CASSAVA DEVELOPMENT IN UGANDA

A COUNTRY CASE STUDY TOWARDS A GLOBAL CASSAVA DEVELOPMENT STRATEGY

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1 INTRODUCTION

Cassava, introduced in Uganda between 1862 and 1875, is currently one of the most important staple food crops in the country. Approximately 3.5 million tonnes have been produced from c. 0.4 million ha of land. The crop is grown in mixtures of legumes and cereals in small plots of land. Major constraint to production include pests and diseases particularly the African cassava mosaic virus which has decimated production in the country, bacterial blight, mealybug and green spider mite. A severe form of African cassava mosaic virus disease appeared in 1988 and has since eliminated cassava in many parts of the country. In order to restore cassava production an aggressive programme of on-farm trials, multiplication of mosaic-resistant varieties, training of extension staff and farmers was carried out. A national network of cassava workers (NANEC) and an integrated strategy for mosaic resistant cassava variety development stem multiplication and distribution were developed and used to implement the programme. Lack of planting materials of suitable varieties and bitterness in cassava also limit production. Despite some limitation and failures, government interventions through investments in infrastructure (roads, marketing, etc.), cassava processing, restructuring agricultural research and marketing systems, investment in cassava research and technology transfer has had some positive impact on cassava production in the country. The cassava programme has the mandate to develop new technologies for cassava production. Its specific objectives include development and transfer of improved varieties acceptable by farmers, developing sustainable methods for pest and disease control, development of improved technologies for production and utilization of the crop. Achievements so far include release of new varieties of cassava resistant to mosaic virus, biological control of mealybug and green spider mite and multiplication and distribution of over 70 000 ha of planting materials of the mosaic resistant varieties. Future strategies for cassava development will rest on government policies and infrastructures that will be supportive of cassava research and development, increased funding and human resource deployment and motivation, improved processing, storage, commercialization and marketing of the crop. It is proposed that in order to accelerate transfer of agricultural production technologies, indigenous knowledge must be learnt and utilized. The value of such new technologies must be tested in different agro-ecological conditions and farmers' circumstances and the best technologies selected based on the farmers' criteria and priorities. Finally obstacles to adoption must be identified and eliminated.

2 BACKGROUND TO THE STUDY

This is a report of a comprehensive case study of cassava in Uganda. The study was commissioned by the International Fund for Agricultural Development (IFAD) as apart of wider studies on Global Cassava Development Strategy (GCDS) and is based on reviews of secondary data, interviews with key personalities and from personal experience of the authors. A brief terms of reference for the study is outlined.

2.1 TERMS OF REFERENCE

Purpose: To analyse the past and the présent situation of cassava in Uganda, with a view to describing the lessons learned from past development interventions and their implications for a strategy for future investment in cassava research and development.

2.2 KEY ELEMENTS

1. A description of the evolution of cassava development in Uganda which includes the identification of significant interventions that have influenced that evolution. To include: (a) trends in cassava production and utilization over a given time period (up to the présent day), at the country level and by major cassava producing regions within the country; (b) major interventions, both at the national and regional level, that have influenced the evolution of the cassava sector, including for example: (i) changes in the development model adopted by the country (e.g. from a model of import substitution to a model of trade liberalization); (ii) changes in import, pricing or credit policies for cassava or competing commodities; (iii) investment in cassava research or development, including production, processing and marketing of the crop; (iv) investment in infrastructure and services to promote rural development and/or the development of the crop (both service infrastructure, roads, storage facilities, etc. and processing infrastructure).
2. An analysis of the successes and failures (or limitations) of the interventions identified above in removing the constraints to and/or realizing the opportunities for the development of the crop. Criteria for analysing the relative success of each intervention might, depending on the information available, include:
    - total economic benefit;
    - return on investment;
    - impact on equity, including gender;
    - impact on the environment;
    - impact on the development of institutions and organizations associated with the cassava sector.
3. Derive from the above-mentioned analysis, an enumeration of the lessons learned from past experiences.
4. A synthesis of the implications for a future strategy for cassava development in Uganda.

3 ACKNOWLEDGEMENTS

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4 UGANDA

Uganda (Figure 1) is a land locked nation located in East Africa and lies astride the equator, stretching 1°S to 4°N longitude and 29°to 35° east latitude and covers 241 038 km^2 of land, one-sixth of which is water and swamps. The country is predominantly an elevated basin averaging 1 000 m to 1 300 m above sea level. Annual rainfall varies considerably by region; the highest amounts averaging over 2 000 mm per annum are found in the fertile crescent along Lake Victoria. In contrast, Karamoja, the driest region in the north east, can get as little as 500 mm annually. Vegetation varies from dry savannah in the west and north east, to remnants of tropical rain forests in south and southwest.

About 20 million people live in Uganda but the population density is highest in Kampala (entirely urban), the east and southwest, the central region and parts of the West Nile region. Indices show that in four decades, the population and population density of the country more than trebled, implying dramatic increases in pressure on the land. Over 25 percent of Uganda's land is considered suitable for agriculture. This is much higher than the average for sub-Saharan Africa (6.4 percent). Of the cultivatable land, only 28 percent is currently in use. The most fertile soils and a double rainy season predominate most parts of the country. Consequently, agriculture accounts for more than 60 percent of GDP, about 98 percent of export earnings and over 40 percent of government revenue. Farming is labour intensive, with women and children providing 60–80 percent of the labour.

Many crops are cultivated in the country both as cash and food security crops. Despite the widespread cultivation, food security is still uncertain due to frequent, unfriendly weather and other environmental conditions. Of the food crops cassava has for a long time been the food security base of the country and has been considered one of the most important crops in the country.

Figure 1. Map of Uganda showing districts and principal towns

5 PRODUCTION AND UTILIZATION OF CASSAVA IN UGANDA

5.1 INTRODUCTION SPREAD AND ECONOMIC IMPORTANCE

Cassava was introduced to Uganda through Tanzania by Arab traders between 1862 and 1875 (Langlands. 1972). Following its initial introduction, cassava quickly spread to other areas of Uganda. It is currently one of the most important food crops in Uganda. It ranks second to bananas in terms of area occupied, total production and per capita consumption, respectively (Otim-Nape, 1990). It is regarded as the most important staple crop by over 50 percent of farmers surveyed recently in the eastern, central, southern and northern areas of Uganda (Otim-Nape and Zziwa, 1990; COSCA, Uganda, 1996). Over 71 percent of the farmers interviewed grew cassava as a subsistence crop. In addition to subsistence, some 19 and 9 percent of the farmers grow the crop for cash or other uses, respectively (Otim-Nape and Zziwa, 1990). Drinks, animal feed and use of brewing waste as a cementing agent in local construction are other uses of cassava (Otim-Nape and Zziwa, 1990).

Traditional cash crops (cotton, coffee and tea) which were formerly the main source of income for the rural farmers of Uganda have declined in status in recent years because of a poor marketing system and unattractive prices (Ocitti p'Obwoya and Otim-Nape, 1986). This has led to the emergence of cassava as the main source of income for over 60 percent of rural farmers who regard it as a 'new' cash crop in their farming systems (Ocitti p'Obwoya and Otim-Nape, 1986). In most cases the tubers are sold while the crop still stands in the field and the buyers, usually traders or ordinary consumers from within the village, are responsible for harvesting (Ocitti p'Obwoya and Otim-Nape, 1986).

5.2 PRODUCTION TRENDS

Since its introduction, cassava has been quickly adopted and its production expanded rapidly. Cassava cultivation increased greatly during the outbreak of the tropical migratory locust (Locusta migratoria migratoriodes S&F) from 1931 to 1933 (Jameson, 1964). Increases also occurred after the droughts of 1939 and 1941 when it became imperative to conserve local foods during the war (Jameson, 1964). The outbreak of African cassava mosaic virus and the shortage of food in some parts of Uganda notably Teso (now Kumi and Soroti districts) in 1943–44 encouraged an eradication campaign and introduction by the district councils of a by-law which made it mandatory for each farmer to grow at least 0.4 ha of cassava mosaic resistant varieties as a safeguard against famine.

The high yield ability of the crop and flexibility of the crop in the farming and food systems, abilities to do well in marginal and stressed environments, its abilities to give satisfactory yields where most other crops fail, to demand low labour requirements and to be left in situ for over two years without spoilage and its apparent resistance or tolerance to pests and diseases, particularly locusts (Jameson, 1970) encouraged its rapid spread and adoption and made it an excellent food security crop. Moreover, its value as a famine

reserve crop that was available when others were not was appreciated (Jameson, 1970). Consequently, cassava plantings increased rapidly as the crop became a cheap source of food in quantity (Jameson, 1964).

By 1950, 191 200 ha of cassava were grown in Uganda (McMaster, 1962). The land area planted to cassava and production of the crop in the country increased from 0.3 million hectares and 3 million tonnes in 1981 to 0.4 million hectares and 3 million tonnes in 1989, respectively. By 1994, an estimated total of c. 3.1 million tonnes of the crop were produced from c. 0.4 million hectares of land grown in the country. National and regional production by area and yield per hectare of cassava in Uganda is shown for 1970–1994 (Table 1). National statistics indicate a general increase in area up to 1975 and a general decline up to 1988 which later increased up to 1990. Similarly, production increased up to 1977 followed by a decline up to 1981. It then increased up to 1990, then declined but later picked up by 1993. The causes of this decline are complex and may be due to some or all of the following: poor extension services, acute shortages of agricultural inputs; (mostly hand hoes and animal implements), the 1979 liberation war and northern insurgency and frequent occurrences of severe epidemics of African cassava mosaic disease (ACMD). Regional production generally followed the national trend. Regions however differ in terms of agro-ecological characteristics, farming and food systems and practices which have a bearing on production.

Cassava is grown throughout Uganda (Appendix Tea - lc)/ The districts of Mbale, Iganga, Apac, Kamuli. Lira. Tororo and Kumi are the leading producers. Cassava production is low in the districts of central region where bananas and plantains have been the traditional staple food crops. Production of cassava in the central region is expanding rapidly as farmers have realized the advantages of cassava compared to bananas whose production is decreasing due to declining soil fertility and the effects of pests and diseases (COSCA, Uganda 1996).

5.3 PRODUCTION PRACTICES

Cassava land holdings vary from 3 to 15 ha per farming family (Ocitti p' Obwoya and Otim-Nape, 1986) and land is either inherited from parents or is purchased, borrowed or rented (Otim-Nape and Zziwa, 1990). As a change from past practices, most farmers now begin their crop rotations with cassava (Otim-Nape and Zziwa, 1990). A majority of farmers plant cassava on land of average fertility while only a minority, use either poor or very good land (Otim-Nape and Zziwa, 1990). Most planting is done in the first rather than in the second rains of the year. Over 95 percent of the farmers sampled select and plant 30–40 cm lengths of matured stems of preferred varieties. Spacings of 0.75 m × 0.75 m – 2 m × 2 m are used and are usually irregular depending on the other crops grown as intercrops.

