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The Recent Cassava Surge in Zambia and Malawi

by

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1. OVERVIEW

A. Background and Objectives

Cassava and maize both came to Zambia and Malawi from Brazil. These two New World crops arrived on the African continent in the late 1500's aboard Portuguese sailing ships, then transited inland at varying speeds. Cassava probably arrived in Zambia via the Congo Basin, where it was well-established by the 1650's (Jones, 1959). Accompanying the in-migration of the Bemba people from the west, cassava became well known in northern Zambia by the early 1700's. Some may have reached the Bemba zones of northern Malawi early on as well, in the northern lakeshore area where it remains the dominant staple even today. A later thrust via Portuguese Mozambique brought cassava inland from the east coast of Africa where it penetrated into southern Malawi by around 1800 (Jones, 1959). Maize, also a Portuguese import, transited similar trade routes to Zambia and Malawi, early on via the Congo basin and northern Zambia and later via explorers heading inland from Portuguese Mozambique (Miracle, 1966).

Over time, these two imported foodcrops revolutionized agriculture in Central Africa. From the beginning, their histories have remained inextricably intertwined. Gains in one have frequently come at the expense of the either. And policy makers have vacillated in the attribution of their affection towards these two rivalrous siblings. Government policies throughout most of the independence years have overwhelmingly favored maize, to the ultimately dangerous neglect of cassava. A series of natural disasters, coupled with the abandonment of unsustainably high maize subsidies in the early 1990's have triggered an astonishing renaissance in cassava production in both countries. The epidemic outbreak of HIV/AIDS in both countries may have contributed as well, as a diminished rural labor supply induces a move to labor-saving, low-input crops like cassava (Marten, 1978; Chiwona-Karltun, 2001). Over the past decade, cassava production in Malawi and Zambia has probably grown between 6% and 8% per year, among the fastest rates of growth in Africa – indeed in the world (Table 1; Figures 1 and 2). This paper aims to understand why.

B. Scope of the Case Study

Geographically, this paper focuses on Zambia and Malawi, two neighboring – and formerly confederated -- countries in Southern Africa. They share a common history of policy preference for maize followed by a very recent abrupt recognition of the importance of cassava. Both endured a series of natural disasters, including and insect and mosaic virus infestations in their cassava crop coupled with drought-induced stress to their maize. In both cases, these production plunges first highlighted the importance of their cassava crops to agricultural policy makers. In addition, both countries dismantled their government maize subsidy machinery during parallel economic liberalizations in the early 1990's. They share an HIV/AIDS epidemic that some observers feel has contributed to farmer uptake of cassava, a low-input, low-labor crop. Cassava constitutes the staple foodcrop in the northern part of both countries.

Yet they differ in important ways as well. Though comparable in population, Malawi is much smaller, leading to population density 10 times greater (Table 2). Absent the mineral wealth of Zambia, Malawi depends far more heavily on agriculture for its national livelihood.

Yet productivity and input use in maize remain comparable, and both have declined substantially following the abrupt withdrawal of fertilizer and maize subsidies in the early 1990's (Smale and Jayne, 2003). In each case, abrupt realignment of incentives has favored rapid growth of cassava.

C. Data and Methods

In order to understand the apparently rapid rise in cassava production in Zambia and Malawi, we have visited researchers and farmers in both countries, in addition to reviewing available secondary data. But data on cassava area, yield and output remain subject to wide margins of error.

Production values, estimated as area times probable yield, attract uncertainty from both components of this equation. Because farmers harvest cassava 18 to36 months after planting, it becomes difficult to know how much total cassava area is actually harvested in a given year. Double counting may occur if mature cassava remains unharvested to counted in both one crop year as well as the next. Some agencies endeavor to distinguish between "mature" and "immature" cassava, though this is difficult given 18-month plus window for harvesting even mature cassava. Yield data and hyv adoption rates remain highly fragmentary. Even close field monitoring becomes difficult given farmers' tendency to "milk" the cassava plants by partial harvesting throughout the year. Research station yields, though more perfectly measured, may not prove representative of farmer achievements. Though we present official data, in many cases we have proposed adjustments based on discussions with cassava experts in each country, in our efforts to understand what has happened and why.

Primary data are available from two nationally representative farm household surveys, Zambia's Post-Harvest Survey of 2001 and the IFPRI/Bunda College farm survey of 2000 in Malawi. We have analyzed these data directly in order to shed light on some of the key issues affecting cassava distribution and growth. The Zambia data, in particular, offer glimmers of evidence on both cassava production and prevalence of HIV/AIDS, thus permitting an early empirical examination of possible relationships between rural labor availability and trends in cassava production.

