava growing areas of sub-Saharan Africa, multiple crops are produced in multiple fields by each farmer. Results from the COSCA show that farmers grow an average of six to seven crops, with a range of one to 15 crops. Only about 25 percent of the fields were planted with a single crop. Rice, yam and cassava were the crops grown most often as sole crops. It is clear that for cassava mixed cropping is the usual practice

Labour use. Results from statistical analyses carried out by Tshiunza (1996) using COSCA data, on cassava field production labour (family as well as hired) under different conditions of demographic and market pressures are presented in Table 4. They show that total field production labour varies from country to country, with the highest in Nigeria and lowest in Côte d'lvoire. Farmers allocate more labour to all farm operations, except land clearing, in high than low population density areas. This counterbalances the lower labour input allocated to other farm operations and results in a lack of significant difference in total field labour between the two “demographic” areas, as shown in Table 4.

Overall, the total amount of labour allocated to the production of cassava is highest under recurrent cultivation and statistically the same between shifting and continuous cultivation systems. The amount of labour allocated to each farm operation under recurrent cultivation is greater than that under shifting cultivation. The difference in total field production labour between recurrent and continuous cultivation systems and between shifting and continuous cultivation is due to land clearing and weeding operations. More labour is allocated to land clearing operations in shifting and recurrent than continuous cultivation. The opposite holds for weeding operations.

Table 4. Total field labour (person days/ha) in cassava production by selected factors by country

Factors	Overall	Côte d'lvoire	Ghana	Nigeria	Tanzania	Uganda	Zaire
Population density							
High	194[a]	-	188[a]	225[a]	182[a]	190[a]	190[a]
Low	191[a]	181[a]	179[a]	221[a]	184[a]	183[a]	194[a]
Cultivation system							
Continuous	184[a]	170[a]	182[a]	218[a]	168"	182[a]	180[a]
Recurrent	222"	198"	217[b]	255°	204"	214[b]	240[b]

Factors	Overall	Côte d'lvoire	Ghana	Nigeria	Tanzania	Uganda	Zaire
Shifting	183[a]	158[a]	186[a]	200[c]	166[a]	172[a]	195[c]
Field location							
Nearby	197[a]	175[a]	190[a]	227[a]	201[a]	201[a]	212[a]
Distant	192[a]	168[a]	182[a]	211"	176[a]	176"	202[a]
Average	195	150	189	222	183	188	202

Source: Adapted from Tshiunza (1996)
Note: For each factor, means (in column) with the same letter are statistically the same

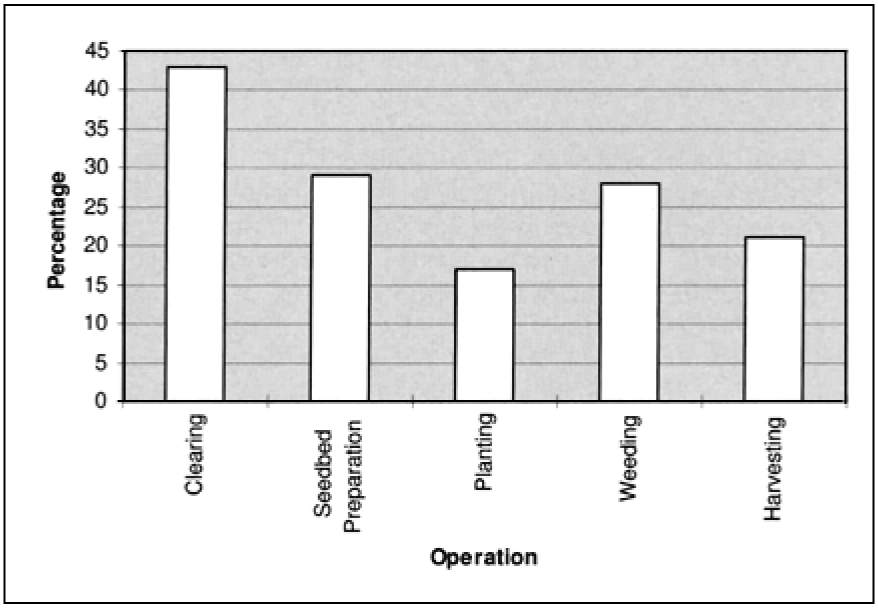
The results also indicate that good access conditions to market places and higher levels of cassava result in agricultural intensification since they result in increased total field production labour.

Hired labour is the most frequently used external input in farm production systems in sub-Saharan Africa. COSCA showed that it is employed for use in one or more farm tasks in 41 percent of the fields of the major food crops including cassava (Nweke, 1994b). The proportion was highest for yam (67 percent), lowest for sweet potatoes (13 percent) and close to the overall average for cassava (40 percent). Hired labour is used in various combinations with family labour in the performance of land clearing, seedbed preparation, planting, weeding, harvesting and field-to-home transportation operations. It is used more frequently in land clearing and seedbed preparation (Figure 7).

In cassava production systems in sub-Saharan Africa, only three operations are usually mechanized: land clearing, seedbed preparation and field-to-home transportation. Of the three farm operations, transportation is the most frequently mechanized, with transport of cassava from 30 percent of the fields being by motorized means (Tshiunza, 1996). Pingali *et al*. (1987) also reported that transport is usually the first farm operation to be transferred from human to animal power and only then comes ploughing. Primary tillage and transport are extremely power-intensive and are usually transferred to a new source of power even when wages are low.

Generally, the cultivation of cassava is thought to require less labour per unit of output than most other major African staples (Goering, cited in Berry, 1993). This view is corroborated by results of crop budgets developed by Kaindaneh (1996), which shows that cassava requires less labour per unit of output, relative to upland rice, inland valley swamp and maize production, in Sierra Leone. Expansion of cassava production in Africa would seem to be leading to increased labour productivity in the region.

Figure 7. Percentage of cassava fields by farm task executed with hired labour



Source: COSCA

Credit use. COSCA data show that among traditional credit sources, namely, moneylenders, cooperative societies and traders who provide production credit to farmers, the cooperative societies were the most widespread, being available in 70 percent of the COSCA villages surveyed, apart from Zaire, where they were available in only 15 percent of villages. The societies are more prevalent in areas where farmers have easy access to market. Production credit from traders was available in only 20 percent of the villages (Nweke, 1996). It was common in Nigeria, but completely absent in Uganda. Access to money lenders was most common in Ghana and Nigeria and least in Tanzania and Uganda. It is clear that access to production credit, especially from institutional sources, is restricted in cassava growing areas.

3.3 USE OF IMPROVED PLANTING MATERIALS

Development of improved varieties. In addition to the germplasm introduced by the Portuguese, subsequent introductions and breeding efforts have generated high yielding, resistant genotypes. The early challenges for improvement were diseases like African Cassava Mosaic Disease (ACMD) and Cassava Bacterial Blight (CBB). During the 1970s, the development of improved cultivars incorporating disease resistance was a major breakthrough in cassava improvement in Africa. ACMD-and CBB-resistant genotypes are available at IITA as virus-indexed plantlets, ready to be shipped to any institution.

Several clones which combine good levels of resistance to the Cassava Green Mite (CGM) in addition to the other diseases and pests and low cyanogenic potential, have also been developed. Many cassava improvement programmes in Africa have received these materials in tissue culture and true seed forms. They have then tested them under their local environmental conditions, selected varieties that outperform local varieties and released them to farmers. For example, in West Africa, over 25 improved cassava varieties have been released or are recommended by the National Programme in Nigeria; in Sierra Leone up to eight varieties have been released by the Institute of Agricultural Research and four in Ghana. In East and Central Africa, Cameroon has released seven varieties, Zaire five, Uganda four, Tanzania ten and Zimbabwe four. At least three varieties have been released in virtually all the other cassava producing countries in sub-Saharan Africa.

Interspecific hybridization and spontaneous polyploidization have resulted in the production of polyploids that promise even higher yield plateau than current diploids. Ploidy manipulation will also give breeders great versatility for moving genes between Ploidy levels of cassava and provide a powerful tool for the study of the plant gnome.

Procedures for meristem culture and virus indexing for ACMD in cassava have been established. Since the early 1980s, an agreement has been reached with African phytosanitary regulatory agencies to permit the movement of *in vitro* virus-tested cassava germplasm in Africa. The meristem culture technique has been successfully used to transfer cassava germplasm from the field gene banks at IITA and in Ghana and the Republic of Benin, to the *in vitro* gene bank at IITA and from IITA to a number of countries in Africa and to Centra International de Agricultura Tropical (CIAT), in Colombia.

Cassava is propagated by cuttings that are generally large and awkward to transport and handle when compared with grains. A method has been developed for rapid multiplication and easy distribution of healthy cassava planting materials. This method, which involves primary (researchers), secondary (researchers and non-governmental organizations, NGOs) and tertiary distribution (NGOs and farmers sites) has been established and has been used successfully in several countries such as Cameroon, Malawi and Uganda. Techniques for overcoming physiological and pathological problems in the production of planting materials have been developed and are being disseminated through special projects such as ESCaPP and other various rapid cassava multiplication programmes.

Adoption of improved varieties. Despite the achievement mentioned above, Table 5 shows that adoption of improved varieties of cassava was not widespread by 1991, except in Nigeria. However, more recent evidence points to increased adoption rates in a number of countries, such as Ghana, Sierra Leone and Uganda.