As in many other parts of Africa, intercropping is a common practice with cassava in Uganda. Common crop mixtures are cassava/cereals/legumes (i.e. cassava/maize or sorghum or finger millet/beans, or groundnuts or cowpeas or soya beans) and cassava/bananas/coffee (Otim-Nape and Zziwa, 1990). The cereals or legumes are

planted two to three weeks before or after planting cassava, the spacing of cassava being wider (1.5 x 1.5 m) than for the normal sole crop. For the cassava/banana/coffee mixtures, cassava is introduced into the system when the banana or coffee are still young. Each row of bananas or coffee is planted to two or three rows of cassava planted at a wider spacing (about 2.5 m x 2.5 m to 2 m x 2 m).

5.4 UTILIZATION

Cassava plays an important role in the national diet and contributes a substantial proportion of the caloric requirements of the population. Peeled sweet cassava roots are eaten raw, boiled, fried, roasted or after drying and pounding, they are turned into a paste. Peeled bitter cassava are turned into flour after a solid state fermentation process, or after steeping in water (wet fermentation) and subsequent sun-drying. Also boiling the whole pieces, immediately after soaking, occurs. Especially bitter cassava is preferred for brewing local beer and distilling Waragi (a local gin).

According to studies (COSCA, Uganda 1996; Otim-Nape and Zziwa, 1990), carried out in selected villages in Uganda, boiled fresh cassava was regarded as the most important product; followed by flour in 16 percent of the villages and fermented drinks in 12.5 percent of the villages. However, flours were the most important cassava product in 65 percent of the villages where cassava is the second most important crop; and in 52 percent of the villages where cassava is the third most important crop; 32 percent of these third ranked villages reported drinks as their most important cassava product. These results indicate that while boiled cassava is the preferred form of cassava product, flours and drinks are also produced in significant quantities. Local gin, (enguli, waragi) are produced from dried cassava chips ground into flour, brewed and distilled. A flow diagramme showing the stages for processing different products is shown in Figure 2.

Figure 2. Processing steps for various products from cassava roots

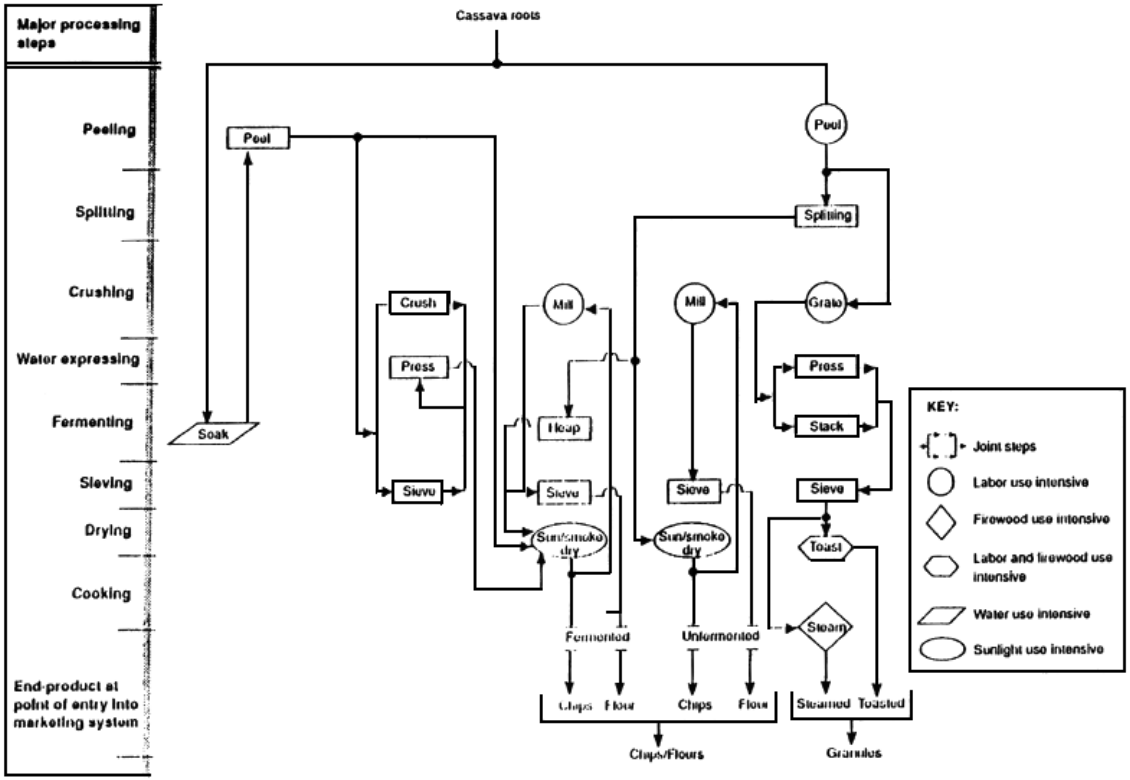


Table 1. National and regional quantitative cassava production trends: 1981–94

YEAR	NATIONAL			EASTERN			NOTHERN			WESTERN			CENTRAL		
	Area	Output	Yield	Area	Output	Yield	Area	Output	Yield	Area	Output	Yield	Area	Output	Yield
	(Million ha)	(Million tonnes)	(Tonnes/ ha)	(Million ha)	(Million ha)	(Tonnes/ ha)	(Million ha)	(Million ha)	(Tonnes/ ha)	(Million ha)	(Million tonnes	(Tonnes/ ha)	(Million ha)	(Million tonnes)	(Tonnes /ha)
1970	0,6	2.6	4,3	0.1	0.6	6.2	0.2	1.3	7.6	0.0	0.2	6.7	0.1	0.3	5.8
1971	0.5	2,4	4.8	0.1	0.5	3.8	0.2	1.6	6.9	0.1	0.1	1.7	0.1	0.2	2.7
1972	0.4	2.7	7.1	0.1	0.6	5.3	0.2	1.5	9,5	0.1	0.3	4.5	0.0	0.3	7.5
1973	0.5	2.1	4.4	0,1	0.5	4.0	0.2	1.1	5.2	0.1	0.2	3.5	0.1	0.3	3.6
1974	0.5	2.4	4.8	0.1	0.6	6.0	0.1	1.1	8.5	0.1	0.2	2.6	0.1	0.4	3.3
1975	0,6	3.0	4.8	0.2	0.8	3.8	0.2	1.6	7.1	0.1	0.2	2.5	0.1	0.4	4.0
1976	0.5	2.8	5.5	0.2	1.0	4.3	0.2	1.0	6.3	0,1	0.2	4,4	0.1	0.6	8.3
1977	0,5	3.0	5.5	0.3	1.3	4.9	0.2	0.9	5.3	0.0	0.2	4,2	0.1	0.6	8.8
1978	0.5	2.0	3.8	0.2	0.6	3.5	0.2	0.6	3.4	0.1	0.1	2.4	0.1	0.5	7.3
1979	0.3	2.1	6.5	0.1	0.7	5,3	0.1	1.0	9.2	0.0	0.1	3.4	0.0	0.3	5.9
1980	0,3	2.1	6.9	0.1	0.5	6.9	0.1	0.6	6.9	0.0	0.2	6.9	0.1	0.5	6.9
1981	0.3	3.0	9.7	0.1	0.8	9.7	0.1	1.1	9.7	0.0	0.3	9.7	0.1	0.7	9.7
1982	0.3	3.1	9.4	0.1	0.8	9.5	0.1	1.2	9.5	0.0	0.4	9.5	0.1	0.7	9.5
1983	0.4	3.2	6.7	0.1	0.8	8.7	0.1	1.2	8.7	0.1	0.4	8.7	0.1	0.8	8.7
1984	0.4	1.9	4.7	0.1	1.0	7,5	0.1	1.0	7.5	0.1	0.4	7.5	0.1	0.6	7.5
1985	0.4	1.7	4.3	0.1	0.7	9.0	0.1	1.0	9.0	0.0	0.3	9.0	0.1	0.6	9.0
1986	0.4	1.9	5.2	0.1	1.1	8.0	0.1	0,9	6.0	0.0	0.4	6.0	0.1	0.5	6.0
1987	0.3	3.1	9.0	0.1	1.1	9.0	0.1	1.0	9.0	0.0	0.4	9.0	0.1	0.6	9.0
1988	0.4	3.3	9.1	0.1	1.2	8.9	0.1	1.0	9.0	0.1	0.5	9.5	0.1	0.6	9.4

5.5 TRENDS IN CASSAVA DEMAND

Analyses of food supply and demand shows that up to 1994 on average, Uganda had a surplus in cassava (Table 2). The period 1981 to 1994 (data not shown) shows gradual increase in surplus. From 1985 however, the surplus declined steadily. For instance, between 1981 and 1987, the surplus level was 1 231 million tonnes per annum. This level however declined to about 677 000 tonnes per annum between 1987 and 1994. The projected national cassava supply, demand and surplus figures (in million tonnes) are given in Table 2.

Table 2. The projected national cassava supply, demand and surplus figures (in million tonnes)

Year	Cassava supply	Cassava demand	Surplus
1995	2 137	2 185	-49
1996	2210	2 269	-61
1997	2 381	2 358	22
1998	2 567	2 449	117
1999	2 768	2 545	222
2000	2 985	2 643	340

The main reason for decline in levels of surplus is the outbreak in 1989 of the cassava mosaic disease which destroyed the crop and also affected productivity in most of the cassava growing areas. This has also affected human consumption levels. However, despite the average drop, increase is envisaged as better yielding and mosaic resistant varieties are planted and come onto the market. Cassava used to be the leading food item in northern and eastern Uganda. It is expected that with multiplication and distribution of resistant varieties, cassava output (and consumption) will significantly, increase in these regions.

Although population growth is estimated at about 2.5 percent per year, per capita human food consumption in the last five years declined (Table 3). Unless this trend is reversed, increase in total cassava demand will be lower than increase in cassava supply, necessitating processing, the use of cassava as industrial raw materials and for animal feed.