From our discussions, field visits, and data analyses, it has become clear that cassava production and marketing is changing rapidly in both Zambia and Malawi in the past decade. The following account attempts to unravel the basic trends and their causes.

D. Key Phases in the Cassava Transformation

Our review of the historical evidence suggests four clear phases in the evolution of cassava production and policy regimes. Though the datings below refer specifically to Zambia, the trends and turning points in Malawi approximate those within a couple of years.

Phase 1. Cassava as a famine reserve (1930 to 1963)
Phase 2. Maize as king (1964 to 1981)
Phase 3. The cassava crises (1982 to 1990)
Phase 4. Cassava takes off (1991 to 2002).

Cassava performance in each of these periods has varied considerably. This paper aims to understand the sources of this extraordinary growth over the past decade, what actors have been responsible, what these changes mean for ordinary farm families and what the future portends.

2. CASSAVA AS A FAMINE RESERVE CROP, 1930 TO 1963

A. Zambia

Agriculture held little interest for the British South Africa Company (BSA), which governed Northern Rhodesia under a Crown Charter from 1900 to 1924. Mineral development, locally and via labor export to BSA holding elsewhere in Southern Africa, preoccupied company officials. When the British Colonial Office took over direct administration of Northern Rhodesia in 1924, they retained an economic focus on mining. They largely ignored agriculture, except insofar as it could contribute to cheap urban food supply for the mines. For this purpose, they encouraged white settlers to establish farms along the line of rail leading north to the copper mines. In 1936, the colonial authorities established a Maize Control Board (MCB) and Cattle Control Board (CCB) to facilitate control of food prices and bulk procurement for the urban mining centers. The MCB became government's instrument of subsidized support for commercial maize production. MCB procurement policy clearly favored the white settlers through differential pricing and the allocation of internal and export quotas (Wood et al., 1990). In urban areas and for white farmers, maize was king.

Cassava held interest only as a famine reserve crop in the African farming zones. As elsewhere in British Africa, colonial authorities not only urged but even ordered Zambian farmers to produce cassava as a precaution against periodic famines (Jones, 1959).[1] Under the threat of penal sanctions, farmers in Zambia were instructed to cultivate a plot of cassava. During our field interviews, old farmers volunteered that District Officers would come to inspect their cassava fields armed only with a stone. Standing in one corner of the cassava field, the inspecting officer would throw the stone as far as he could. If he could launch it out of the field, the field was too small. For this reason, cassava is often regarded as a "colonial" crop (Marter, 1978).[2]

B. Malawi

[1] Note that African tribal leaders sometimes invoked similar regulations for these same reasons. Jones (1959), in his famous review of cassava in Africa, cites a legend from the Congo Basin as reported Torday and Joyce (1911): "During one season of his reign the harvests of the Bushongo were completely destroyed by locusts and the people were in imminent danger of perishing from hunger. But they were saved by Samba Mikepe (King of the Bushongo) who showed them the use of manioc which could not be destroyed by any amount of locusts." (Jones, 1959, p.64).

[2] Likewise, old people who had experience growing cassava during the 1950's and 1960's, have proven the most ready adopters as government and NGO's re-introduce improved planting material following the 2002 drought in Southern Province of Zambia (Pongolani and Kalonge, 1999).

3. MAIZE AS KING, 1964 TO 1981

A. Zambia

At independence, in 1964, government orders for growing cassava fell into disuse along with a host of other colonial edicts. Maize, the reigning king among the commercial farmers, came to rule of all of Zambian agriculture. Agriculture remained a low priority for the new government. As before, mining and industrial development held highest priorities in government policy and planning. Agriculture held interest only as a vehicle for ensuring cheap food to the mines. And the preferred food there was maize.

So the few government resources allocated to agriculture focused largely on maize. The MCB became the National Marketing Board (NAMBOARD). It guaranteed input supply and output markets for maize, from 1974/75 at a fixed pan territorial price which clearly favored commercial farms close to the line of rail (Wood et al., 1990). Through a growing network of farmers cooperatives, government supplied subsidized fertilizer and seeds on credit as well as guaranteed outlets for the maize. Subsidy schemes promoted animal traction as well as tractor plowing. In the late 1970's, the work oxen supply project and the Lima Pack program aimed to expand subsidized maize input packaged throughout Zambia (Wood et al., 1990; Kokwe, 1997).

As a result, maize area, yields and production all soared, even in regions where cassava, millet and sorghum were traditionally grown. In the face of substantial input subsidies and guaranteed outlet, even farmers in the cassava zones of Zambia put land into maize cultivation (Kokwe, 1997). The heavy maize subsidies and omnipresent government marketing machine made maize preeminent as both a food and a cash crop rolled into one. Cassava, like sorghum and millet, languished under this maize-oriented push (UNZA, 1999).