Table 5. Percentage distribution of villages according to the proportion of farmers using improved cassava planting materials in selected countries in 1991

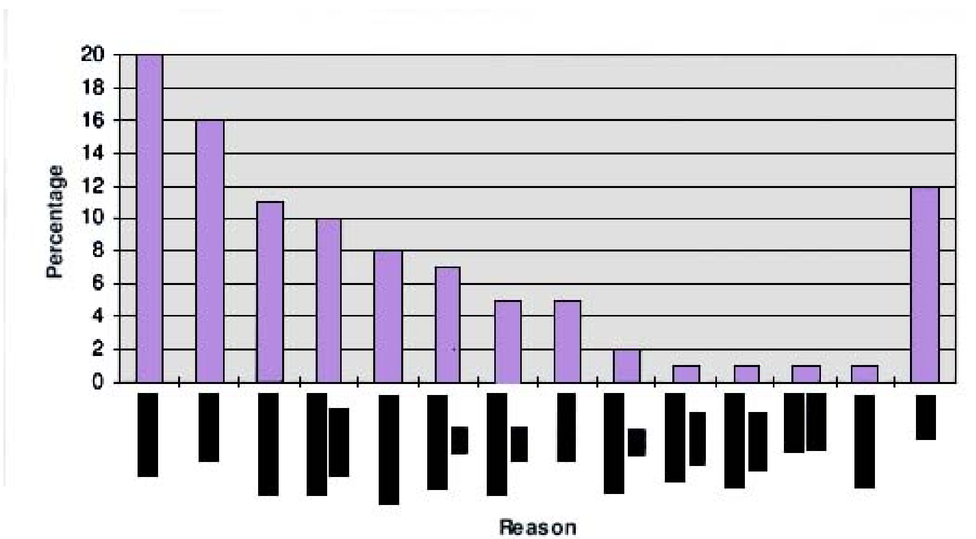
Proportion of farmers using	Côte d'Ivoire	Ghana	Nigeria	Tanzania	Uganda	Zaire
None	100.00	100.00	11.3	50.0	87.5	97.2
Few	0.0	0.0	30.2	50.0	4.8	2.8
Many	0.0	0.0	35.8	0.0	4.8	0.0
Most	0.0	0.0	22.6	0.0	4.8	0.0

Source: Nweke et al., 1994

Given the broad spectrum of improved varieties available on the shelf and the low level of adoption of such technologies outside Nigeria, questions of the appropriateness of such varieties, the adequacy of extension systems, or the policy environment, arise. These issues are discussed later.

Reasons for abandoning varieties. Figure 8 shows the relative frequency of reasons given by farmers for abandoning varieties. They give a good insight into the characteristics farmers are looking for in improved varieties.

Figure 8. Percentage distribution of cassava genotypes which were no longer cultivated by farmers, by reason of abandonment



Source: COSCA and Nweke 1994

The most frequent cited reason was "late bulking". The implication is that in villages where the cultivation of those genotypes was abandoned, the farmers were selecting for early bulking. Where farmers were selecting for high root yield, weed suppression, good in-ground storability, disease and pest tolerance, good processing qualities, desirable branching habit, low HCN potential, good cooking qualities, good planting material yield, etc., the varieties that did not have the desired traits were abandoned.

Fertilizer use. Though research on fertilization has shown that cassava is able to grow and give reasonable yields in low fertility soils, adequate fertilization is needed for the crop to reach its maximum production potential. Cassava requires relatively little nitrogen to achieve high yields, so that it responds to no more than 100 kg/ha of nitrogen, after which diminishing marginal returns set in (Tshiunza, 1996). Phosphorus is the most important nutrient for obtaining yield increases in cassava, with yield response to applications of as much as 400 kg/ha, though levels of 100 to 150 kg/ha are frequently recommended (Cook, 1985). Cassava extracts more potassium from the soil than any other element. A good crop extracts 100 kg/ha or more. To maintain high yield when cassava is grown in one area continuously, potassium fertilization is essential. Potassium availability also affects quality, since its deficiency leads to lower dry matter and starch content and consequently a higher cyanide content.

COSCA data shows that chemical fertilizers are applied to about 3 percent of cassava fields and manure to about 7 percent of the fields. This compares to 2 percent of banana/plantain fields, 11 percent of rice fields, 15 percent of maize fields, 20 percent of yam fields and 5 percent of all fields (Nweke, 1994b). Lageman (cited in Tshiunza, 1996), observes that, in the densely populated village of Umuokele in Nigeria, farmers applied mulch and manure to their outer fields. Nweke *et al.* (1994) state that while fallow periods decline as population density increases, the use of organic manure, livestock grazing and other agricultural land use intensification cultural practices become more frequent in the cassava-producing zones of sub-Saharan Africa.

While it is not possible to determine what the optimum level of fertilizer use should be for cassava systems within the framework of this review, it is clear that, despite its ability to do well in poor soils, levels of use should increase, particularly for phosphorus and potassium, if cassava is to fulfil its potential in sub-Saharan Africa.

3.4 PRODUCTION CONSTRAINS

Shortening fallow periods and declining soil fertility. The predominance of different fallow systems varies among villages, depending on soil fertility status and on pest/disease, market and demographic pressures. It is often reasoned that as fallow periods decline, cassava will increasingly replace crops which demand higher soil fertility and production labour. However, although cassava is well adapted to growing under continuous cultivation, it is not as frequently grown under that system as other major staples.

The farmers' ability to respond to declining fallow periods due to demographic, market, pests/disease and other pressures by replacing more susceptible crops with cassava is constrained by its long cropping cycle. Cassava can be harvested from six months after planting, but most available local varieties do not attain maximum yield before 22 months. Currently improved varieties attain their maximum yield at 12–15 months. Under intensive cultivation where the fallow period is often less than one year, such varieties are not ideally suited because they may be harvested before they attain maximum yield. However, early-bulking varieties are not likely to reduce this pressure unless they are combined with agronomic practices for greater water and nutrient-use efficiency. Shortening fallow periods require varieties selected for efficient nutrient assimilation and for better ability to be intercropped with legumes or other soil fertility conservation strategies.

Insufficient and poor quality planting material. Cassava production is dependent on a supply of vegetative planting materials (i.e. stem cuttings). The multiplication rate of these materials is very low in comparison with grain crops which are propagated by true seed. In addition cassava planting materials are bulky and highly perishable as they dry up within a few days after harvest and hence their multiplication and distribution are expensive relative to conventional (grain-based) seed services. The yield stability and environmental development of cassava is highly dependent on the quality of planting materials and there is evidence that the initial use of healthy cuttings is a very important factor in the subsequent attainment of good yields. Conversely, cuttings with low vigour and which are infested/infected by pests and diseases, often limit cassava production. However, there is insufficient knowledge concerning criteria appropriate for selection of vigorous and clean cuttings and on the optimal conditions for their propagation and maintenance. Pests and diseases, together with poor cultural practices, combine to contribute to yield losses that may be as high as 50 percent.

In dry agro-ecosystems, where biomass production is usually low in comparison with more humid areas and in areas where new materials such as improved varieties are being introduced for the first time, the production of planting materials in sufficient quantities is a major restriction to the widespread and rapid adoption of the crop or a variety.

Lack of well adapted varieties. COSCA data indicate that in surveyed countries representing at least 80 percent of cassava production in Africa, farmers are abandoning old cultivars and introducing new ones. This indicates the farmers' need for better varieties, but also highlights the danger of loss of genetic diversity. While it is increasingly evident that cassava is expanding into the semi-arid and mid-altitude zones, the available improved germplasm is mostly adapted to the lowland humid tropics. Therefore, germplasm adapted to more agro-ecological zones is needed. Expansion of the utilization of cassava to new industrial uses requires germplasm with high yield as well as quality that is tailored to specific end-uses.

Plant pests and diseases. Historically, cassava had few serious pests and diseases in Africa. However, the situation changed as cassava cultivation intensified and exotic pests were introduced. Although it is now widely accepted that cassava in Africa is attacked by a number of serious pests, only a few in-depth studies of the ecological and economic importance of any of these species have been carried out. The major cassava pests in Africa include relatively few phytophagous arthropods, plant pathogens and weeds compared to the pest complex found in the neotropics. Together, these species could reduce cassava production by as much as 50 percent. The most severe pests are the exotic species accidentally introduced into areas where the local germplasm is susceptible to attack, where effective natural enemies/antagonists are absent and where a tradition of practices to cope with the introduced pests has not had time to evolve. In addition, pest problems are being created where intensification of cassava production erodes the environmental stability inherent in balanced agro-ecosystems. The major pest concerns are cassava green mites, variegated grasshopper during outbreak episodes, root mealybug in the rain forest ecozones, African Cassava Mosaic Disease (ACMD, cassava bacterial blight (CBB), cassava anthracnose disease (CAD) and root rot in the humid lowlands. The role of termites, nematodes and certain weed species particular to specific ecozones have been reported as constraints but have not received adequate attention. Other root rot are also found in other ecozones including the highlands.

The appearance of cassava mealybug (CM) and CGM as introduced pests in the 1970s in Africa had devastating effects in farmers' fields. In particular, the CM attack was so severe that it threatened the future of cassava in Africa. Massive efforts spanning several continents and involving numerous international and national research institutions under the leadership of IITA led to the development of a successful continent-wide biological control programme. Natural enemies of CM were identified in South America and the parasite *Epidinocaris lopezi* has been released in many countries in Africa. Biological control, along with improved varieties and cultural practices, provide a cost-effective, sustainable and environmentally friendly technology for the control of CM without using insecticides. The wide-spread establishment and documented impact of exotic predatory mite species offers good hope for biological control of the CGM as well.

The longer shelf life of fresh cassava and extended storage of dried cassava (chips/flour) will aggravate the problems caused by post-harvest pests. These include the devastating larger grain borer (LGB) and a number of root rot. LGB can consume as much as 74 percent of cassava chips in only four months after harvest. Fungi are also known' to infest cassava chips during processing and handling, in the field or during storage; they may lead to the formation of mycotoxins, making the chips unable to meet trade and health standards.

4 CASSAVA AS A FOOD SECURITY CROP

Cassava plays a food security role in areas prone to drought, famine and in periods of civil disturbances. The crop's ability to provide a stable food base is a function of its flexibility in terms of planting and harvesting strategies and because of its relative tolerance of poor soil and pests/disease problems. It is also widely appreciated as a low cost carbohydrate source for urban consumers especially where it is available in convenient forms for working urban housewives.

4.1 STABILITY OF PRODUCTION

Cassava producers, like all farmers, face two types of risks, production and price risks. Production (or yield) risks are those which arise because of natural causes such as variation in rainfall, weather, pests or diseases. Yield fluctuations are largest for an individual plot of land. Therefore, a particular producer may reduce exposure to yield risk by farming spatially dispersed plots of land, diversifying crops and growing crops less subject to the effects of drought, e.g. cassava. Across the continent, the fluctuations are also reduced by the diversity of population size and income levels.