Table 3. Quantitative food demand trends for cassava (1981–1994)

Year	Population (millions)	Human consumption (million tonnes)	Industry use (tonnes)	Total demand (million tonnes)	Per capita consumption (kg per head)
EASTER REGION					
1991	3.31	0.54	0	0–54	1–64

Year	Population (millions)	Human consumption (million tonnes)	Industry use (tonnes)	Total demand (million tonnes)	Per capita consumption (kg per head)
1982	3.38	0.55	0	0.55	164
1983	3.46	0.57	0	0.57	164
1994	3.53	0.58	0	0.58	164
1985	3.61	0.59	0	0.59	164
1986	3.69	0.59	0	0.59	160
1987	3.77	0.62	0	0.62	164
1998	3.85	0.63	0	0.63	164
1989	3.94	0.63	0	0.65	164
1990	4.02	0.66	0	0.66	164
1991	4.13	0.59	0	0.59	142
1992	4.22	0.60	0	0.60	142
1993	4.31	0.61	0	0.61	142
1994	4,41	0.63		0.63	142
NORTHERN REGION					
1981	2.49	0.48	0	0.48	195
1982	2.54	0.50	0	0.50	195
1983	2.60	0.51	0	0.51	195
1994	2.67	0.52	0	0.52	195
1985	2.73	0.53	0	0.53	195
1986	2.79	0.55	0	0.55	
1987	2.86	0.56	0	0.56	195
1988	2.93	0.57	0	-0.57	195
1985	1.00	0.59	0	0.59	195
1990	3.07	0.60	0	0.60	195
1991	3.15	0.47	0	0.47	148
1992	3.23	0,47	0	0.47	145
1993	3.31	0.49	0	0.49	148
1994	3.38	0.50	0	0.50	148
WESTERN REGION					
1981	3.39	0.39	0	0.39	115
1992	3.48	0.40	0	0.40	115
1983	3.58	0.41	0	0.41	115
1994	3.67	0.42	0	0.42	115
1995	3,77	0.43	0	0.43	115
1996	3.99	0.44	0	0.44	1–15

Year	Population (millions)	Human consumption (million tonnes)	Industry use (tonnes)	Total demand (million tonnes)	Per capita consumption (kg per head)
1987	3.98	0.46	0	0.46	115
1989	4.09	0.47	0	0.47	115
1989	4.20	0.49	0	0.49	115
1990	4.31	0.49	0	0.49	1–15
1991	4.43	0.38	0	0.38	8–5
1992	4.55	0.79	0	0.39	95
1993	4.67	0.40	0	0.40	95
1994	4.80	0.41	0	0.41	8–5
CENTRAL REGION					
1981	3.21	0.38	0	0.39	119
1992	3.30	0.39	0	0.39	119
1983	3.40	0.41	0	0.41	119
1984	3.51	0.42	0	0.42	119
1985	3.61	0.43	0	0.43	119
1998	3.72	0.44	0	0.44	1–19
1987	3.83	0.46	0	0.46	119
1988	3.95	0.47	0	0.47	119
1989	4.06	0.48	0	0.49	119
1990	4.19	0.50	0	0.50	119
1991	4.07	0.52	0	0.52	128
1992	4.19	0.54	0	0.34	129
1993	4.32	0.55	0	0.55	129
1994	4.45	0.57	0	0.57	129
UGANDA					
1980	12.63	.73	0	1.73	137
1981	13.33	1.83	0	1.83	137
1982	13.69	1.99	0	1.99	137
1983	13.94	1.91	0	1.91	137
1984	14.19	1.94	0	1.94	137
1985	14.49	1.99	0	1.99	137
1996	14.99	2.04	0	2.04	137
1987	15.30	2.10	120	2.10	137
1988	15.72	2.15	122	2.15	137
1989	6.15	2.02	145	2.02	125
1990	6.60	2.07	140	2.07	125
1991	6.67	2.08	194	2.08	125

Year	Population (millions)	Human consumption (million tonnes)	Industry use (tonnes)	Total demand (million tonnes)	Per capita consumption (kg per head)
1992	17.52	2.19	171	2–19	125
1993	18.00	2.25	157	2:25	125
1994	18.49	2.31	195	2.31	125

Source: EPAU, 1996

6 FACTORS THAT HAVE INFLUENCED DEVELOPMENT OF CASSAVA IN UGANDA

6.1 BIOPHYSICAL CONSTRAINTS

As for many other African crops, the productivity of cassava in Uganda (7–8 tonnes ha in 1987–89) is much lower than the world average (9–10 tonnes ha in 1987–89). These low yields are due to constraints that challenge the production and utilization of the crop. Such constraints are (a) the use of inferior and low yielding varieties; (b) lack of good quality planting materials; (c) pests and diseases; (d) deteriorating land availability and soil conditions; (e) lack of credit facilities and farm inputs; (f) poor price incentives; (g) labour bottlenecks and poor cultural practices; (h) bitterness and cyanogenic glucosides hinder the utilization of the crop; (i) bulkiness and perishability hinder commercialization of the crop; and g) poor methods of processing and utilization (Ocitti p'Obwoya and Otim-Nape, 1986. Otim-Nape and Zziwa, 1990).

Farmers in over 54 percent of the villages interviewed in many parts of Uganda identified pests and diseases as the main hazards in cassava production (Otim-Nape and Zziwa, 1990; Ocitti p'Obwoya and OtimNape, 1986). The major pests are briefly outlined below.

6.1.1 Pests

Cassava mealybug (Phenacoccus manihoti [Matile-Ferrero]). The cassava mealybug which was accidentally introduced into Africa in the early 1970s in the present Zaire has spread all over Africa (Hahn and Williams, 1973). By early 1992 it was identified in eastern and western Uganda (Tororo and Masindi districts) probably from the neighbouring Kenya and Zaire, respectively. This pest causes severe damage to cassava leading to considerable yield losses; it is still a serious dry season pest in some parts of the country particularly in Kumi, Masindi (Buliisa), Pallisa and Soroti districts, most probably because of the harsh, intensive and prolonged dry seasons in these areas. Early planting in areas with heavy and long first rains sustain minimal damage because the number of the mealybug is markedly reduced below economic in ury level during the rainy seasons (Fabres, 1980; Herren, 1981). This enables the plants to establish and withstand the attack of the mealybug in the succeeding months of the dry season. In countries with clearly defined yearly dry and wet seasons, several workers have recommended early planting for the control of cassava mealybug (Leuschner, 1980;

Akinlosotu and Leuschner, 1981). However, this recommendation may not be widely adopted in Uganda because of interfering with the different cropping patterns.

There are now some high yielding varieties such as Migyera, Nase I and TMS 4 (2) 1425 which are tolerant to P. manihoti and recovers quickly with the first rains after attack by the pest during the dry season. Chemical treatments of late planted cassava with systemic insecticides (Furadan 5G) or foliar insecticides (Ultracide 40 EC, Rogor) did not lead to significantly higher yields than those from the control plots. The subsequent discovery of Epidinocarsis lopezi in South America and its introduction and release in Afrcia, signalled an integrated approach to the control of this pest throughout the region. Life-table analysis confirmed that E. lopezi is the key mortality factor in reducing mealybug population (Neuenschwander, 1990). A combination of crop resistance, optimal insecticide use mostly to disinfest planting material, early planting, weed control and biological control by use of E. lopezi can sustain an effective control of the mealybug infestation at the farm level and raise yields and production.

The green spider mite (Mononychellus tanajoa Bonder, Tetranychideae) is currently one of the most important arthropod pests of cassava in Uganda (Otim-Nape and Odongo, 1984). This pest was inadvertently introduced into Uganda, where it was first reported in 1971 (Nyiira, 1975). The amount of crop damage by cassava green spider mite depends on the fertility of the soil, cultivars used in particular localities and more so on the rainfall pattern. Heavy infestation of susceptible cultivars especially during the dry season in poor soils can cause total leaf defoliation resulting in yield reduction of up to 46 percent (Nyiira 1975). An annual yield loss of 17–33 percent (Nyiira, 1975) amounting to US$7 million in 1984 has been estimated (Otim-Nape and Odongo, 1984). The use of acaricides to control green mites is economically inviable considering the period of the growth cycle of cassava (8–16 months), toxicity to users, cost of the acaricide, its deleterious environmental side effects and the possibility of selecting for acaricide resistance.

In 1994, one species of exotic phytoseiid mites *Typhlodromalus aripo* was introduced and released at Namulonge. The functional and numeric responses of *Typhlodromalus aripo* on green spider mites population effectively controlled green mite population development and crop damage on release fields. It is likely that this could form the basis of biological control of the pest. Integrated control measures involving the use of resistant varieties, cultural practices and natural enemies have been recommended.

Whiteflies (Bemisia tabaci [Genn]). In Uganda *B. labaci* is important as a vector of African cassava mosaic disease (ACMD). The possibility of developing cassava varieties that have some relative resistance to *B. tabaci* could form the basis of an integrated approach to its control and to the control of ACMD. The use of cultural practices such as barrier crops is still being investigated. Early planted cassava was reported to suffer higher virus contamination than late plantings. An integrated approach to control is being developed.

6.1.2 Elegant grasshoppers (Zonocerus variegates [Thunb])

In Uganda grasshoppers are reported on cassava in the drier areas of West Nile, Soroti and Kumi districts. Their attack is mostly during the dry season and at the onset of the first rains. Their feeding damage can cause total defoliation of the crop and with heavy infestation, green stems are consumed, leaving only the white wood. Chemical control using Dieldrin, fenitrothion, etc. have been effective to control this pest in Uganda. A possibility of biological control is being investigated.

Other pests include the cassava scales (Aonidomytilus albus [Cockerell]), Root knot nematodes (Meloidogyne incognita), terminates and vertebrate pests such as wild pigs, monkeys, mole rats, etc.

6.1.3 Diseases

Contrary to earlier views (Jameson, 1970) diseases are now by far the largest constraints to cassava production in Uganda. Many diseases which infect cassava are summarized in Table 4 and are briefly outlined below.

Cassava brown streak disease caused by a whitefly-transmitted virus was first reported in Uganda in 1945 (Nichols, 1950) at Bukalasa experimental station, central Uganda. It was assumed to have been introduced in 1934 in cassava stems from Amani Tanzania. An eradication campaign was carried out between 1945–1950 and since then there has been no report of this disease and the campaign seems to have been successful (Emechebe, 1976).

The African cassava mosaic disease (ACMVD) caused by a whitefly transmitted geminivirus (Bock and Wood, 1983) was first reported in Uganda in 1928 (Hall, 1928; Martin, 1928). It is considered the most important and serious disease of cassava in the country (Otim-Nape, 1990). A severe epidemic devastated crops in the eastern region from 1933–1944 (Jameson, 1964). Vigorous breeding and selection for mosaic-resistant varieties carried out at Amani, Tanzania, resulted in genotypes that were widely tested and released in Uganda as varieties Bukalasa 8, Bukalasa 11, etc. They were multiplied and distributed to farmers (Jameson, 1964). A bye-law instituted in the 1950s made it mandatory for farmers to uproot all infected and susceptible local varieties and replace them with the new ones (Jameson, 1964).

6.1.4 The current epidemics of severe cassava mosaic disease in Uganda

Since 1988, severe epidemics have traversed the country from north to south and caused devastating losses and food shortages. Comprehensive surveys carried out in 1990–1992 (OtimNape, 1993) and again in 1994 in all cassava-growing districts revealed that ACMD occurred throughout the country. There was almost total infection in most parts of the country where symptoms were very severe. Healthy planting material of local Ugandan varieties introduced to the high incidence areas encountered high inoculurn pressure and became heavily infected within a few months of planting.

Movement of the epidemic. Observations on the progress of the epidemic across Uganda revealed that since 1988, it moved c. 140 km southwards towards Kampala. By May 1997, the epidemic reached Kampala and continued to spread southwards along a broad front at a rate of c. 5–20 km per annum. The front is characterized by a large population of whiteflies and by a high incidence of ACMD mainly due to recent infection by the whitefly vector. The lower leaves of plants infected in this way seem healthy while the youngest leaves show severe symptoms. They are reduced in size and show marked distortions and malformation which give infected plants a paint brash like appearance. The plants harbour numerous adult whiteflies on the young shoots and large nymphal populations on the undersides of the lower leaves (G. W. Otim-Nape, unpublished).