B. Malawi

A similar maize-focused support program formed the cornerstone of post independence Malawian agricultural policy. Through the parastatal Agricultural Development and Marketing Corporation (ADMARC), the Malawian government assured delivery of subsidized fertilizer and maize seed to small farmers and guaranteed purchase of farm production at a fixed pan-territorial price. ADMARC held responsibility for holding maize security stocks, price stabilization and even maize breeding until 1978 when government spun off the breeding work to the newly established the National Seed Company of Malawi (Jayne and Smale, 2002).

Heavy fertilizer and seed subsidies stimulated rapid growth in maize production, particularly during the 1980's. With the subsequent withdrawal of input subsidies, nitrogen to maize prices quadrupled and returns to land fell from abruptly $137 per hectare to negative for high-input hybrid maize (Jayne and Smale, 2002, Table 6). Though maize expansion proved unsustainable once government withdrew its subsidies, the focus of government food policy in post-independence Malawi centered clearly on maize.

4. THE CASSAVA CRISES, 1981 TO 1990

A. <u>Cassava achieves recognition at the high policy table</u>

1. <u>Zambia</u>

In the late 1970's and early 1980's, maize production faltered in Zambia during a sequence of drought years -- in 1978, 1980, 1981, 1983 and 1984 -- just as a lethal invasion threatened Zambia's cassava zones. Introduced inadvertently from South America on a shipment of farm equipment to Uganda in the late 1970's, two exotic pests, the cassava mealybug (CM) and the cassava green mite (CGM), rapidly ate their way across Africa (Neugard, 1988).

Both pests arrived in Luapula Province, in northern Zambia, in 1981/82. Yield losses under CM infestation rose to 60% to 100%, while the CGM infestation resulted in 10 to 30% losses in root production. The resulting damage devastated Zambia's cassava crop in the northern zones where it served as the principal food staple.

The seriousness of this threat forced the Zambian government, for the first time since independence, to take an active interest in cassava. They turned for support to the IITA-led consortium which had developed effective biological control of these pests via the introduction of predator wasps. Starting in 1984, the Government of Zambia together with IITA's Biological Control Program instituted trial releases of E. Lopezi, a predator wasp which had effectively controlled outbreaks of CMV in other regions of Africa. In 1986, with financial support from IFAD, the Zambian team launched a country-wide program of mass rearing followed by aerial and ground release of both sets of predator wasps. The releases continued for four years. By 1990, the CMB population had declined significantly and a pest-predator equilibrium had been established (Ministry of Agriculture, 1989; Malambo et al., 1998). Though CGM responded to the predator T.aripo, it establishment has proven difficult and CGM remains a serious problem in much of Zambia.

The simultaneous threats to maize and cassava crop, forced cassava into the limelight for the first time since independence. In 1982, for the first time ever, NAMBOARD listed procurement prices for sorghum, millet and cassava (Wood et al., 1990). Meanwhile budgetary shortfalls, slumping copper prices and donor pressure forced a critical rethinking of the large-scale copper-financed maize subsidies. Gradual withdrawal of fertilizer subsidies resulted in steady increase in maize prices. A startling 130% increase in consumer maize prices in 1985 led to riots in the Copper Belt and subsequent Zambian government retreat from the IMF recommended liberalization reforms. Though maize remained king, it's virtual monopoly on government resources to agriculture had been broken.

2. Malawi

Though beginning several years later, a similar scenario played out in Malawi. The cassava mealybug entered Malawi along the northern shores of Lake Malawi from Tanzania, arriving in early 1986. The mealybug rapidly decimated the cassava crop in the northern regions where it served as the principal food staple. A subsequent drought in central Malawi threatened the country's maize crop. With its two principal food staples threatened, the government of Malawi declared a national food emergency which lasted from January to August 1988 (Pelletier and Msukwak, 1990)

As in Zambia, the Malawians rapidly initiated a program of biological control of the cassava mealybug. Through mass rearing and distribution programs of E. Lopezi, the predator wasp, the Malawians gradually brought the mealybug under control. As in Zambia, this large-scale threat to the cassava crop propelled cassava from virtual anonymity to center stage in food policy debates.

The subsequent drought of 1991/92 further accelerated interest in cassava. Government explicitly enunciated its shifting policy stance in November 1994 in the Agricultural and Livestock Development Strategy and Action Plan which advocated that, "production of maize in areas that are not suited to its production, largely as a result of low rainfall, will be discontinued to give room for more drought-resistant crops such as cassava and sweet potato to improve household food security" (MOALD, 1995, cited in Teri et al, 2001). As a result of this series of natural disasters, cassava emerged with a place at the high policy table.