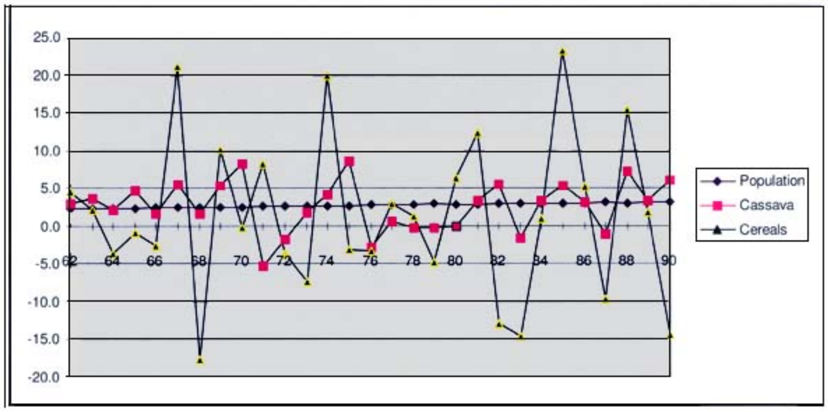
Price risks affect the prices of the commodities farmers produce and the inputs they buy. As output price risk seems to be the most important element of farmers' decision-making processes and also because African cassava farmers hardly ever use purchased inputs that are foreign to the area of production, it follows that reference to risk, as far as cassava producers are concerned, should be addressed mainly to output price risk.

At the market level, price and production risks are intimately related. Hence, at a country level, a critical difference is whether the commodity is non-tradable [1] or tradable. For a non-tradable commodity, assuming fluctuations in demand to be negligible, the original source of risk lies in the fluctuations of domestic production. Price fluctuations are then directly linked to production fluctuations as low equilibrium prices clear the market when production is high, implying a negative correlation between production and prices. Since the major portion of cassava produced in Africa is non-tradable, it reinforces the need to focus on output price risks.

By giving producers the flexibility to adjust to changing market conditions, cassava facilitates income stabilization and mitigates the effects of risk for specialized commercial producers, as well as for low income farmers who consume a large share of their output. This suggests in turn that the flexibility in income management derived from cassava production may also be important for issues of urban food supply as well as for rural income.

In Figure 9 annual growth rates for population, cereal production and cassava production are plotted to give an idea of the variability of production. While population growth rate in sub-Saharan Africa has exhibited very little variation over three decades, annual output growth for both cassava and cereals has fluctuated quite a bit. However, the variation in cassava output has been less than that for cereals as a whole[2], range from -2.5 to 11 percent, that for cereals ranged from -13 to 32 percent. This confirms that cassava is a more dependable food crop than cereals in sub-Saharan Africa.

Figure 9. Population, cassava and cereals production growth rates in sub-Saharan Africa, 1962–1990



Source: FAO/WATI

4.2 SOURCE OF LOW COST NUTRIENTS

Cassava is a major source of dietary energy for low income consumers in many parts of tropical Africa, including major urban areas (Dahniya, *et al.*, 1991, Berry, 1993, Nweke, 1994). Table 6 shows that farmers in a third of villages in the cassava growing areas of sub-Saharan Africa rated it as the most important crop. In half of the countries covered it was rated as the most important food crop. Maize was chosen as the most important crop in three countries (Burundi, Kenya and Malawi), while yam was rated as most important only in Nigeria. Cash crops as a group were chosen as most important only in Côte d'lvoire.

It is important to know whether with expected changes in technology, policy and prices, cassava could play an even greater role in improving the quality of urban diets by increasing supplies of the low cost staple foodstuff in “easy to cook” forms. This will depend on the evolution of production and marketing costs, as well as the price of cassava relative to those of other staple foods, particularly cereals.

Table 6. Percentage distribution of villages in which farmers reported that selected crops are the most important crop in cassava growing areas of sub-Saharan Africa, by country, 1991

	Côte d'lvoire	Ghana	Nigeria	Tanzania	Uganda	Zaire	Zambia	Malawi	Burundi	Kenya	Weighted Mean
Cassava	8.41	35.00	20.53	51.59	42.45	80.00	60.61	12.37	9.62	7.58	32.82
Yams	17.76	21.25	35.79	-	-	-	-	-	-	-	7.48
Cocoyam	-		-	-	-	-	-		2.88	-	0.29
Potato	-	-	-	-	-	-	-	-	5.77	-	0.58
Plantain	-	16.25	-	-	-	-	-	-	-	-	1.63
Bananas	-	-	-	5.66	1.89	-	-	-	-	-	0.76
Maize	-	12.50	15.26	21.70	13.21	12.14	12.12	82.80	31.73	68.18	26.96
Rice	16.82	-	3.16	2.83	-	3.57	-	-	-	4.55	3.11
Other food crops	-	3.75	25.26	12.26	34.91	4.29	27.27	4.84	50.00	4.55	16.71
Cash crops	57.01	11.25	-	5.66	7.55	-	-	-	-	15.15	9.67

Source: COSCA

Tables 7 and 8 show the relative importance of four food crops in sub-Saharan Africa, in terms of calories and protein produced. Though cassava does not produce as much calories as rice, it contributes at least twice as much as maize, sorghum and millet. The increasing importance of cassava as a provider of calories in sub-Saharan Africa is illustrated by the reduction in the gap between cassava and rice. These figures are influenced by the investment in projects to increase the production of the individual crops in the region. The gap between cassava and the cereals would have been even smaller had equivalent amounts been invested in cassava and cereal production projects over the last three decades.

Table 7: Calories from major food staples in sub-Saharan Africa, 1961–1990 (1 000 million kilocalories)

Period	Cassava	Rice	Maize	Sorghum/Millet
1961–1970	11	15	6	6
1971–1980	14	19	8	6
1981–1990	19	22	9	7

Source: FAO/WATI. Nutrient values were obtained from FAO food composition tables

Table 8. Protein from major food staples in sub-Saharan Africa, 1961–1990 (1 000 tonnes)

Period	Cassava	Rice	Maize	Sorghum/Millet
1961–1970	184	1 281	757	884
1971–1980	230	1 606	1058	963
1981–1990	279	1 734	1 085	1 078

Source: FAO/WATI. Nutrient values were obtained from FAO food composition tables

However, FAO statistics indicate that cassava makes a much smaller contribution than cereals to protein supplies, partly because cassava leaves are not considered as a food item and consequently as a source of protein. In spite of this, the growth in supplies of protein, over the period under consideration has been the same for cassava and rice (20 percent). Only maize had a higher growth rate (28 percent), while sorghum and millet increased their contribution to protein supplies by only 8 percent.

One of the main obstacles to the expansion of cassava is the lack of understanding of cyanogenesis in cassava. Recent studies have clarified much of the confusion around the toxic potential of cassava and have clarified the mechanisms of the removal of cyanogenic compounds from cassava during processing.

Asinobi (1997), in a study of the effects of cassava consumption on malnutrition, concluded that:

- pre-schoolers in cassava growing areas of Nigeria have good nutritional status, though significant differences exist between sexes and among age classes;

- total expenditure on all food rather than expenditure on individual food items determined the nutritional status of pre-schoolers;
- cassava consumption does not cause under nutrition, rather children from high cassava food expenditure households had better nutritional status because such households had higher cash incomes and hence spent more on food than low cassava food expenditure households.

Food policy-makers in sub-Saharan African countries are now equipped with scientific conclusions that indeed cassava consumption in itself does not cause malnutrition. If anything children in cassava producing households are better nourished. This information needs to be widely disseminated. Additional information on the genetics of cyanogenesis is required for the production of cassava varieties suited for specific end uses.

4.3 SOURCE OF CASH INCOME

Nweke (1994), using COSCA data, shows that the proportion of cassava sold by small-scale producers is positively correlated with the proportion of fields owned by women, the degree of use of purchased inputs and the proportion of cassava processed before sale. An average of approximately 40 percent of cassava was planted purposely for sale, with West African coastal countries, notably Côte d'lvoire and Ghana, having a greater proportion. Fresco (1982) estimated that women farmers in southern Zaire sold 20–40 percent of their cassava, while Tollens (1992) and Gossens (1996) estimated that the proportions of total cassava production marketed were 42–46 percent in Bandundu and 55 percent in the Bas-Zaire regions of Zaire. Spiro (1980) estimated that an average of 72 percent of cassava was planted for the market in southwestern Nigeria, compared with 68 percent for maize.

In cassava producing areas, food crops contribute about 40 percent of household cash income, industrial crops and non-farm activities about 25 percent each, while livestock contributes about 10 percent (Nweke, 1996). About 26 percent of cash income from all food crops in cassava growing households (91 percent of all households) was derived from the sale of cassava. This proportion was exceeded only in rice growing households (29 percent of total households) where 29 percent of food cash income was derived from rice sales. It is clear that in cassava growing areas, where the most important source of cash income is food crops, cassava is the most important food crop generating cash income.

Apart from its potential as a source of increasing total income from agriculture, cassava may also play a role in achieving a more egalitarian pattern of income distribution. However, whether or not income derived from cassava production is more or less equally distributed than income from other crops depends on the structure of cassava production and marketing and on consumption patterns of different income classes, both of which are likely to change over time.

In southeastern Nigeria, for example, men withdraw from yam production to concentrate on palm oil, leaving the women to maintain local food supplies by increasing production of cassava (Berry, 1993). As regional markets for cassava expanded, however, young men began to engage in cassava processing, in order to capture some of the profits to be made in local markets, (Martin, 1984 cited in Berry, 1993). More recently, the emergence of large-scale cassava farming in Nigeria and Zaire raises questions about the future trends in control over income from cassava.

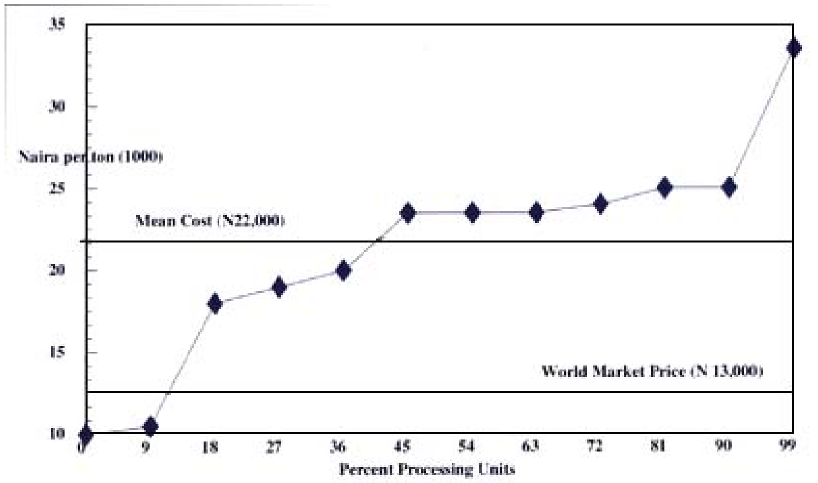
4.4 CASSAVA AS A SOURCE OF FOREIGN EXCHANGE

Virtually all cassava production in sub-Saharan Africa is used domestically, so cassava has not played any role as a foreign exchange earner, or in import substitution[3]. However, there now appears to be a window of opportunity opening up for export of cassava products, as the traditional Asian exporters appear to be having difficulties in satisfying demand particularly on the European Union market due to changes in the relative costs of production and comparative advantage. Some sub-Saharan African countries are already taking advantage of this trend. For example exports of cassava chips from Ghana which commenced with 500 tonnes in 1993, reached 29 000 tonnes in 1996.