Table 4. Cassava diseases and their pathogens in Uganda

Disease	Pathogen	Reference
A. Viral diseases		
1. Cassava brown streak	Cassava Brown Streak I virus	Storey, 1936
2. African cassava mosaic	African Cassava Mosaic Geminivirus	Storey and Nicholas, 1936: Emechebe, 1976
3. Kumi cassava virus	Cassava Chlorotic Portex Virus	Harrison, 1991 (Pers. comm.)
B. Bacterial diseases		
1. Cassava bacterial blight	Xanthomonas campestris manihotis (Dye)	Otim-Nape, 1977
2. Cassava bacterial leafspot	Xcampestris p. r cassavae	Hansford 1936, Wiebe and Dawson, 1962
C. Fungal diseases		
1. Cassava anthracnose	Colletorrichum gloesporoids manihotis	Otim-Nape, 1977
2. Brown leafspot	Cercasporidum heningsii	Jameson, 1970, Emechebo, 1976
3. Blight leafspot	Cercospora	Otim-Nape, 1988
4. White leafspot	Phaeoramularia	Otim-Nape, 1988
5. Botryodiplodia stem rot	Botryodiplodia theobromae	Otim-Nape, 1984
6. Armilleriella wilt and root rot	Armilleriella mellea	Emechebe, 1976; Jameson, 1970
7. Verticillium wilt	Verticillium	Emechebe, 1976
8. Phytopthora root rot	Phytopthora	Emechebe, 1976
9. Dry root rot	Riqidosporus liqnosus	Emechebe, 1976
10. White root rot	Sclerotium rolfsii	Emechebe, 1976
11. Rosellinia root rot	Rosellinia necatrix	Emechebe. 1976
D. Nematode Diseases		

Source: Bridge et al., 1991

Impact of the epidemic on cassava production. Fifteen to twenty kilometres behind the front, all plants show severe ACMD symptoms due to the use of cuttings from plants infected by whiteflies the previous year. If this material is used in the absence of adequate stocks of healthy cuttings, the ensuing plants are severely stunted and produce no or very poor yields. Consequently, farmers become discouraged and in the absence of adequate amounts of healthy planting material, they abandon growing cassava (Figure 3). Annually over 60 000 ha of cassava, equivalent to over 600 000 tonnes (US$60 million) of fresh cassava roots are lost in this way (Otim-Nape *et al.,* 1997). The causes of the epidemics are being investigated. More aggressive strain of the virus has been identified as the most likely cause. The possibility of a new biotype of whiteflies B. tabaci is being investigated (Otim-Nape *et al.,* 1997).

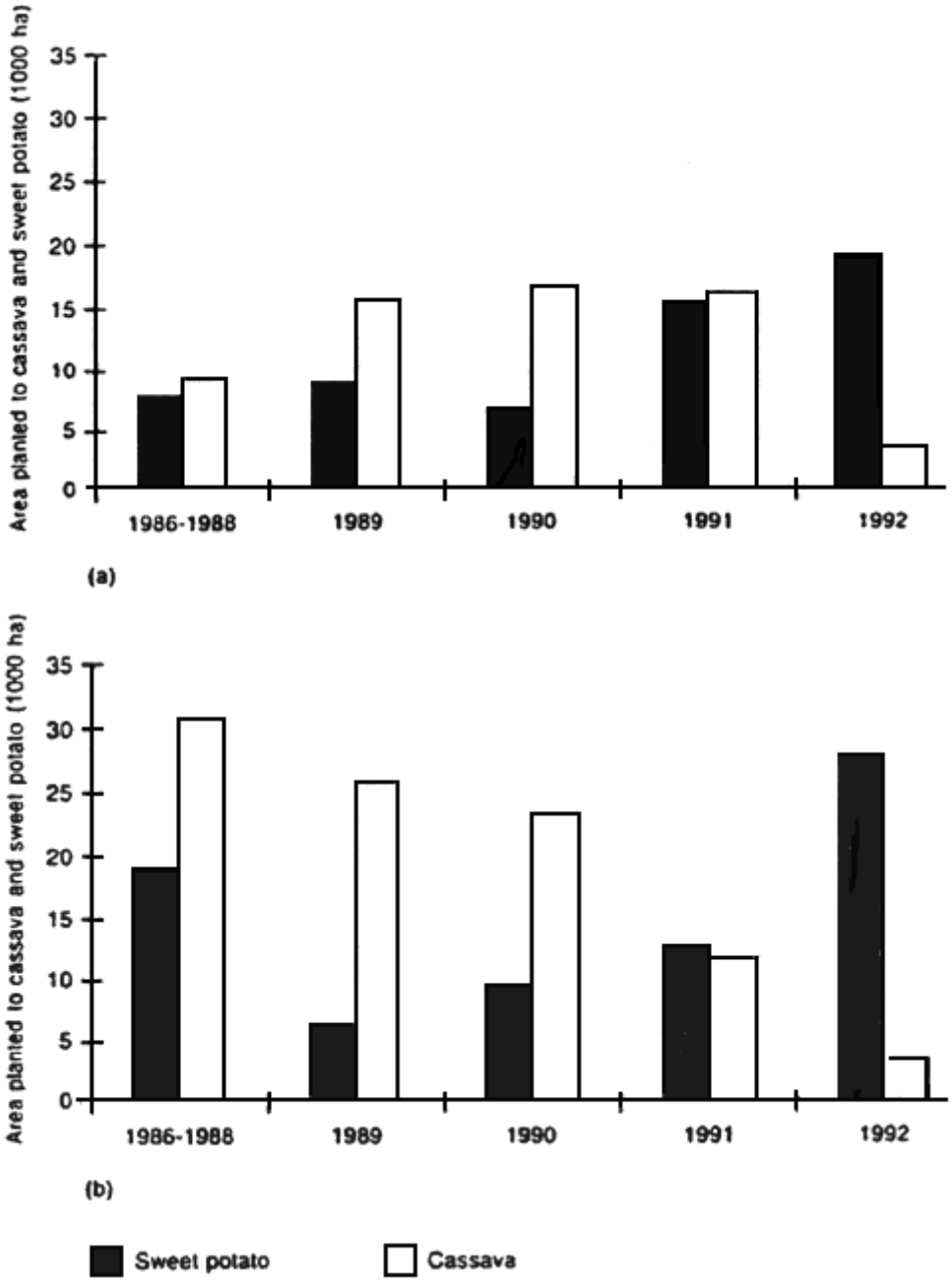
The current epidemic has led to a drastic decrease in cassava production and to the virtual elimination of the crop in some areas. Moreover, over 500 local cassava genotypes are

threatened with extinction and special measures have been required to protect them. The epidemic has had serious consequences on communities heavily dependent on cassava as a staple food and cash crop. There have been massive food shortages and starvation in some districts, especially in the east and north.

The “Kumi” cassava virus disease also proposed to be known as cassava chlorotic virus (CCV) (Harrison, 1991, pers. corn) was first discovered in Kumi district, eastern Uganda in April 1991 (OtimNape and Thresh, 1991. unpublished). The aetiology of the disease, its transmission, distribution in Uganda, economic importance and control of the disease is unknown.

Cassava bacterial blight (CBB) caused by Xanthomonas campestris pv. manihotis was first reported in Uganda in 1976 (Otim-Nape, 1976). It was found widespread in the country and caused severe losses in the savannah areas particularly on susceptible varieties grown on poor soils (OtimNape and Sengooba, 1980). CBB causes up to 70 percent reduction in yields of cassava tubers and planting materials. The disease is spread through infected planting material, wind driven rain splash, insects and the movement and use of infected implements (Lozano and Sequeria, 1975, Otim-Nape and Sengooba, 1980). The use of resistant varieties, cultural practices and sanitation are the recommended control methods (Otim-Nape and Sengooba, 1980).

Figure 3. Changes (1988–1992) in land area planted with cassava and sweet potato in (a) Soroti District and (b) Kumi District



Cassava bacterial leafspot (CBL) (Xanthomonas campestris pv. cassavae) was first reported by Hansford (1936) as Bacterium cassavae. A type species of B. cassava was later found synonymous to Erwinia larythi (Mann and Taubenhaus), which is ubiquitous saprophyte (Wiehe and Dowson, 1962). However in 1962 Wiehe and Dowson (1962) isolated Xanthomonas cassavae from a similar disease in Malawi. The disease in Uganda was later attributed to this pathogen. Later, Maraite and Weyns (1980) isolated X cassavae from a number of samples from Uganda. Xanthomonas, X campestris pv.

cassavae became the new name of the pathogen (Dye *et al.*, 1983). Unlike CBB, CBL causes only angular leaf spotting on cassava and is a relatively unimportant disease in Uganda.

Cassava anthracnose (Collectotrichum glosporoides f. manihotis) was first reported in 1983 (Otim-Nape, 1983) and is widespread. The disease dissemination is aided by an insect Pselidotheraptus devastans group. Under normal conditions, the disease is unimportant but it can be serious when hailstones predispose the crop to infection. Use of resistant varieties is the recommended control (Otim-Nape, 1983). Brown, blight and white leaf spots and Botryodiplodia stem rot are prevalent in the country but they are unimportant economically. Cases of Armilleriella and Verticillium wilts have been reported. They appear less sporadic and are also unimportant.

The root rot complex (Phytopthora, dry, white and Rosellinia root rots) are quite common but little is known about them. Similarly, cases of root knot nematodes have been reported on the crop, but information and their distribution and economic importance is lacking.

6.1.5 Weeds

Weed can cause significant yield reductions if uncontrolled. Competition exerted by weeds reduce yields and can favour survival of pathogens when the weeds act as alternate hosts. Yield reduction of up to 90 percent can be achieved when weeding is delayed especially during tuberization and tuber enlargement. In Uganda, varieties like Migyera which have been developed and released to the farming community have the ability to compete favourably with weeds. Until recently manual digging has been the only control option available to the farming community. However, chemical control using glyphosate (roundup) is becoming common as the cost of labour rises.

6.1.6 Lack of improved varieties

A majority of farmers plant local varieties which are characterized by low yields and susceptibility to diseases. As a result, although farmers may plant large land area to cassava, low yields result in low output. However, several programmes to improve varieties resulted in improved cassava varieties like, Bukalasa 8, Bukalasa I, etc., Nase 1, Nase 2, Migyera, etc. which have been or are being distributed to farmers.

Apart from the poor soil types in some parts of the country, another problem is the deteriorating soil fertility as a result of continued use of the same land. Furthermore, poor methods of cultivation has led to increased soil erosion, thereby reducing productivity. There is therefore, need for improved agricultural techniques and increased use of fertilizers whose prices are prohibitive to most farmers.

6.1.7 Support services

Survey findings and discussions with farmers suggest that in general, extension services are inadequate. Associated with this is the lack of farmer training. In the northeast and northern parts of the country, draught oxen used to be the most widely used technology.