There are also some import substitution possibilities for cassava flour and industrial starch. For example Djoussou and Bokanga (1995) report that cassava flour produced by a new method is in high demand by four large biscuit manufacturers around the city of Ibadan in Nigeria. They have consequently put a high premium price on it compared to the traditional “lafun” flour. Women's groups that were processing cassava into *gari* have organized themselves to take advantage of this new market, particularly since the price offered by the biscuits factories is high and the returns much better than what was obtained from *gari*. Results of economic analysis by Djoussou and Bokanga (1995) show that with a 15 percent substitution rate of wheat flour with cassava, Nigeria could save up to US$14.8 million in foreign exchange annually, with US$12.7 million going to cassava processors and US$4.2 million to cassava farmers.

The potential of cassava as a foreign exchange earner in sub-Saharan Africa needs to be carefully assessed. Preliminary indications are that the average cost of production of pellets and chips may be too high to allow West Africa to compete with Asian countries in the international market, For example, a survey of 11 cassava pellet producers in southwest Nigeria in 1996 showed that their mean production costs for dry pellets was 22 500 Naira per tonne (80 Naira was approximately one US dollar). Only about 10 percent of establishments produced at less than or equal to the monthly mean world market price (FOB) of 13 000 Naira per tonne for January and February 1996 (Nweke and Lynam, 1996) (Figure 10).

Figure 10. Percentage cumulative frequency distribution of cassava chips production by processing cost



Source: Nweke and Lynam, 1996

5 ENVIRONMENTAL EFFECT OF CASSAVA

COSCA shows that three important fallow systems were present in cassava producing areas, namely continuous cultivation, cropping and fallow and cropping and shifting cultivation (Table 9).

Continuous cultivation of cassava, which involves at least ten years of cropping on a given piece of land, with less than one year fallow between crops, is already widespread in sub-Saharan Africa, especially in the non-humid and highland zones. Where fallow is used, cassava is grown frequently just before, or just after fallow. Farmers therefore use the crop to close a rotation cycle and in instances of severe infestation by pests and diseases, to open the cycle.

Table 9. Percentage distribution of cassava fields by cropping practice in sub-Saharan Africa, 1991

Practice	Humid	Subhumid	Non-humid	Highland humid
Continuous cultivation	35	43	74	66
Cropping and fallow	59	42	20	29
Cropping and shifting cultivation	6	4	5	0
Other forms of cultivation	1	12	2	6

Source: COSCA

Several authors, including Boserup (1965), Ruthenburg (1980), Grigg (1979), Pingali *et al.* (1987) and Fresco (1993), have described land use intensification as an increase in the frequency in the use of land and therefore, in the use of inputs for a given land area. This is expected to lead to a decrease in the cultivated area per capita, which ultimately results in the emergence of annual and continuous cropping. Depending on the combination of agro-ecological, socioeconomic and demographic characteristics, farming systems could follow very divergent evolutionary pathways towards land use intensification.

Analysis of the COSCA data and other studies (Berry, 1993; Nweke, 1994a; Gossens, 1996) shows that the primary response to the growing population pressure in cassava growing areas of sub-Saharan Africa is still the expansion of area under cultivation. As indicated earlier, cassava is replacing fallow and cassava farmers are cultivating their plots more intensively. The simultaneous cultivation of newly opened land and old fields may lead to overall extensification (i.e. a declining labour to land ratio because of a more rapid growth in land area than in population) and land degradation.

Degradation of land is a reduction in its productivity that may result from soil loss, breakdown in soil structure, salinization, water logging, nutrient loss and pollution from toxic substances. The fallow period serves to suppress weeds, reduce pests and restore soil fertility. In most soils in sub-Saharan Africa, organic matter is a key component of soil fertility, as a reservoir of nitrogen, phosphorus and sulphur, as the main source of cation-exchange capacity and as a major promoter of aggregate structural stability. When fallow periods are reduced below a critical minimum, the soils degrade very rapidly. Associated with a substantial decline in organic matter status, nutrient limitations become apparent, acidity and aluminium toxicity are increased and structural coherence is diminished, resulting in runoff and erosion, unless adequate corrective measures are taken.

The factors mentioned above do not necessarily imply that expansion of cassava cultivation in sub-Saharan Africa will lead to land degradation. Rather, the expansion may be in response to demographic and other pressures causing land use intensification. These may be causing a shift to cassava as a less labour demanding and low soil fertility tolerant crop. It might even be suggested that cassava delays intensification in some cases by enabling farmers to produce a crop under marginal circumstances instead of shifting to crops that require higher production inputs and by increasing farmers' flexibility in the face of agro-ecological and socioeconomic instability.

On the other hand, in the case where land use intensification is dominant and there is stable demand, cassava could be grown intensively as a cash crop for urban consumers. Ruthenberg (1980, p.361), even predicts a shift from traditional cereals to higher yielding roots and tubers under increasing intensification. Trends from COSCA give some evidence of this scenario.

There is thus a need to know whether a growing dependence on cassava will ultimately lead to stagnation, or whether cassava can be the key to land use intensification once the land frontier is reached. Particularly, once the transition to land use intensification is made, there is a need to know whether cassava will be replaced by other cash crops such as maize, groundnut, cotton or perennials on the higher slopes and by rice on the lower areas.

Improved technology could also affect all of these factors. In the different cassava regions, the varying degrees of land scarcity, labour and capital availability as well as market access, suggest that divergent technical pathways may be emerging. Even before land in a given area becomes absolutely scarce, one would expect the substitution of land through the introduction of high-yielding varieties and inputs such as fertilizer. Even in highly populated areas cassava is following an extensification pathway (Fresco, 1993).

A thorough analysis of whether expansion of cassava production in sub-Saharan Africa will lead to further land degradation, as intensification or extensification continues is needed, but is beyond the scope of this review.

6 INFRASTRUCTURE AND PRODUCT MARKETS

6.1 INFRASTRUCTURE AND MARKET ACCESS

Rural infrastructure, comprising rural roads, markets, irrigation systems, water supply, health and educational facilities, are basic to quality of life in rural areas and are important engines in economic development (Ahmed and Donovan, 1992). All elements have a critical role to play in any agricultural development strategy for Africa (Cleaver, 1993). However, rural roads are considered as being a fundamental factor for the development of agriculture. Research in Asia found that in villages with better roads, fertilizer costs were 14 percent lower, wages were 12 percent higher and crop output was 32 percent higher than in villages with poor roads (IFPRI, 1990). In Africa rural road construction has been found to be associated with increases in agricultural production especially in non-food export crops, expanded use of agricultural credit, large increases in land values, proliferation of small shops and expansion of rural markets (Anderson *et al.*, 1982).

The rural transport system in the Humid and Subhumid Tropics (HST) as in most of sub-Saharan Africa, is grossly inadequate (Spencer, 1996). Table 8 shows that there are about 300 000 km of rural roads in the HST, with an average density of 63 km/1 000 km^2 . The lowest coverage is in the Congo, with the highest in Nigeria. These densities are much lower than those in other developing countries and what they should be, given the existing population densities in the countries[4]. The target density for Nigeria in Table 10 is calculated using the level achieved by India in 1950, when there was a population density roughly equal to that of Nigeria today. The targets for the other countries in the HST are calculated using a factor equal to the ratio of their present population density to that of Nigeria. The resulting figures in Table 8 illustrate that to achieve a road density equivalent to that in India at the start of the green revolution, HST countries should have an average density of 388 km/1 000 km , roughly six times what exists today. Densities should range from 47 in Congo to 718 in Nigeria. Another major problem with the existing network is its poor state of repairs. It is estimated that half of the rural road network in sub-Saharan Africa requires substantial rehabilitation (Riverson et. al., 1991).

Table 10. Rural road network in HST countries

Country [a]	Total (Km)	Density (Km/1 000 Km^2)	
	Existing	Existing	Required [b]
Bénin	4 066	36	291
Cameroon	18 000	38	168
CAR	14 400	23	33
Congo	200	1	47
Côte d'lvoire	30 224	94	258
Equatorial Guinea	450	16	103
Gabon	2 400	9	30
Ghana	4 000	17	429
Guinea	11500	47	161
Guinea-Bissau	1404	39	186
Liberia	3 615	33	159
Madagascar (1/2)	19 750	67	137
Mozambique (1/2)	6 725	17	135
Nigeria (3/4)	67 425	97	718
Sierra Leone	5 767	80	391
Tanzania (1/3)	20 760	66	181
Togo	4 181	73	447
Zaire	84 100	36	110
HST	298 967	63	388

Source: Spencer, 1996
[a] *Figures in brackets are proportion of land area that is estimated to be in the HST*
[b] *To achieve a coverage equivalent to that of India in 1950. Where population densities are less than that of India in 1950, required densities are adjusted downwards in proportion to the present population density of the country*

COSCA data show that only 20 percent of villages in cassava growing areas are accessible by motor vehicle, with the proportion being significantly lower in Burundi, Malawi, Uganda and Zaire (Table 11). In over 70 percent of villages, produce must be head loaded to market, with distances of more than 10 km in 11 percent of all villages. In Zaire, the second most important producer of cassava in sub-Saharan Africa, farmers in over 40 percent of villages must head load their produce over 10 km to market.

Participation of cassava marketing middleperson would facilitate the marketing process, especially to distant markets. Farmers would be able to spend more time on production activities and less on marketing. However, farmers in most cassava producing villages do not have access to the services of the marketing middleperson.