However, following civil strifes and cattle rustling, farmers' means of opening land has significantly been affected. Similarly in most parts of the country, tractor-hire services are minimal. Labour is also generally in short supply as youth and males migrate to urban areas.

6.1.8 Weather

Uganda's agriculture is rainfed. Any short fall in the amount of rain expected for agricultural production affects output. Over the past years, the Karamoja region, Moyo and parts of northern and central Uganda have had continuous rain shortages, resulting in low output levels. On a few occasions, however, too much rain has also destroyed crops particularly when the rains come when crops have sprouted or are nearing harvest.

7 INTERVENTIONS THAT HAVE INFLUENCED CASSAVA DEVELOPMENT

7.1 CHANGES IN THE DEVELOPMENT MODEL ADOPTED

Since independence, Uganda has adopted outward-looking growth strategies aimed at investment promotion and export development and diversification. This policy framework is embedded within the context that Uganda's economy is dominated by agriculture and remains dependent on growth in the agriculture sector. Indeed, agriculture is the mainstay of Uganda's economy and that accounts for about 50 percent Gross Domestic Product (GDP), 80 percent of employment and over 90 percent of exports. Within agriculture, food crops contribute more than 70 percent and also record the highest growth rate and provide the major source of nutrition to the population. Hence, the potential of food production development and exports is huge.

On the basis of the above-mentioned resource endowments and the development potential that exist in the country, the following development models within the macroeconomic policy frameworks have been designed and adopted in Uganda. The post independence period of the 1960s adopted “The Move to the left and the Common Man's Charter” paradigm in which the Government played a central role in the control of the economy. Following the political strife of the 1970s, “Economic War Policy” was adopted. Meanwhile in 1980–1985, “Mixed Economic Policy” characterized by exchange rate policy of floating the currency was developed and utilized. The period 1986–1997 was characterized by a structural adjustment in which the economy is liberalized with most trade privatized.

7.1.1 The move to the left and the “common man's” charter (1960s)

This policy was adopted with a view to alleviate poverty at grassroot level. The then government of Uganda played a leading role in the control of the economy with the participation of the rural poor.

Although the “common person” from this socialist approach, investment promotion strategy was hampered and crop production with cassava inclusive was greatly affected. This was due to the shift in focus from production of raw materials for processing and/or direct export to food production for the domestic market. The strategy limited the continued rapid growth in food production due to its dependence on the size of the domestic markets.

7.1.2 Economic war policy (1970s)

The economic war policy of the 1970s was geared toward involvement of the indigenous Ugandans in running the economy of the country. It, therefore, resulted in the expulsion of the foreign investors. This model discouraged investment promotion with minimal export developments.

Accordingly, the economic development in Uganda in the 1970s has been hostage to the effects of armed conflicts, the disintegration of public infrastructure and services, the collapse of government regulation and the uncertainties of high inflation and scarcities of foreign exchange.

This also had enormous impact on crop production like cereals, pulses, oils and root crops due mainly to limited domestic markets and Uganda's export crops became less competitive in the international markets.

7.1.3 Mixed economic policy (1980–1985)

The engine of growth in the 1980s resulted from the release of foreign exchange constraint through floating of the currency, rehabilitation of key infrastructure and adoption of free-market policies -including the decontrol of food prices and trade. This resulted in an expansion in food production as production and marketing costs fell. Cassava as the second main food crop in Uganda, took advantage of this change and its production grossly increased. Basically, food production remained the lead sector in agriculture, both in 1980–1983 and since the advent of the current government in 1986. Trend growth in food production was 3.2 percent per annum for the decade and 4.8 percent per annum since 1986.

7.1.4 Liberalized economic model (1986–1997)

Since 1986, Uganda has put into place government development strategies in the face of structural adjustment. The structural adjustment was deemed necessary in placing the macroeconomic policy framework at the centre of economic activities.

With the guidance of the IMF and the World Bank, Uganda formulated and is implementing a structural adjustment policy that promotes liberalization of the economy where market mechanism is considered the apparatus for government action and the private sector is seen as the engine of growth. This strategy is adopted on the basis that the development of Uganda is influenced by its own historical heritage, political situation, geographical position, economic endowment and social standard.

Accordingly, Uganda's liberalized economic model is set to serve as not just a formal implementation of structural adjustment but also a goal-oriented action system. Specifically, the Government places high priority on restructuring the agricultural sector so as to meet its objectives in providing sufficient food requirements, generate foreign exchange and improve living standards. Rapid growth in the food sector since 1986 has returned the country to food self sufficiency and brought about a broad based increase in rural incomes.

Within this policy framework, cassava has played a leading role in bridging the food gaps and increasing the internal economy of the rural farmers. This has been due to the use of improved varieties with high yields and replacing the traditional staple food crops like bananas and finger millet whose yields have been declining due to decline in soil fertility and disease and pest constraints. This was coupled with the free and attractive market environment that stimulated the production of cassava over the years. However, the most fragile aspect of the recovery programme in Uganda now is the lack of response in exports which must grow in value in the next few years if the economic growth is to be sustained.

Consequently, in the short-term, the agenda for adjustment and investment should continue to focus on increasing agricultural exports in both traditional and non-traditional cash crops. While in the medium term, measures should be taken to diversify agricultural exports, improve technology generation and dissemination in the sector, reduce transaction costs, entry barriers and market failures in the land, labour and capital markets. This requires adding values to crops like cassava through processing mechanisms to broaden the utilization base of the crop.

In its efforts to restructure its economy, Uganda also developed a political structure under a decentralization strategy in 1992. The main objective of the decentralization programme is to transfer functions, powers and responsibilities from the central government to the local government. The framework focuses on activities financed by the recurrent budget but implemented at the district level. The districts prioritize objectives, define core functions based on effective requirements and conditions at local levels.

The decentralization programme is deemed to offer an institutional framework for community based organizations and NGOs to effectively deliver the most needed social services to the poor.

The Uganda cassava programme has been operating within this framework and has developed a national network for cassava workers that bring together all the stakeholders in the cassava research and development in the country.

However, this new policy approach should widely be understood and shared within the administration at all levels in order for the poor to take maximum advantage of this opportunity.

7.2 INVESTMENT IN CASSAVA PROCESSING: THE LIRA STARCH FACTORY (LSF)

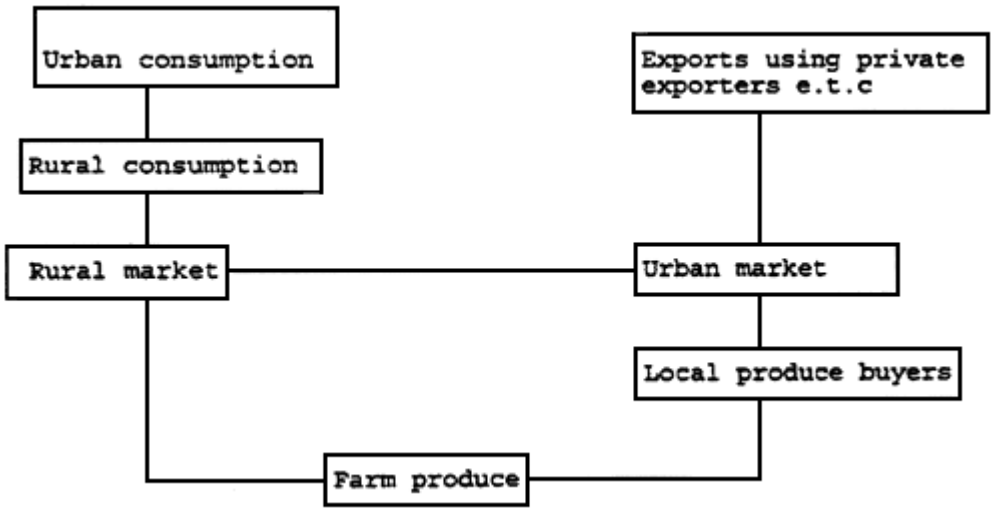
The Lira Starch Factory was established in 1968 with the aim of manufacturing commercial starch from cassava. Until the mid 1980s, the factory purchased raw cassava from farmers in eastern and northern Uganda and sold, both locally and abroad, quantities of starch and by-products. The factory created a market for raw cassava and stimulated more cassava production. Unfortunately, this factory was badly destroyed during the insecurity of the 1980s and has never been rehabilitated.

7.3 CHANGES IN THE CASSAVA MARKETING SYSTEM

7.3.1 Internal cassava marketing

A detailed survey conducted in 1990–94 by the Collaborative Study of Cassava in Africa (COSCA) revealed limited village markets for cassava and only 24 percent of the villages surveyed had markets. This implies that commercialization of food crops especially cassava had not been deeply entrenched at village level. However, there is now increasing demand for cassava which will likely raise prices and stimulate production (COSCA, 1996; Bua *et al.,* 1991). Currently, the market is dominated by small-scale wholesale and retail traders who operate at different levels from the village to district and urban markets. The traders sell through a network of rural and urban markets spread all over the country (Figure 4). Such markets lack appropriate facilities such as proper storage and weighing facilities. There are no product standards and as a result, transactions are made through face-to-face bargaining involving rigorous examination, touching and testing. It is estimated that there are over 3 000 village assembly markets and 300 weekly markets in Uganda (EPAU, 1996). Lack of market information in rural areas is yet another problem faced by producers. Most of the traders usually buy the cassava from the farmers fields and in a way this may cheat the farmers because what is harvested from a stool may be mo e than the price agreed upon.

Figure 4. National food marketing channel



Source: EPAU Food Security Survey, 1996).

7.3.2 External markets

Cassava is one of the non-traditional agricultural exports. The available data indicates that some cassava enter external markets and is exported (Table 5). Additionally, reports indicate that over the last three years, cassava flour has been exported to Rwanda. There has been cross-border trade in cassava especially on the Kenya, Sudan and Zaire borders and potential markets in Israel and South Africa exist where it can be sold in the form of chips and used in the chemical industries (Ogwal, UEPB, per. comm).

7.3.3 Changes in marketing policy

Policies in both the pre-colonial and post-colonial periods have been geared towards production of export crops and crops such as maize, rice and wheat, among others, to meet increasing urban demand with the hope that self-sufficiency in food could be met by these crops. Consequently cassava was only being promoted as a famine reserve crop with little investment. There has been no government intervention in the pricing of cassava as in other crops, because for a long time cassava was referred to as a famine reserve crop. Currently the Government is pursuing a policy of price and trade liberalization and promotion of non-traditional crops. Consequently there is competition between buyers with the consequent benefit to farmers. These policies have stimulated the export of cassava.

7.4 INVESTMENT IN STORAGE INFRASTRUCTURE

Farm storage is inadequate, poorly constructed and therefore does not serve the overall purpose of ensuring safe storage. In most districts in eastern and northern Uganda, granaries are the main means of storing farm produce, these are prone to attacks by pests, rodents and theft. In addition, the technology used is poor and when rains come most of

what is stored gets spoilt. It is believed that poor storage accounts for between 50–70 percent of the total crop losses (EPAU, 1996). However, different storage methods have been developed by research and some have been passed on to the farmers. In regional and major towns sizeable storage capacity exist. These mainly belong to the Produce Marketing Board (PMB), hence at regional level there seems to be a fairly adequate storage infrastructure (Table 6).