Table 11. Percentage distribution of surveyed villages by indices of output market access by country

Transport means and distance	Côte d'Ivoire	Ghana	Nigeria	Tanzania	Uganda	Zaire	Zambia	Malawi	Burundi	Kenya	Weighted means
<10km on foot	63	43	54	43	68	45	31	34	93	39	60
Motor vehicle [a]	27	39	38	31	4	7	35	5	0	18	20
Other means[b]	3	4	5	11	28	8	13	2	4	25	9
>10 km on foot	7	13	3	15	0	41	21	8	4	18	11

[a] *Motor vehicle for any distance*
[b] *Other means of transportation (like boats, animal, etc.) any distance*

6.2 POST-HARVEST HANDLING TECHNOLOGIES

Thirty percent of the cassava tubers produced in Africa is for fresh consumption. Also, cassava leaves are a preferred vegetable in many countries. Shelf life of cassava roots rarely exceeds two days. Storage and packaging technologies to extend shelf life will contribute to increasing cassava root availability and reliability, stabilizing prices and facilitating export. However, there is little reported research on ways of extending their shelf life and reducing post-harvest losses.

The high perishability of harvested cassava and the presence of cyanogenic glucosides call for immediate processing of the storage roots into more stable and safer products. The extent to which the potential market for cassava may be expanded depends largely on the degree to which the quality of various processed products can be improved to make them attractive to various markets, local and foreign, without significant increases in processing costs.

Traditionally, cassava roots are processed by a variety of methods into many different food products, depending on locally available processing resources, local customs and preferences. Figure 11 shows the main channels of cassava product marketing in sub-Saharan Africa. There are two main channels for farmers to market their tubers. In the first, traders conversant with the area of production - mostly the region from which they hail, or speak the local dialect purchase the standing crop and spend anywhere from three to seven days harvesting the tubers (field purchase). Alternatively, they may purchase cassava already harvested by the farmers (home purchase). After assembling a sufficient quantity, the traders rent space in a truck or a boat to convey the cassava to an urban market. The second channel is one in which small traders visit periodic markets to purchase tubers directly from producers who have transported them there.

On arrival at the urban markets, traders sell tubers by the sack load either to retailers, or directly to consumers. Most small traders prefer not to sell to consumers directly, since they want to off load the cassava as quickly as possible so that they could return to their buying posts for further purchases and avoid losses from spoilage. Trading in the city usually takes place in the lorry parks or large open spaces. In most cases appropriate market structures are not available.

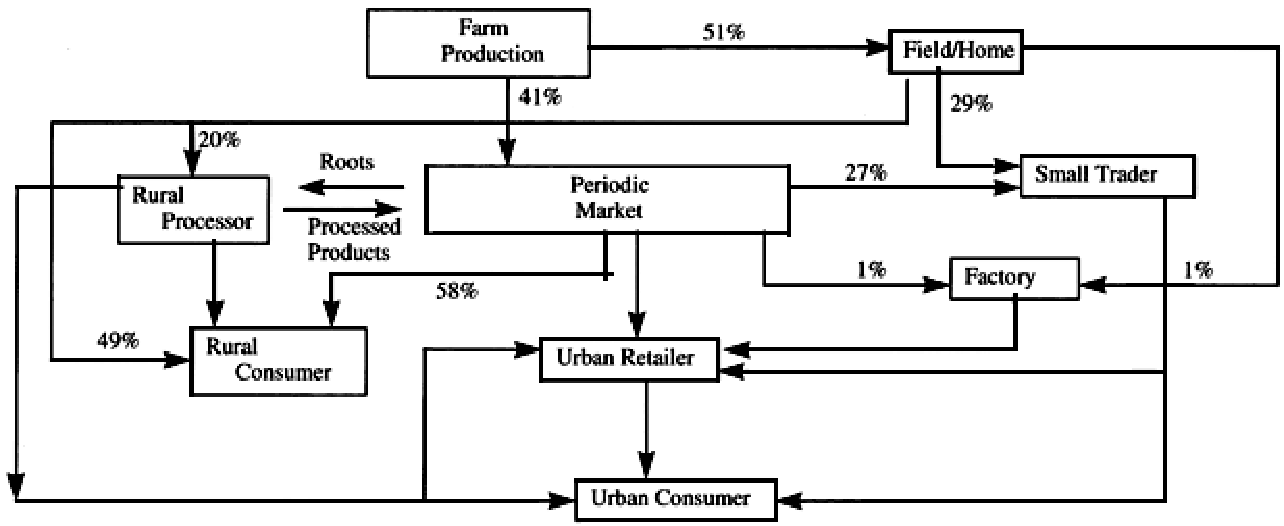
Processors are mainly located in rural areas and obtain their supplies of tubers in the same way as itinerant traders. Less than 2 percent of cassava is processed through factories sometimes owned by cooperatives.

Ugwu and Ay (1992) classified cassava products in sub-Saharan Africa into nine groups as follows:

- cooked fresh roots;
- cassava flours: fermented and unfermented;
- granulated roasted cassava *(gari);*
- granulated cooked cassava *(attieke,* kwosai);

- fermented pastes;
- sedimented starches;
- drinks (with cassava components);
- leaves (cooked as vegetable);
- medicines.

Figure 11. Flow of cassava roots and processed products through the marketing system in sub-Saharan Africa



Flours are the most widely used cassava product in Africa and are processed in a variety of ways. Drying and milling are the most essential steps. Flours from unfermented cassava roots are more common in areas where sweet cassava varieties dominate.

Table 12 shows that over 50 percent of all villages have some form of cassava processing centre and Table 13 shows that use of processing machinery, particularly mills is widespread, except in Central African countries.

Table 12. Distribution of villages with or without cassava processing centres by country (percent)

Centre	Côte d'lvoire	Ghana	Nigeria	Tanzania	Uganda	Zaire	Zambia	Malawi	Burundi	Kenya
Yes	100	78.75	100	54.55	100	99.33	100	100	97.20	98.61
No	0	21.75	0	45.45	0	0.67	0	0	2.80	1.39

Source: COSCA

Table 13. Percentage distribution of villages with cassava processing machines (mills, graters, presses) in COSCA villages by country

Country	Type of machinery		
	Mill	Grater	Press
Côte d'lvoire	13	10	28
Ghana	88	17	8
Nigeria	54	50	3
Tanzania	35	0	0
Uganda	56	0	0
Zaire	1	0	0
Zambia	5	0	0
Malawi	34	0	0
Burundi	8	0	0
Kenya	38	0	0

Source: COSCA

Mechanized processing has been found to be positively associated with population density. Also, as access to market improves, cassava processing tends to be more mechanized Ugwu and Ay (1992).

A package of improved cassava processing equipment has been designed and tested by research institutions for use at farm and village levels with the objective of reducing post-harvest losses, increasing labour productivity and improving product quality. This equipment includes a peeling tool, manually operated chipping, grating and grinding machines, an efficient multiple fuel type frying stove, a de-watering device and a tray type dryer. Simple processes allowing farmers to convert the highly perishable cassava roots into dry, easily stored and freely traded commodities such as chips and flour, are available. They make it possible for high volume users, such as agro-industries, to develop cassava-based operations

6.3 PROCESSING COST[5]

High labour requirements appears to be the only resource constraint in cassava processing which none of the traditional techniques is able to circumvent. Evidence from Eastern Nigeria shows that high root yields attained through the adoption of improved cassava varieties would not have a substantial cost saving advantage using manual processing technology (Nweke *et al.*, 1991). Field production costs per unit weight of output, decline as yield increases because most are constant per unit area, irrespective of the yield, so that the percentage contribution of field production to total costs per unit weight of output declines as yield increases. However, processing costs per unit weight of output are constant as yield increases, because of manual processing which has low capital investment. Consequently, the percentage contribution of processing to total costs per unit of output increases as yield increases. Thus, the cost saving advantage of yield increasing technology may not fully translate into expanded production and hence into expanded cash income opportunities, if there is no matching investment in cost saving technology at the processing stage. Some Nigerian farmers using IITA's high yielding TMS 30572 variety to produce *gari* have been observed during certain seasons to drastically cut back on planting because they were unable to process the previous season's plantings (Nweke *et al.*, 1991).

6.4 GENDER ROLE IN CASSAVA TRADE AND PROCESSING

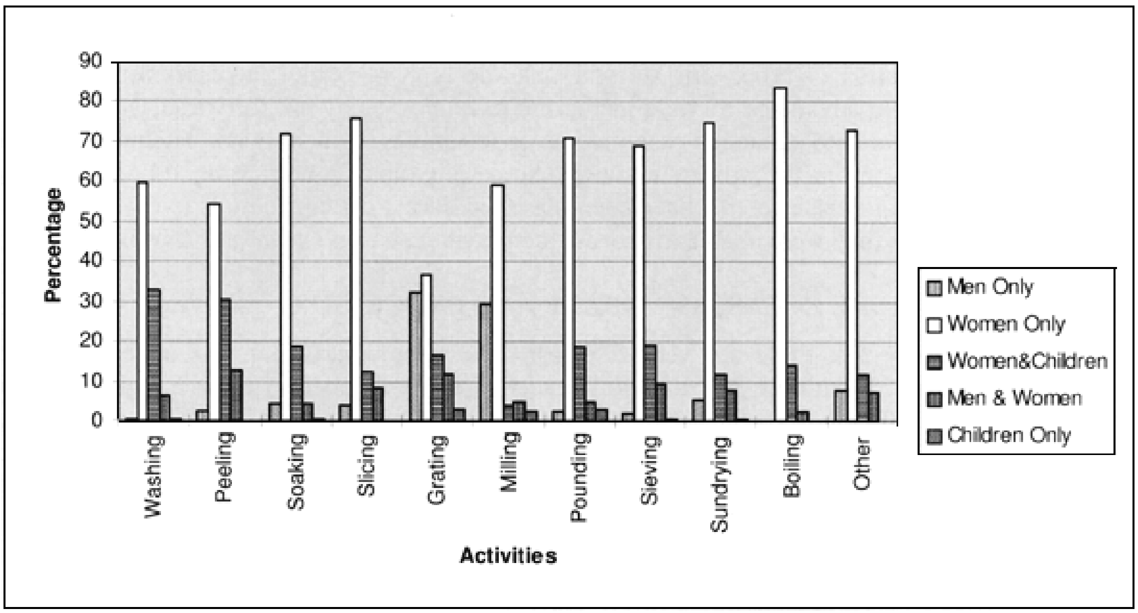
COSCA data show that there are very few instances where marketing was undertaken by large commercial traders. In virtually all situations, traders are city dwellers without a regular government or private sector job and without a personal means of transport. Across the continent, there are no indications that the bulk of cassava marketing is done by any single sex. While most small-scale traders are men in Central and Southeastern Africa, the majority of traders are women on the West Coast. Gossens (1996) and Tollens (1992), indicate that most cassava traders have very little or no formal western education.

While the sexes are equally represented in trading, women and to a lesser extent children, dominate in processing (Figure 12). As opportunities for commercialization increase (arising from favourable market opportunities for cassava and its products), the number of women involved in processing increases. Growth in cassava production is therefore likely to provide increased employment opportunities for women.

However, there is a tendency that as mechanized processing equipment (such as graters and mills) are acquired, men's involvement in cassava processing tends to increase, as they often control and operate these machines. Figure 12 shows that participation of men is highest in the grating and milling operations in which machinery is most extensively used. Women may therefore loose some of the benefits of increased employment, as they loose control of some of the income. Steps need to be taken to ensure that this does not happen, e.g. by increasing the access of women to credit for acquisition of post-harvest machinery and training them to properly operate the equipment. This means that the needs of women should be kept in mind even at the equipment design stage.

Post-harvest processing of cassava is laborious and a drudgery to women and children. New labour-saving and quality improving technologies exist, but they are mostly located in urban and peer-urban environments. Ex-ante studies are needed to understand why these technologies are not more widely implanted in rural areas, where they would be of most use in helping to relieve the drudgery of women.

Figure 12. Respondents indication of different gender combination participation in alternative cassava processing activities (percent)



Source: COSCA

7 RESEARCH AND EXTENSION

7.1 RESEARCH INSTITUTIONS

Research in cassava is active in sub-Saharan Africa by International Agricultural Research Centres (IARCs), National Agricultural Research Systems (NARS) and regional networks. The most active IARC is the International Institute of Tropical Agriculture (IITA) which is funded through the Consultative Group on International Agricultural Research (CGIAR) and deploys 50 percent of the senior research staff months contributed by the CGIAR in sub-Saharan Africa (SPAAR, 1996). The Centro Internacional de Agricultura Tropical (CIAT) the other CGIAR centre active in Africa operates through IITA. Smaller international programmes are executed by the French Centre de cooperation internationale en recherche agronomique pour le développement (CIRAD) and the National Resources Institute (NRI) of the United Kingdom.

IITA conducts a full programme from breeding and pest management to farming systems and post-harvest research in cassava. CIAT mainly provides germplasm to IITA's breeding programme. CIRAD and the Institut de recherches scientifiques pour le developpement en cooperation (ORSTOM) have programmes for genetic improvement and physiology.

National programmes for cassava exist in most sub-Saharan Africa countries in which cassava is found. There are particularly strong programmes in Cameroon, Congo, Côte d'lvoire, Malawi, Nigeria, Sierra Leone, Tanzania, Uganda and Zaire. Most of these national programmes are linked together through networks, the most important of which are the conference of the African countries in charge of agro-economic research (Conférence des responsables de recherche agronomique africains -CORAF), the Eastern Africa Root Crops Research Network (EARRNET), the Southern Africa Root Crops Research Network (SARRNET), the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), the Southern African Centre for Cooperation in Agricultural Research and Training (SACCAR) and the Institut du Sahel (INSAH).

Many of the NARS face constraints due to human resource problems, shortage of funding and problems of management and coordination of research programmes. The Special Programme for African Agricultural Research (SPAAR) has developed four Frameworks for Action (FFA) in order to provide guidelines and outline strategies that will enable NARS to fulfil their role. These frameworks are based on the building of coalition between national and regional institutions in technology generation and transfer. The key features are strengthening of the NARS in order to make them more client responsible and to develop their capacity for policy and economic analysis. Implementation of the FFAs generally calls for a number of principles including:

- preparation of a National Agricultural Research Strategy or Master Plan;
- the establishment of adequate, sustainable, stable and timely funding through a transparent and accountable funding mechanism that pools the collective efforts of donors to address priority national and agricultural research;
- enhancement of institutional and management capacity of NARS;
- the strengthening of research - extension - farmer linkages;
- the formation of research advisory groups consisting of coalition of all the major research partners;
- effective regional collaboration among national, regional and international research institutions.

The FFAs are to be implemented through regional coordinating mechanisms which are CORAF for West and Central Africa, INSAH for the Sahel, ASARECA for East and Central Africa and SACCAR in Southern Africa.

Progress in achieving the aims of the FFAs was recently reviewed by a team appointed by SPAAR. Overall, the team found that considerable changes had been brought about in management and organization of NARS through application of the basic principles of the FFAs in East, West and Southern Africa (SPAAR, 1995). Such principles are now institutionalized. Of particular note is progress made in development of strategies for national agricultural research systems and determination of priorities for research. The wide acceptance of the principles has provided a foundation for introduction of improved systems of accountability, staff deployment and programming. These were widely debated by stakeholders and particularly by national scientists in NARS producing a genuine sense of ownership of projected activities which augers well for the future strengthening of NARS and improvement of outputs and impact.

The process of formulation and reorganization under master planning draws attention to potential benefits arising from regional research activity and its utility in strengthening intercountry exchange of information, conduct of mutually beneficial research and possible resource savings. Important advances are also apparent in installation of both hardware and software to manage existing NARS resources more effectively. These will be important in the context of the need to shift resources to meet the new priorities set in Master Plans. Despite the significant improvements in management and organizational culture, a universal problem is the shortage of operational funding. This persists despite the serious attempts by management to reduce staff levels and research sites to meet the requirements of the new priorities and agenda.

The creation of fora for exchange of information between NARS and their donors is a marked achievement of the implementation of the FFAs. The desirability of involvement of the private sector in this information exchange and priority setting is creating avenues for possible additional funding. Modes of tapping into these sources are being actively explored by NARS. Among options are use of cess funding and contract research.

A major success of the SPAAR/FFA activity has been the progressively higher profile taken by NARS in planning their activities with full donor involvement. This is giving increased credibility within their own administrations and confidence to NARS in creating much more demand led research agendas. Difficulties still remain in achieving the much sought after farmer perspectives on research agendas. However, interesting mechanisms are being tried and require further evaluation to ascertain whether they have wider applicability.

The report draws attention to the complex and numerous organizations involved in research coordination and networking. There is a particular need to define the relationships between these organizations now and to ensure that duplication of effort and dissipation of scarce staff and funding resources are minimized. The time is particularly opportune to examine the relationships between NARS and IARCs in view of the moves towards ecoregional research in the CGIAR system. The Ecoregional Programme for the Humid and Subhumid Tropics of Sub-Saharan Africa (EPHTA), is an emerging mechanism for NARS research coordination.

A panacea is unlikely to emerge from implementation of the FFAs since every NARS has its own political, historical and national perspective. Many of the concepts however are sound and their wider application will lead to significant strengthening of NARS capability, output and credibility.

7.2 EXTENSION

Extension can be described as the process of assisting farmers to become aware of and adopt, improved technology from any source to enhance production efficiency, income and welfare (World Bank, OED, 1994). In a broader context, it also involves general farmer education and organization. The rate of adoption of technology by a farming population will depend on the characteristics of the production circumstances of the individuals, the characteristics of the technology itself, the socio-cultural characteristics of the individual farmers, how rapidly the population is made aware of the technology and its application to local production systems.

An extension service can have an important function in increasing the *rate of adoption* which enhances productivity and producer welfare by being directly involved in increasing awareness, in facilitating skill acquisition and in assisting in understanding of technology and its relevance to farmer circumstances. It also has an important role in *feeding back* information on farmer constraints, potentials and farmers experiences with new technology to the research system, as well as in working with farmers and researchers in developing and spreading *indigenous solutions* to problems.

During the last decade donor institutions, particularly the World Bank, have funded extension projects all over Africa. A recent qualitative assessment of extension institutions and programmes in four countries (Burkina Faso, Ghana, Madagascar and Tanzania) investigated the organizational structure of extension programmes, the extent to which clients (i.e. farmers) are involved in the process of technology transfer, the extent of association of the private sector (e.g. seed and fertilizer dealers) and the non-governmental organizations (NGOs) with the extension programmes, perceptions of farmer organizations and the NGOs of the extension service, the extent and the manner in which extension addresses complex issues such as, Integrated Pest Management (IPM), farm and soil management and includes relevant messages relating to issues such as animal health, fisheries and agroforestry.

The study (Spencer and Butare, 1996) found that virtually all reforms of national extension systems undertaken in World Bank-funded projects, have included the creation of a unified extension system using the “Training and Visit” (T&V) approach. However, it is evident that a unified extension service cannot be developed to serve all purposes and conditions. For example private sector organizations and NGOs may need to adopt other extension systems that better meet their needs e.g. the Strategic Extension Campaign which is more participatory and focused, or the Intervention Society Model in which extension is involved with input supply, marketing and other functions. Even government run national extension systems are better able to serve the needs of the farmers if they have the flexibility to move into areas such as input supply where such intervention is critical. The World Bank and other donors must ensure that national extension systems funded by them have such flexibility.

It is clear that in many countries, the introduction of the unified extension system has had a very positive effect by increasing the efficiency of extension and reducing the degree of duplication and waste of resources due to the uncoordinated nature of such activities earlier. The downsizing and training of staff that has accompanied introduction of such systems has enhanced the sustainability of the systems. However, the problem of long-term funding of extension systems from national budgets still remains. National governments and donors need to continue to work out strategies that will provide agricultural extension as well as research with secure long-term funding.

In many countries national extension systems using the T&V approach are not effectively handling complex farming systems issues such as IPM and intercropping. This is partly due to the unavailability of appropriate technologies for such systems for research institutions, but is also clearly due to the nature of the T&V approach which requires extension messages to be broken down into simple components, a task that may be difficult for the Subject Matter Specialists.

Another area that needs improvement in the unified extension system is the feedback mechanism. It is evident that it is not working well in the countries visited. Messages flow effectively from the extension system to farmers but not in the opposite direction. A more participatory approach needs to be formally incorporated into the T&V system.