Table 5. Exports of cassava and other selected food crops (tonnes); 1990–1996

Commodity	1990	1991	1992	1993	1994	1995	1996
Bean	9 278	14 209	9 327	8 500	26 955	29 008	6 245
Maize	26 910	33 891	29 639	110 26	87 285	101 754	52 426
Finger millet	115	1.285	710	0	286	1.591	481
Sorghum	91	21	962	1778	3 904	8 623	274
Rice	2	100	113	89	90	301	0
Wheat	1	0	2 283	216	761	516	1076
Cassava	60	183	10	5	0	85	0
	0	-	23	84	14	-	-
Groundnuts	136	239	84	457	360	444	30
Simsim	9 207	17 805	12 863	8 184	4 245	9 507	7218
Soyabea is	41	2 382	1 104	3 300	1449	4 343	6 028

Source: Compiled by EPAU from Uganda Revenue Authority (URA) and Ministry of Finance and Economic Planning (MFEP) EPAU, 1996

Table 6. Region, location and capacity of storage facilities

Region	Location	Capacity (tonnes)
Eastern	Jinja	20 000
	Tororo	18 000
	Mbale	10 000
Northern	Gulu	6 000
	Arua*	6 000
Western	Kasese	6 000
	Kabale*	3 000
	Mbarara*	3 000
Central	Kampala	18 000
	Masaka	3 000

** Estim ates*

7.5 INVESTMENT IN ROADS INFRASTRUCTURE

Field surveys by the Agricultural Secretariat indicate that high cost of transport and poor road network are a major hindrance to both agricultural production and food security and

export diversification. Of the 18 districts visited, 14 indicated a poor road network and lack of affordable transport as a factor affecting food security. Most of the rural roads become either very slippery or impassable during rainy seasons. As a result of the above, transport charges are high and this in turn affects the producers returns.

A number of major trunk roads have been rehabilitated but a large portion of the rural feeder roads which provide important linkage between the rural food supply and demand areas are still in poor shape. Some of the roads are impassable during the rainy seasons. As a result transport costs are high, contributing to reduced returns to the farmer with negative impact on production. Currently the Government has put high priority on the improvement of both trunk and rural feeder roads.

7.6 INVESTMENTS IN AGRICULTURAL RESEARCH INFRASTRUCTURE

7.6.1 The early days of research

The history of agricultural research dates back as early as 1898 when the Botanic Gardens were established "for better examination and development of the agricultural resources of the Uganda Protectorate". This later developed into Kawanda and Serere research institutes and substations such as Ngetta, Kituza Kalengere, etc. A British cotton research institute located at Namulonge, was later handed over to the Government of Uganda in 1972 and became the Namulonge Agricultural and Animal Production Research Institute (NAARI). Despite these positive trends, little research efforts were devoted to food crops. For the selected cash crops, the research was of a very high standard which by the 1950s and 1960s was well organized throughout East Africa and in some cases beyond the region.

7.6.2 The period 1971–1990

Since 1971 there has been a steady decline in research due to a number of factors internal to the country. Analysis of the research stems from during the period showed faced major constraints that adversely affected its responsiveness, relevance and productivity. The most important of these constraints were destruction and decline of infrastructure including the breakdown in the research infrastructure, inadequate and unstable research funding and severe problems of communication and security, ineffective mechanism for the delivery of research results to clients (farmers, producers and development agencies). In spite of these problems, there had been some research at research stations and contact with the international agricultural research centres appeared to have increased significantly during those decades.

7.6.3 After 1990: The National Agricultural Research Organization (NARO)

NARO is a semi-autonomous public sector national agricultural research organization, established in 1990 by an act of parliament. It is composed of a supervisory board, a secretariat, eight research institutes and two stations. It was formed by reorganizing the old colonial-era research system to meet the new requirements of independent Uganda.

Its main objective is to undertake, promote and coordinate research on all aspects of crops, livestock, fisheries and forestry. Cassava research is accorded high priority in NARO and is adequately staffed and funded.

7.6.4 Other cassava research institutions which contributed to cassava development in Uganda

Amani Research Station in Tanzania. Owned by the East African Common Services Organization, this station was founded at the beginning of the 20th century. It pioneered serious research on cassava in East Africa and was responsible for developing cassava varieties such as Bukalasa 8, 11, etc., which managed to control the cassava mosaic epidemic of the 1930s-40s. Some of the mosaic resistant varieties it developed later formed the basis of cassava breeding programmes in Nigeria and IITA, etc.

The International Institute of Tropical Agriculture (IITA), with its headquarters in lbadan, Nigeria, was founded in 1967. It is one of 13 non-profit, CGIAR research centres. Its broader goal is to increase the productivity of key food crops, including cassava; and to develop sustainable agricultural systems. Since its establishment, IITA has conducted research on major cassava constraints and generated a number of technologies which has greatly benefited cassava development in Uganda. It has contributed greatly to cassava human resource development in the continent and Uganda in particular.

The East and Southern African Regional Research Centre for IITA (ESARC). Located at Namulonge Research Institute, the ESARC was established in 1994 as a regional centre to address issues of cassava, banana and plantain development in east and southern Africa; coordinate all related network activities and work closely with the NARS. The centre's major responsibility on cassava includes development of suitable varieties, IPM of major pests and diseases, improvements in cassava post-harvest methods and development of NARS human resource capacity. Despite its recent establishment, ESARC has made a significant contribution to cassava improvement in the region and in Uganda in particular.

Regional cassava research networks. Uganda benefited greatly from regional cassava networks such as the East and Southern African Root Crops Research Network (ESARRN) which linked up national cassava research programmes in Angola, Burundi, Ethiopia, Kenya, Madagascar, Malawi, Mozambique, Rwanda, Uganda and Zambia. ESARRN was initiated in 1986 and assisted greatly in the introduction of cassava germplasms, training and exchange of information and visits. ESARRN later (in 1992) split into the East African Root Crops Research Network (EARRNET) and linked national programmes in Burundi, Kenya, Madagascar, Rwanda and Zaire; and the South African Root Crops Research Network (SARRNET) which linked Angola, Malawi, Mozambique and Zambia. The networks have contributed greatly in cassava development in Uganda.

7.7 INVESTMENTS IN CASSAVA RESEARCH AND DEVELOPMENT

7.7.1 Priorities for cassava research

Priorities for cassava research have been developed by the National Agricultural Research Organization (Table 7). This has been based on the country's national objectives and weighted criteria methodology and are reviewed periodically. Currently, because of its importance as a staple and food security crop, cassava is among the high priority crop research commodities in NARO (Table 7). Constraints receiving high priority consideration are cassava mosaic disease, bacterial blight, mealybug, green spider mite, lack of improved varieties and their planting materials, post-harvest systems, weeds and lack of suitable cropping systems (Table 8).

Table 7. Priority ranking of crop commodities by group for each region

Commodity	Region 1	Region 11	National	Priority ranking
Banana plantain	5.54	7.45	6.50	1
Cereals				
1. Maize	7.35	7.67	7.51	1
2. Millet	7.63	5.85	6.74	1
3. Sorghum	7.58	5.72	6.65	1
4. Rice	6.20	5.59	5.89	2
5. Wheat	5.27	5.45	5.36	3
6. Barley	5.07	5.23	5.15	3
Root tubers				
1. Cassava	7.35	6.97	7.16	1
2. Sweet Potato	7.10	6.67	6.89	1
3. Irish Potato	4.93	5.92	5.42	2
4. Yams	ns	4.32	4.32	3
Oil Crops				
1. Groundnuts	8.35	7.15	7.75	1
2. Sesame	7.67	6.00	6.84	1
3. Soybean	6.46	6.45	6.46	2
4. Sunflower	6.23	5.62	5.93	
5. Indus. Oil Crop	ns	4.62	4.62	3
Grain Legumes				
1. Beans	7.13	7.77	7.45	1
2. Cowpea	6.98	5.36	6.17	2
3. Pigeon peas	6.39	5.01	5.70	
4. Gram	5.83	4.77	5.30	3
5. Field peas	5.02	5.54	5.28	3
Cash Crops				
1. Cotton	7.38	6.47	6.93	1
2. Robusta Coffee	5.51	7.39	6.45	1

3. Arabica Coffee	6.18	5.99	6.09	1
4. Sugarcane	6.06	6.35	6.20	2
5. Tea	5.27	6.58	5.93	2
6. Tobacco	5.98	5.75	5.86	2
7. Cocoa	4.77	5.53	5.15	3
8. Cashewnut	5.43	4.61	5.02	1

Priority: 1 g high priority;
2 g medium priority; and
3 g low priority
Region: Region 1 g eastern and northern regions, Region 2 g central and western regions

Table 8. Cassava production constraints and their scores and priority rankings

Nature of constraint	Constraint name score	Priority rank	
Diseases of cassava	African cassava mosaic	2.38	1
	Nematodes	2.07	1
	Root rot	2.05	2
	Bacterial blight	2.04	2
	Anthracriose	1.87	3
	Cercospora leaf spot	1.82	3
Pests of cassava	Cassava micalybug	2.39	1
	Green spider mite	2.18	1
	Rodents (mole rats)	1.96	2
	Grass hopper	1.79	3
Post-harvest/food technology	Storage systems	2.22	1
	Storage pests	2.20	1
	Diversification of products	2.15	1
	Lack of processing technology	2.12	1
Varietal improvement	Poor quality seeds	2.43	1
(for all roots and tubers)	Lack of low altitude	2.21	1
	Lack of improved varieties (Irish potato)	2.20	1
	Genetic erosion of local germplasm		
	(sweet potato and cassava)	2.04	2
Crop management	Weeds	2.28	1
(for all roots and tubers)	Plant population	2.29	1
	Lack of suitable cropping	2.18	1
	systems (crop mixture)		
Low of soil productivity	Nutrient deficiency	2.21	1
Socioeconomics (for all roots g tubers)	Poor marketing	2.18	2
	Labour shortage	2.09	2
Agricultural engineering	Lack of animal-drawn implements	2.00	2
	Lack of improved hand tools	1.92	2

7.7.2 Cassava research programme goal and objectives of the programme

The goal of the programme is to supply adequate food and raw materials, stimulate production for export in order to raise income and improve quality of rural life while conserving the natural resource base. The broad objective is to develop and disseminate improved cassava technologies to farmers. Specific objectives include:

Objective 1: To develop high yielding mosaic and mealybug resistant cassava varieties which meet requirements of consumers (sweet taste, mealyness, etc.) in different agro-ecologies.

Objective 2 To develop ecologically sustainable methods of controlling important pests and diseases such as cassava mealybug (CM), green spider mite (CGM), weeds, African cassava mosaic disease (ACMD), bacterial blight (CBB) and anthracnose (CAD).

Objective 3 : To develop improved crop management practices which are within the means of resource poor farmers.

Objective 4 : To develop improved production practices and methods of storing, processing and utilizing cassava roots so as to improve the commercial value of the crop.

Objective 5 : To accelerate the transfer of improved cassava production and utilization of cassava through closer linkage and training of extension staff and farmers.

7.7.3 Human resource capacity

The programme consists of an interdisciplinary team of breeders (2); agronomists (1); plant pathologists (1); plant virologist (1); entomologist (2); food scientist (1); socio-economists (2); and biotechnologist (tissue culture) (1). It collaborates effectively with scientists from other programmes within and outside the institute on a regular basis. Research projects conducted by the programme in 1996–97 are shown in Appendix 2. The achievements are summarized in Tables 9–12.

Table 9. Achievements of the Cassava programme in generation and transfer of improved technologies

Cassava			
Constraints	**Technology generated**	**Technology transferred**	**Technology adopted**
African Cassava Mosaic Disease (ACMD)	Nase 1, Nase 2 and Migyera resistant varieties Messed; rouging; Selection of clean planting materials	Nut 1, Nut 2 and Migyera varieties. Rouging planting materials	Nase 1, Nase 2 and Migyera; & election of planting materials, rouging
Cassava mealybug	Use of natural enemy (Epidinocarstlopezi)	E. lopezi released in 10 selected districts	E. lopezi successfully established and CM g maintained below damage threshold Revel
Cassava green mite	Timely planting in relation to seasonal pest population dynamics. Use of natural enemy resistant varieties	Nase 1. Migyers; 7: aripo screened; mass reared and released,, costly planting emphasized	Resistant varieties; l'aripo well established
Nanow genetic div cosily at farm level	Fifteen resistant varieties developed and or screened	As generated	Nase 1, Nest 2 and Migyera released; while SS4 and SS8 are recommended for release
Poor and	Improved intercropping	Spacing (ion a 1 m)	Adoption level not known

Cassava			
Constraints	**Technology generated**	**Technology transferred**	**Technology adopted**
inappropriate agronomy practices	systems; slanting scheduled; weed control packages, spacing for production and stem multiplication		
Tack of adequate planting materials	Multiply and distribute adequate slanting materials through the NANEC systems	Over 70 000 ha of mosaic resistant varieties multiplied and distributed to most districts	AH distributed planting materials of all varieties adopted. Demand for stems still very high
Inherent nutritional limitation aggravated by marrow base to handle and process	Release of food culture specific varieties; improved cyanide reduction methods; improved sun-drying; improved heap fermentation, *Gari* From W. Africa. Flotilla from S, American	Food culture specific varieties, cyanide reduction methods; improved sun-drying and heap fermentation; Gad	Knowledge on adoption level on cyanide method, sun-drying, heap fermentation and Gad making not available
Narrow utilization base and limited product development	33 cassava recipes developed	Recipes demonstrated, recipe booklet prepared and distributed	Adoption level not known
Poor storage technologies	3 months fresh storage technology developed	Technology tested in selected urban markets	Adoption level not known
g Limited utilization of cassava in the one percent stock sector	Snipping cassava leaf (or foliage establishment	Nil	Nil

Table 10. Number of on-farm trials on cassava conducted by the National Root Crops Programme in the six Gatsby and nine other districts of Uganda during the cropping

Location	1990/9	1991/1992	1992/1993	1993/1994	1994/1995	1995/1996	1996/1997	Total
Gatsby								
Apac			16	12				28
Kibaale			24	12	8	6	4	54
Lira		9	16	6		5	5	41
Luwero	16	12	24	16	8	6	4	86
Masindi		12	24	24	16	6	4	86
Mpigi		12	24	16	16	6	5	79
Subtotal	16	45	128	86	48	29	22	374
Other gs								
Arua			12	8				20
Hoima			12	8				20
Iganga			12	8				20
Kasese			12	8				20
Masaka			12	8				20
Mubende			12	8				20
Mukono						6	5	11
Soroti						6	5	11
Subtotal	0	0	84	56	0	12	10	162
TOTAL	16	45	212	142	48	41	32	536

Table 11. Technology generation new cassava varieties developed

Variety	Maturity period (months)	Yield (tonnes/ha)	ACMD resistance
Released varieties			
Nase 1	2–14	25	Resistant/ tolerant
Nase 2	12–15	40	Moderately resistant
Nase 3 (Migyera)	10–12	45	Resistant/tolerant
Awaiting Release			
SS4	12–14	55	Resistant/tolerant
TMS 4(2)1425	10–12	35	Moderately resistant
8911988-2 UYT/PDB	10–12	30	Resistant/tolerant
Migyera 81	10–12	25	Resistant/tolerant
Migyera 16	10–12	30	Resistant/tolerant

Table 12. Estimated area of improved cassava varieties (ha) established in the six Gatsby and seventeen other districts of Uganda between 1991–1992 and 1995–1996

Districts	1991–1992	1992–1993	1993–1994	1994–1995	1995–1996	Total
Gatsby supported						
Apac		3	41	194	944	1 182
Lira	4	39	213	1 327	8 195	9 779
Kibaale	0	<1	1	9	59	69
Luwero	0	2	194	1 126	6 078	740
Masindi	8	50	305	1 857	11 143	13 363
Mpigi	9	69	438	2614	14 490	17819
Sub total	22	163	1192	7 128	41 109	49 614
Others						
Arua	16	129	775	2 171	5 861	895
Gulu	2	19	99	593	3 471	4 184
earring	0	0	2	13	79	94
Jinja	0	<1	3	18	106	127
Kamuli	0	0	1	2	13	15
Kiboga	1	1	10	61	365	437
Kitgum	1	4	23	139	167	334
Kumi	5	90		1542	4 164	635
Masaka	0	2	14	86	521	623
Mbale	0	**<1**	1	5	30	36
Mayo	5	31	182	1 095	6 575	7 888
Mukono	**<1**		11	65	394	472
Nebbi		<1	1	6	36	43
Pallisa		2	21	137	823	993
Rukungiri		4	22	130	778	932
Soroti	1	27	165	789	5 952	6 934
Tororo	0	0	1		75	91
Subtotal	30	311	1 879	6 867	29 410	3 840
Total	52	474	2 891		70 519	89 111

Notes
1. All figures rounded off to nearest whole number
2. See Tables 6 and 7 for detailed breakdown by variety
3. Areas presented indicate total area (ha) under improved varieties i.e. project controlled and self-diffused materials

Table 13 Survey data (ha) for 23 participating and 19 non-participating subcounties in the six Gatsby districts: 1996

District	Cultivated area sampled	Sampled area under cassava	Sampled area under improved cassava	Area under cassava as of cultivated area	Area under improved cassava as total cultivated area	Area under improved cassava as total cassava area
Participating subcounties of						
Mpigi (3)	47.7	21.9	9.3	46	19	42 69
Luweru (5)	158.7	81.9	56.7	52	38	52
Masindi (4)	132.1	87.8	45.7	66	35	36
Lira (4)	75.0	30.3	10.9	40	15	62
Apac (4)	219.3	95.6	59.5	44	27	49
Kibaale (3)	63,2	15,5	7.6	25	12	
Subtotal (23)	695.1	333.0	189.7			
Meaty per subcounty	30.2	14.5	8.2	48	27	57
Non-participating subcounties of						
Mpigi (1)	8.9	3.2	0	36	0	33
Luweru (4)	140.9	49.0	16.2	35	11	24
Masindi (3)	175.3	60.3	14.2	34	8	10
Lira (6)	133.5	59,2	6.0	44	4	16
Apac (3)	96,8	46.9	7.7	48		8
Kibaale (2)	49.8	10.6	0.8	21	2	
Subtotal (19)	605.2	229.2	44.9		7	20
Mean per subcounty	31.9	12.1	2.4	38		
Total (42) (Mean)	1 300.3	562.2	234.6	(43)	(18)	(42)

Table 14. Number of Extension Staff, Opinion Leaders and Farmers trained in the six Gatsby (G) and three other districts of Uganda 1991–1996

Finees 5	Lira (G)	Luwero(G)	Masindi(G)	Mpigg(G)	Apac (G)	Kibaale (G)	M# Gatsby	Kumi	Soroti	Pallisa	Grand Total
Extension											
1991/92	106	26	14	53	8	?	>207	?	?	?	>2071
1992/93	23	8	15	51	33	?	>130	?	?	?	>130
1993/94	106	48	MSC	33	4	?	>192	?	?	?	>192
1994/95	97	221	47	79	30	?	>474	?	?	?	>474
1995/96	30	77	2	18	30	29	196	65	50	47	348
	362	380	79	234	£05	29	>1 189	>65	>50	>47	>1 351
Opinion leaders											

Finees 5	Lira (G)	Luwero(G)	Masindi(G)	Mpigg(G)	Apac (G)	Kibaale (G)	M# Gatsby	Kumi	Soroti	Pallisa	Grand Total
1992	?	42	?	?	?	?	>42	?	?	?	>42
1993	?	9	400	?	6	?	>406	?	?	?	>406
1994	50	347	539	87	50	?	>1073	?	?	?	>1073
1995	48	26	?	110	50	?	>234	?	?	?	>234
1996	32	107	?	?	?	?	>139	20	?	?	>159
Total	>130	>522	>939	>197	>106	?	>1894	>20	?	?	>1 914
Farmers											
1991/92	756	303	708	113	?	?	g l 880	?	?	?	>1880
1992/93	1 119	245	1 622	179	128	?	>3 293	?	?	?	>3 293
1993/94	1 227	357	326	243	78	?	>2 231	?	?	?	>2 231
1994/95	977	2 361	256	162	60	28	3 844	283	131	?	>4 258
1995/96	473	1.267	1023	835	60	25	3 683	30	611	289	4613
Total	4 552	4 532	3 935	1 532	>326	>53	>14 931	>313	>742	>289	>16 275

Table 15: Cassava constraints, technology application gaps and possible solutions to bridge gaps and envisaged holders involvement

Constraints	Technology application gap	Solution to bridge gap	Envisaged holders involvement
African Cassava Mosaic Disease (ACMD)	Limited awareness of the benefits accruing from proposed technologies at farm level; socioeconomic application implications, lack and/or inactive government policy on disease/pest control	Strengthen training and sensitization of all actors; avail resistant planting materials; enact and revitalize government policy on disease/pest control; strengthen research capacity on virus diseases; train in area of biotechnology	Farmers, extension, researchers, policy-makers, donors
Cassava Mealybug (CM)	Lack of farmer awareness leading to chemical application in intercropping systems jeopardizing released natural enemies	Socioeconomic studies to identify and document farmers attitude towards use of natural enemies	Farmers, excursionists, researchers and policy-makers
Cassava Green Mite (CGM)	Farmers' perception to the potential of *T. aripo* awaits capturing; variance in farmers' labour profile from the recommended lime schedules	Technology testing at farmer level; further screening of clones for resistance	Farmer extensionists, researchers
Narrow genetic base	Limited multiplication and distribution in place; lack of facilities to handle wide generic base	Adequate financial support for multiplication and distribution; strengthen biotechnology facilities and personnel skills	Farmers, extensionists, researchers, donors, policy-makers and training institutions
Poor and inappropriate	Limited knowledge and labour intensive; high cost;	Demonstration of benefits, five researchers; boost field staff;	Farmers, extensionists. researchers, donors,