7.3 DEVELOPMENT ACTIVITIES

Investment programmes funded from national budgets, for cassava production, marketing, research and extension, exist in the most important cassava producing countries. They generally focus on the introduction of improved planting materials emanating from research programmes and post-harvest activities on a much smaller scale. Post-harvest development programmes include funding for setting up of small-to medium-scale cassava processing plants particularly in the processing of products such as *gari*. There is a need to create the enabling environment, such as good roads and credit availability to link farmers to both the input and output markets, as a way of improving their income-generating capacity and consequently alleviating their poverty.

Bilateral and multilateral donors are also funding some projects which have important cassava components. It is important to determine whether the level of current investment in such projects is adequate to meet the development needs of the crop. Such an assessment is however, beyond the scope of this review.

8 CONCLUSIONS AND FUTURE NEEDS

Future needs and directions for cassava in Africa have been discussed throughout the body of this review. In this section some of the important points are highlighted.

8.1 NEED FOR IMPROVED STATISTICS

The accuracy of published statistics on agriculture in Africa in general and root crops in particular, leaves much to be desired. Time series data from FAO, the most readily available source, often do not correlate with national statistics and other sources.

Although the COSCA study has provided a wealth of first hand information on cassava production, processing and marketing, part of the data is waiting analysis and in some countries, the later phases of the study have not been carried out. Complementary baseline data are being collected by other regional research projects and networks, such as ESCaPP, RRPMC[6], EARRNET and SARRNET. Available information should be consolidated in an electronic database accessible to all interested parties. The consolidation process will reveal information gaps that would need to be addressed. National and international organizations should increase investment in collection and processing of agricultural statistics in Africa.

8.2 PREPARE TO MEET INCREASED DEMAND

Table 15 summarizes the likely outcome of population and income growth on cassava in Africa, indicating that demand is likely to increase under all scenarios. This provides justification for substantially increased investment in the crop.

In individual countries cassava market development should be centred around the creation of an enabling environment through, for instance, improved access of farmers to both input and output markets, as well as introduction and adoption of improved cassava varieties that have the characteristics required in local communities and other improved and sustainable practices.

Table 15. Summary of Likely Effects of Population and Income Growth on Cassava in Africa

Scenario	Increased per capita income	Increased population
Increased per capita income		Rising incomes lead to a greater demand for diversity in the diet. Demand for carbohydrates like cassava will not increase as fast as that for other staples. Substitution also takes place within the starchy staples, but increased population will lead to higher demand for fresh tubers and processed products
Lower per capita income		This will increase the demand for cassava products of various forms.
Government intervention	Some limited help to producers -constrained by the degree to which consumers switch to less starchy staples	Constrained by the degree to which the market can absorb the increased production - a factor dependent on post-harvest processing costs.

8.3 AGRO-ECOLOGICAL CONDITIONS AND AGRICULTURAL INTENSIFICATION

The relationship between population/market pressures and agricultural intensification is unlikely to be a linear one. Increasing demographic population and market pressures will result in changes in agricultural production systems, though these changes will follow divergent evolutionary pathways towards agricultural intensification depending on the natural endowments of each location. The conventional way of measuring the availability of land (arable land per capita) is unsatisfactory, since it does not take into account the differences in soil quality and climate (Biswanger and Pingali, 1988). In analysing the process of agricultural intensification measures of demographic and market pressure should be used in combination with measures of agro-ecological factors to account for the inherent production potential (carrying capacity) of each agro-ecological zone. It is, therefore, important that in anticipating the direction of agricultural developments and consequently the sustainability of actual and future agricultural systems, differences in the agro-ecological factors should be considered more closely.

8.4 INTEGRATED PEST MANAGEMENT

Pests and diseases still take their toll on cassava production. Brown streak virus and insect pests are increasingly becoming problems of economic importance. Plant protection research needed to address these issues can broadly be grouped into characterization and adaptive/strategic activities. The major characterization themes include yield loss due to grasshoppers, mealybug and plant diseases like ACMD, CAD and root rot in specific ecozones, resistance screening and soil nutrient trials. These investigations should provide a quantitative basis for deciding whether or not to develop specific pest intervention technologies. It is also important to consider the cassava brown scale, which is an emerging pest problem, especially in Central Africa. Recent reports from parts of Cameroon and Zaire mention total yield losses and, in some cases, arrested production (S. Yaninek, 1997, personal correspondence). There are speculations that the problem could be related to intensification of production, but it is beyond the scope of this study to verify.

Another area of plant protection in cassava that is often ignored is the ecosystem-specific pests. During extensive plant protection diagnostic surveys carried out by ESCaPP, a number of important pest constraints were identified as being associated with specific ecozones, but not exclusively on cassava. These include the variegated grasshopper in the transition forest and moist savannah, termites in the moist and dry savannah, nematodes in all ecozones and vertebrate pests and root rot in the rain and transition forests. Pest constraints such as these are usually relegated to orphan status when R&D activities are targeted on a specific commodity. The programmes responsible for plant health matters should particularly be cognisant of this.

Adaptive/strategic research themes for cassava plant protection and production should include the classical biological control of LGB and CGM and the identification and integration of sustainable control methods for ACMD, CBB, CAD, the root mealybug, weeds, termites, nematodes and vertebrates. The development of packages of integrated control methods for root rot will have a direct impact on the quantity and quality of marketable tuberous roots. Methods to protect cuttings from infection by root and stem rot pathogens would be part of the development of protocols for producing and managing clean and vigorous cuttings. Integrated participatory on-farm trials, where appropriate and the elucidation of indigenous knowledge systems should also be pursued.

8.5 DEVELOPING IMPROVED VARIETIES

Cassava genetic resources in Africa are under the threat of erosion. The COSCA survey indicates that farmers in Africa are abandoning old cultivars in favour of new ones. Old traditional cassava cultivars must be collected to prevent further loss of desirable genetic diversity. Additional variability needs to be tapped, particularly if adapted to harsh environments. The wild relatives of cassava are repositories of genetic potential that should not be ignored. The early cassava introductions were not enough to transfer the wide genetic base existing at the centre of origin of the species. Introduced progenies from Latin America hold promise to further broaden the germplasm base of cassava, by providing unique sources of variability not currently available in Africa.

The search for and utilization of new sources of resistance to all the major pests and diseases need to be intensified, with the aim of diversifying resistance that would prove difficult for the pathogens and pests to circumvent. Problems which are recalcitrant to conventional methodologies need to be addressed using tools of biotechnology.

Protocols for identifying and eliminating pests, diseases and poor plant vigour in cassava cuttings are needed by NARS involved in plant quarantine and plant protection activities and for selection, propagation and management of clean cuttings by extension agents and farmers in a sustainable manner. The objective would be to develop and implement a strategy to produce and maintain clean and vigorous cassava planting material, given the specific requirements of the major cassava growing ecozones in Africa.

Information from COSCA has provided much valuable information on the characteristics of improved varieties most sought after by farmers in sub-Saharan Africa. Prominent among them are high yield and early bulking. Breeding programmes need to develop varieties which reach maximum bulk around nine months, rather than the current average of 15 months.

8.6 IMPROVE POST-HARVEST SYSTEMS

To be competitive and have a chance of increasing their income, cassava farmers need to sell high quality processed products with a long shelf life. One of the major advantages cassava has over other carbohydrate/starch crops is the variety of uses to which the roots can be put. In addition to being a major staple food for humans, it is also has an excellent potential as livestock feed and in textile, plywood, paper and pharmaceutical industries. The major constraint, however, is that cassava deteriorates rapidly. Fresh roots must be transformed into more stable products within two or three days from harvest. This transformation requires various combinations of technology-peeling, grating, boiling, fermenting, drying, frying and milling.

Timely harvests and efficient post-harvest operations play a crucial role in the lives of farmers. Appropriate equipment to carry out these operations reduces crop waste and enables more complete utilization of the food crops grown. This is especially true of farmers who are moving from the subsistence stage to large-scale commercial production.

IITA has devoted attention to designing and fabricating improved equipment. While the primary goals of these technologies have been to minimize crop losses and improve labour productivity and product quality, activities that have evolved recently include on-farm testing and demonstration of the equipment, training of manufacturers and networking to promote the use of improved equipment. It should be borne in mind that by improving the quality of farm products, incomes and standards of living are also raised for farm families who use this technological equipment.

High labour requirement appears to be the main resource constraint in cassava processing. Cassava processing is essentially the responsibility of the female gender. High root yields attained through the adoption of improved cassava varieties would not have a substantial cost saving advantage under manual processing technology. In this regard, there is a need to give even greater attention to cassava processing technologies in sub-Saharan Africa. A better understanding of the distribution of marketing margins in the cassava chain from producers to middleperson to processors to end-users will point the way to targeting of technology dissemination.

Industrialists and entrepreneurs often shy away from using cassava in their applications because of the absence of a local example to follow and the uncertainty of success. Therefore, product development research needs to be strongly promoted and the private sector should be encouraged to participate. Issues that need to be addressed include raw material import substitution; promotion of a positive image for cassava; development of products for existing and new markets; identification of the functional characteristics of cassava genotypes in relation to various end uses; utilization of cassava plant parts (e.g. leaves, peel, etc.) for livestock feeding; suitability of cassava leaves as vegetable; and determination of foliage yield and digestibility for human and animal nutrition. The impact of pathogens and saprophytes on the quality of stored cassava products, including contamination with mycotoxins, should be investigated.

8.7 IMPROVED MECHANISMS FOR COLLABORATION

For various reasons, farmers have not adopted most of the production technologies developed by NARS and IARCs. A new approach to address this dilemma and the outstanding technical issues is being addressed as an initiative of the CGIAR, especially those pertaining to sustainable agriculture and those requiring greater collaboration between NARS, IARCs and other partners.

The goal of this new approach called the Ecoregional Programme for the Humid and Subhumid Tropics of Sub-Saharan Africa (EPHTA), is to assist small-and medium-scale farmers to improve their well-being and alleviate poverty, through the use of sustainable production technologies and post-harvest systems that increase productivity and food security and minimize natural resource degradation, by formalizing and strengthening close collaboration between the NARS, IARCs, international and regional research and development organizations and relevant stakeholders (farmers, NGOs, the private sector).

African NARS have become increasingly aware of the commonality of the problems they face in planning agricultural research and development and mobilizing resources for implementation. To this end, they have set up regional bodies which have obtained international recognition through SPAAR (SACCAR, ASARECA, INSAH and CORAF) which need to be strengthened and supported.

[1] For the purpose of this review a non-tradable product is defined as one for which there is no formal international trade.

[2] Fluctuations for individual cereal crops are even greater.

[3] There is of course some interregional trade in cassava products, especially the flours, but this trade is unrecorded and difficult to quantify.

[4] However, they are higher than densities generally found in the West African semi-Arid tropics. Excluding the Gambia, which has a density of about 88 km/100 km^2, densities in that region range from 1 km/100 km^2 for Mali to 19 km/100 km^2 for Senegal. Rural road densities in East and Southern Africa are generally higher than in the HST, except in Kenya where there is a substantial main road network and Zambia, where there is a significant rail network. Zimbabwe for example, has a rural road density of 219km/100 km^2 , quite comparable to densities found in Asia.

[5] Based on Hiroki *et al.,* (forthcoming)

[6] RRPMC: Regional Research Project on Maize and Cassava

REFERENCES

Al-Hassan, R.M. 1989. Cassava in the economy of Ghana. *In* Status of Data on Cassava in Major Producing Countries in Africa: Cameroon, Côte d'lvoire, Ghana, Nigeria, Tanzania, Uganda and Zaire. COSCA Working Paper No.11. Collaborative Study of Cassava in Africa, International Institute of Tropical Agriculture, Ibadan, Nigeria.

Ahmed, R. & Donovan, C. 1992. Issues of Infrastructural Development: A synthesis of the Literature. IFPRI, Washington, D.C.

Anderson, G.W., Vandervoort, C.G., Suggs, CM. & Clapp-Wincek, C. 1982. Rural Roads Evaluation Summary Report. A.I.D. Programme Evaluation Report 5. US AID, Washington, D.C

Asinobi, C.C. 1997. Nutritional Status of Pre-schoolers in Cassava Producing Areas of Nigeria. University of Ibadan, Nigeria (Ph.D. Thesis).

Benthall, Jonathan. 1986. Disasters, Relief and the Media, I.B. Tauris. 102 p.

Berry, S.A. 1986. Socioeconomic Aspects of Cassava Cultivation and Use in Africa: Implications for the Development of Appropriate Technology. Informal discussion paper for the Rockerfeller Foundation, New York.

Berry, S.A. 1993. Socioeconomic Aspects of Cassava Cultivation and Use in Africa: Implications for the Development of Appropriate Technology. COSCA Working Paper No.8. Collaborative Study of Cassava in Africa, International Institute of Tropical Agriculture, Ibadan, Nigeria.

Binswanger, H. & Pingali, P. 1988. Technological Priorities for farming in sub-Saharan Africa. *Research Observer, World Bank* 3(1): 81–98.

Boserup, E. 1965. The Conditions of Agricultural Growth. George Allen and Unwin, London. 124 p.

Carter, S.E. & Jones, P.G. 1989. COSCA Site Selection Procedure. COSCA Working Paper No. 2. Collaborative Study of Cassava in Africa, IITA, Ibadan, Nigeria.

Cleaver, K.M. 1993. A strategy to develop agriculture in sub-Saharan Africa and a focus for the World Bank. World Bank Technical Paper 203, IBRD, Washington, D.C, USA.

Dahniya, M.T., Akoroda, M.O., Alvarez, M.N., Kaindaneh, P.M., Ambe-Tumanteh, J., Okeke, J.E. & Jalloh, A. 1991. Development and Dissemination of Appropriate Root Crops Packages to Farmers in Africa. Invited paper: Ninth Symposium of the International Society for Tropical Root Crops, 20–26 October 1991, Accra, Ghana.

Djoussou & Bokanga, M. 1995. Cassava Flour Production - Background Information to the Site Visits.

Fresco, L.O. 1993. Dynamics of Cassava in Africa, an Outline of Research Issues. COSCA Working Paper No.9. Collaborative Study of Cassava in Africa, International Institute of Tropical Agriculture, Ibadan, Nigeria.

Gossens, Frans. 1996. Cassava Production and Marketing in Zaire - The Market of Kinshasa. Leuven University Press, Leuven.

Government of Ghana (GOG). 1996. National Cassava Task Force. Final Report on the Promotion of Cassava Production, Processing and Marketing in Ghana. Mimeo, Ministry of Food and Agriculture, Accra, Ghana.

Grigg, D. Esther. 1979. Boserup's History of Agrarian Change: A Critical review. *Progress in Human Geography* 3(1): 64–84.

Hayami, Y. & Ruttan, V.W. 1985. Agricultural Development: An International Perspective, Johns Hopkins University press, Baltimore. 506 p.

International Food Policy Research Institute (IFPRI). 1990. Annual Report. IFPRI, Washington D.C., USA

International Fund for Agricultural Development (IFAD). 1996. Elements for a Global Cassava Development Strategy. Mimeo, IFAD, Rome, Italy.

International Institute of Tropical Agriculture (IITA). 1983, Annual report. Ibadan, Nigeria.

International Institute of Tropical Agriculture (IITA). 1984, Annual report. Ibadan, Nigeria.

Kaindaneh, P.M. 1997. Crop Budgets for the Economic Recovery Credit. A World Bank Consultants Report, Freetown, Sierra Leone.

Nweke, F.I. 1994a. Cassava Distribution in Africa. COSCA Working Paper No. 12. Collaborative Study of Cassava in Africa, International Institute of Tropical Agriculture, Ibadan, Nigeria.

Nweke, F.I. 1994b. Farm Level Practices Relevant to Cassava Plant Protection. *African Crop Science Journal*, Vol. 2, No. 4., pp 563–582.

Nweke, F.I. 1996. Cassava: A Cash Crop in Africa. COSCA Working Paper No. 14. Collaborative Study of Cassava in Africa, International Institute of Tropical Agriculture, Ibadan, Nigeria.

Nweke, F.I. & Lynam, J.K. 1996. Cassava in Africa. Paper presented at the Third International Scientific Meeting. Cassava Biotechnology Network (CBN III), 21–31 August, Kampala, Uganda.

Nweke, F.I., Lynam, J.K. & Folayan, S.A. 1996. Issues for Research Towards Intensive Commercial Production of Cassava In Africa. Unpublished manuscript.

Otim-Nape, G.W. & Opio-Odongo, J.U.A. 1989. Cassava in Uganda. *In* Status of Data on Cassava in major Producing Countries in Africa: Cameroon, Côte d'lvoire, Ghana, Nigeria, Tanzania, Uganda and Zaire. COSCA Working Paper No. 11. Collaborative Study of Cassava in Africa, International Institute of Tropical Agriculture, Ibadan, Nigeria.

Pingali, P., Bigot, Y. & Binswanger, H.P. 1987. Agricultural mechanization and the evolution of farming systems in sub-Saharan Africa. The John Hopkins University Press, Baltimore, 216 p.

Riverson, J., Gaviria, J. & Thriscutt, S. 1991. Rural Roads in Sub-Saharan Africa: Lessons From World Bank Experience. World Bank Technical Paper 141, IBRD, Washington, D.C., USA.

Ruthenberg, H. 1980. Farming Systems of the Tropics. Oxford University Press, Oxford.

Ruttan, V.W. & Hayami, Y. 1984. Induced Innovation Model of Agricultural Development. *In:* Agricultural Development in the Third World. Eicher, C.K. and Staaz, J.M. eds, John Hopkins University press, Baltimore. 59–74 pp.

Scaborough, V. & Kydd, J. 1992. Economic Analysis of Agricultural Markets: a Manual, Natural Resources Institute, Chatham, 166 p.

Special Programme for African Agricultural Research (SPAAR) 1996. Framework for Action (FFA) - West and Central Africa. SPAAR, World Bank, Washington D.C., USA.

Schumpeter, J. 1987. Capitalism, Socialism and Democracy, Unwin, London, 437 p.

Spencer, D.S.C. 1996. Infrastructure and Technology Constraints to Agricultural Development in the Humid and Subhumid Tropics of Africa. *African Development Review*. December, 1996. African Development Bank, Abidjan, Côte d'lvoire.

Spencer, D.S.C. & Butare, I. 1996. Qualitative Assessment of Agricultural Technology Transfer Institutions in Selected African Countries. Report prepared for the World Bank, June 1996.

Spencer, D.S.C. 1997. Rice Trade and Price Policy Study - Final Report. Ministry of Agriculture, Forestry and the Environment, Freetown, Sierra Leone.

Spiro, H.M. 1980. The role of women farmers in Oyo state, Nigeria: A case study of two rural communities. Discussion Paper No. 7/80. Agricultural economics, International Institute of Tropical Agriculture, Ibadan, Nigeria.

Stoorvogel, J.J. & Fresco, L.O. 1991. The Identification of Agro-ecological Zones for Cassava in Africa-with particular emphasis on soils. International Institute of Tropical Agriculture, Ibadan, Nigeria.

Tollens, E. 1992. Cassava Marketing in Zaire: an analysis of its structure, conduct and performance. K.U. Leuven, Belgium (Mimeograph).

Treche, S. 1995. Importance du manioc en alimentation humanine dans differentes regions du monde. *In* Transformation alimentaire du manioc. ORSTOM, Paris. 25–35 pp.

Tshiunza, Muamba. 1996. Agricultural Intensification and Labour Needs in the Cassava-Producing Zones of Sub-Saharan Africa. Doctoraatsproefschrift Nr. 326 aan de Faculteit Landbouwkundige en Toegepaste Biologische Wetenschappen van de K. U. Leuven.

Ugwu, B.O. & Ay, P. 1992. Seasonality of Cassava Processing in Africa. COSCA Working Paper No.9. Collaborative Study of Cassava in Africa, International Institute of Tropical Agriculture, Ibadan, Nigeria.

Valdés, Alberto & Konandreas, P. 1981. Assessing Food Security Based on National Aggregates in Developing Countries. *In* Food Security for Developing Countries. Eds. A. Valdes. Boulder, Colorado.: Westview Press.

Walker, Robert S. 1995. The Information Opportunity. *National Review*, 31 July 1995, 32 p.

World Bank, Operations Evaluation Department (O.E.D.) 1994. Agricultural Extension: Lessons from Completed Projects. Report No. 13000, World Bank, Washington, D.C.