Constraints	Technology application gap	Solution to bridge gap	Envisaged holders involvement
agronomic practices	inadequate extension information due to thin field g lack of product quantity control on the market, unavailability of inputs (herbicides)	socioeconomic audios on the technologies, actors sensitization campaigns; strengthen product quality control mechanisms and standards; streamline and support the local input supply sector(s)	policy-makers bureau of standard chemical companies
Inherent nutritional limitation	Appropriate promising cyanide reduction method percent await farmers' verdict on on-farm inadequate funds to facilitate testing of technologies	Cost-effectiveness of cyanide reduction methods, modification of processing prototypes and support; farmers' sensitization on cassava health related hazards	Extensionists, farmers, researchers, donors, health institution, international research centres
Narrow utilization	Lack of awareness; limited funds to promote small-scale manufactures	Farmer processors sensitization and training; product development and demonstration.	Farmers, extensionists. researchers, donors, processing industries, food science institutions relevant international research centres

8 SUCCESSES, FAILURES AND LIMITATIONS OF INTERVENTIONS

8.1 CHANGES IN THE DEVELOPMENT MODEL ADOPTED

Changes in development models adopted to aim at achieving government agricultural objectives to eradicate poverty through supply of adequate and balanced food in all parts of the country; to supply raw materials for local industries (import substitution); stimulate production for export and raise income and improve quality of rural life while conserving the natural resource base. Although the colonial development models aimed to achieve all the above, it emphasized more the supply of raw materials for industries abroad and to stimulate production for export. Consequently, food crops such as cassava received very little attention. The post independence period of the 1960s adopted a socialist policy of “The Move to the Left and the Common Man's Charter”. Although this favoured the “common person”, it was unpopular among elites; it discouraged investment, resulted in a military coup and greatly affected the economy. The Amin's economic war policy of the 1970s which expelled the Asian business community and foreigners brought the economy to its knees and halted development in all sectors including food production. The 1980s and 1990s policies of rehabilitation of the economy, trade and price liberalization, privatization benefited food production.

However, since the implementation of the Economic Recovery Programme in 1987, the Government of Uganda has achieved unequal results (EPAU, 1996). Significant progress has been achieved in restoring internal and external stability through improved fiscal and monetary performance. However, the distribution of the benefit of growth has not yet significantly contributed to eradicate poverty and increase the standard of rural life.

Notwithstanding, Uganda is generally a food surplus country with high export potential. Hence, with an effective implementation of the integrated development model and national food strategy, not only can Uganda eradicate food insecurity at household level but also enhance food security in the region and some other chronic food deficit countries in Sub-Saharan Africa.

8.2 CASSAVA MARKETING SYSTEMS

Studies (COSCA Uganda, 1996; EPAU, 1996) show that although cassava provides substantial income to rural farmers, perishability, bulkiness, low utilization base and limited village markets hinder commercialization and profitability of the crop. Although the potential for an export market exists, this is not being utilized due to the lack of a well organized cassava export marketing system. However, the current government policy of trade liberalization and promotion of non-traditional exports has improved prices and stimulated interest in production and export of cassava and cassava products.

8.3 INVESTMENTS IN AGRICULTURAL INPUTS

The poor state of the economy during the 1970s affected the supply of agricultural inputs to farmers. This resulted in the decline of the quality and quantity of agricultural production. With the improvements in the economy since the 1980s, the Government increasingly invested in the provision of inputs to farmers through a number of projects. This has had a positive impact on the production of both cash and food crops including cassava. However, the continued supply of subsidized inputs to farmers could have a long-term negative effects as well. Consequently, the Government has divested itself from this activity and left it to the private sector.

8.4 INVESTMENT IN STORAGE INFRASTRUCTURE

In Uganda cassava is principally stored in the ground and harvested as and when needed. In cases when chips are produced, farm storage is inadequate, poorly constructed and unsafe. Modern storage techniques for cassava are yet to be developed. Government investment in improvement of storage infrastructure has been geared to storage of grains and not products such as cassava. Although such facilities could be used for storage of chips and cassava flour, they are inadequate, located only in major towns such as Kampala, Jinja, etc. and do not meet the interests of cassava farmers and traders.

8.5 INVESTMENT IN ROAD INFRASTRUCTURE

The deterioration of the economy, characteristics of the 1970s, resulted in deterioration of both trunk and feeder roads in the country. Although this has been a great hindrance to agricultural production, food security and export diversification, it also greatly affected cassava production and marketing. Current government efforts in rehabilitation of trunk, rural and feeder roads have improved accessibility to inputs and markets with the resultant reduction in costs and improvements in earnings. Although the road rehabilitation has progressed well, vast rural areas which are always the main cassava

producers are still inaccessible and will take time before most cassava farmers harvest the full benefit of this programme.

8.6 INVESTMENTS IN CASSAVA PROCESSING

The LSF purchased cassava from farmers, produced and exported quality starch and by products. This factory provided markets for farmers' produce and greatly stimulated production and commercial value of cassava. The collapse of the factory since the mid 1980s left farmers frustrated with their produce and seriously affected production.

8.7 INVESTMENTS IN AGRICULTURAL RESEARCH INFRASTRUCTURE

The early days of the agricultural research infrastructure in Uganda and East Africa were sharply focused, well organized and well managed. Consequently, it developed a number of technologies which were effectively transferred and had major impact on the agricultural development of the country. Early research on cassava successfully developed and disseminated improved varieties (Bukalasa 8, 11, etc.), agronomic practices and appropriate methods for controlling major pests and diseases of the crop. Consequently the major impact of this was the successful control of cassava mosaic epidemic which ravaged cassava in eastern and northern Uganda during the 1930s-1940s. The research suffered major setbacks in the 1970s and 1980s and as a result very little work was done. The technologies generated out of this work were either inappropriate or were not transferred to clients. Consequently little impact was made.

With the creation of NARO, research gained new impetus. The research was reorganized and redirected to make it more responsive to national needs. Priorities for commodity research and constraints within commodities were developed based on national economic objectives and the needs of clients. Funds were injected to the system and staff were motivated with the concomitant improvement in the vigour of research. By 1997, a lot of research projects were either completed or being carried out in crops, livestock, fisheries and forestry sectors, respectively. Many of the technologies generated were either transferred or being transferred and the overall future of research looked promising.

8.8 INVESTMENTS IN AGRICULTURAL EXTENSION AND FARMER TRAINING

The agricultural extension service was well organized, effective and efficient before the 1970s and made impressive impacts on transferring technologies and educating farmers. The system almost grounded to a halt until the 1980s when attempts were made to restructure it and improve its performance. Substantial injection of funds and other resources have since been made but this is still inadequate and the service is still ineffective although some positive outcomes are beginning to emerge.

8.9 INVESTMENT IN CASSAVA RESEARCH, GENERATION, TRANSFER, ADOPTION AND IMPACT OF TECHNOLOGIES

Improvements in the research infrastructure as a result of the creation of NARO, resulted in a concomitant improvement in cassava research and development. During the colonial period and until the 1980s little attention and funding was given to cassava research. In addition, the research did not adequately address key concerns of clients. The end of the 1980s and the beginning of the 1990s saw invigorated client-oriented cassava research from which a number of technologies were developed, transferred to clients and adopted. A brief summary of the progress achieved includes continuous development of high yielding disease and pest resistant variety comprehensive studies aimed at fully understanding the epidemiology and control of the severe cassava mosaic disease epidemic in the country and ecology and control of its whitefly sector; development of integrated management strategies for the mosaic epidemic, other diseases and pests; successful biological control of the cassava mealybug and some progress of biological control of the cassava green spider mite; development of improved agronomic and other crop management practices and improved traditional methods of processing bitter cassava. Most of the technologies have successfully been transferred, adopted and impacts are beginning to emerge. An outline of this is provided (Table 9).

On average, all the improved cassava varieties out yielded the local ones (Figure 5). The performance of the new Uganda selection SS4 was outstanding among the improved varieties and had a fourfold yield advantage over the local one. The area under improved cassava varieties has been generally increasing since 1991. The proportion of cultivated land that was planted to the new varieties was up to 78 percent (mean 57 percent) in the subcounties which participated in the technology transfer project and up to 40 percent (mean 20 percent) elsewhere. There was considerable diffusion of the new varieties in areas which did not participate in the project (Table 13). Generally, the steady increase in the area under improved varieties in the selected districts indicates the adoption and impact of the improved varieties. In many of the districts such as Luwero, Masindi, Lira and Kumi, resistant varieties were accepted from the outset and the adoption rate was consistently higher each year (Figure 6). This was because the improved varieties addressed farmers' major production constraints which indicates that the strategy adopted in the generation and transfer of the technologies were appropriate.

Training provided a visible indication of an increase in the level of advice provided and farmers' knowledge as a result of contact with research and extension agents. By 1995, there was greater awareness than before among the extension agents, opinion leaders and farmers of the ways in which ACMD spreads and its control. The collaboration of the local staff, NGOs and research as a training component of the cassava multiplication and distribution strategy resulted in training of most of the extension agents in each of the project districts between 1992 to 1995 (Table 14).

8.10 COMPARATIVE ADVANTAGE OF CASSAVA PRODUCTION IN UGANDA

Investing in agriculture in Uganda seems to bring to bear self-evident comparative advantage. It is clear that, given the lower capital-output ratio for agricultural

development, *ceteris parabus*, the more Uganda invests in agriculture instead of other sectors, the higher the resulting increase in total output.

Based on the principle of comparative advantage and the pattern of resource endowment, Uganda's agriculture through food production development, should easily be able to feed the population. Cassava has the attributes in contributing to this development strategy. Compared to other crops, cassava thrives well under mar-environments, it is flexible in farming and food systems and when processed it has wide utilization and industrial use.

With this comparative advantage cassava has over other food crops, it has been possible to achieve enormous area expansion under the crop coupled with increased yields even in stressed environments and limited labour conditions. However, this attribute of the crop has been overshadowed with the infection by African cassava mosaic virus since 1988. With the development and release of resistant/tolerant varieties, this constraint is becoming overcome so as to exploit full potential of the crop, a source of food security in Uganda.

8.11 ECONOMIC BENEFITS AND RETURNS TO INVESTMENTS IN CASSAVA RESEARCH DEVELOPMENT AND PRODUCTION

With proper technology, access to information, agricultural inputs and credits and effective policy guidance, production development and exports of cassava and other competing crops can become a most viable economic activity and provide substantial income earnings for the farmers (Table 16). Production development in food crops and particularly cassava can contribute both in food security at household and national levels and generate higher income for households with the use of improved varieties.

Table 16 further indicates that cassava competes favourably with other substitute crops both as local and improved varieties with the highest return per person-day of US$4.38 when improved variety is used.

Figure 5. Yield of the improved and local varieties, 1995