B. The Research Response

1. Zambia's Root and Tuber Improvement Programme (RTIP)

In the face of recurring drought and the vivid recognition that many regions depended on cassava, the Government of Zambia for the first time established a root crop research and support program, the Root and Tuber Improvement Programme (RTIP), in 1979 with one Zambian university graduate agronomist and a diploma holder. Staffing and resources remained slender until the outbreak of the CM and CGM elicited a substantial boost to deal with the pest invasion. With German assistance, from 1983-1986, RTIP increased the numbers of agronomic trials under way.

As their first task, from 1979 to 1983, RTIP invested considerable effort in collection, inventory and maintenance of local cassava varieties. In addition, during the early 1980's, RTIP staff conducted a series of trials on intercropping, bulking period, time of planting, spacing and weeding. By 1986, RTIP's staff had grown to include 4 Zambian diploma holders and 1 German agronomist. Together the RTIP team had assembled and cataloged a collection of 500 local and 200 exotic varieties of cassava.

In 1981, Swedish SIDA began funding cassava research in Zambia, though they faced difficulties in recruiting an expatriate breeder until 1986 when they successfully posted an Indonesian cassava breeder to the main cassava research station in Mansa. From 1987, they launched a 10-year program of funding for RTIP and a golden age of cassava research began. With the advent of substantial funding increases under the SIDA support program, RTIP launched a series of mass selection trials from 1987 onwards. They screened their 700 accessions systematically for yield, earliness of bulking and resistance to cassava mosaic virus. This led to five recommended clones which went into onfarm trials in 1991/92. Ultimately, in 1993/94, RTIP released three improved local varieties in 1993/94, Bangweulu, Kapumba and Nalumino. They yielded 20 to 30 tons per hectare, compared to an average of 6 from local varieties, bulked 12 months earlier and provided superior resistance to CMV and major pests in both research and onfarm trials (Chitundu and Soenarjo, 1997; Table 3). These recommended local varieties came on stream just as the political and agricultural policy environment took a major shift in favor of cassava by abruptly withdrawing the subsidies out from under the maize establishment.

2. Malawian root crop breeding

Cassava research efforts in Malawi began on a small scale in the mid-1980's through a regional program called the Eastern and Southern Africa Root Crops Research Network (ESARRN) executed by IITA and funded by USAID and IDRC with headquarters in Lilongwe (Teri et al., 2001).[3] The crisis response to mealybug attack of the late 1980's underscored the importance of cassava, particularly in northern regions where it serves as the staple food. As the mealybug emergency faded, efforts gave way to a program of serious cassava plant selection and breeding. The national root crops research program that began in the late 1980's grew to a staff of five full-time scientists by the end of the 1990's (Akoroda, 1999).

As in Zambia, efforts focused initially on identification of the most resistant local varieties and rapid distribution of cleaned, improved cuttings (Table 3). In response to the drought of 1991/92, the Government of Malawi (GOM) began multiplying cassava and sweet potato planting material on a small scale using their own resources (Moyo et al., 1999). The following season, with funding from USAID, SARRNET and the Malawian government began a program of "Accelerated Multiplication and Distribution of Cassva and Sweetpotato Planting Materials as a Drought Recovery Measure in Malawi" (Teri et al., 2000) This three-year program launched a first wave of release of cleaned local varieties selected for mosaic virus tolerance and early bulking, including Gomani, Mbundumali and Manyokola. Concerted efforts at seed multiplication resulted in rapid resuscitation of cassava production throughout Malawi (Figure 2).

[3] This regional effort subsequently expanded with renewed funding in 1994 from USAID under the Southern Africa Root Crops Research Network (SARRNET) .

5. CASSAVA PRODUCTION TAKES OFF, 1991 TO 2003

A. Production

The withdrawal of maize subsidies occurred in the late 1980's just at the moment when Zambia's cassava research team had identified and cleaned three highly superior local varieties for distribution in response to the mealybug attacks. The combination of clearly superior cassava varieties and depressed maize markets produced startling results (Figure 1). Without subsidized seed and fertilizer, and with the maize marketing apparatus in disrepair, farmers in the traditional cassava, sorghum and millet-producing regions rapidly reduced the area they planted to maize (Zulu et al., 1998; UNZA, 1999; Boxes 1 and 2). In its place, they expanded area devoted to cassava, millet, sorghum, groundnuts and sweet potatoes. This rapid area expansion, together with gradual availability of improved clones, resulted in astonishing double boost which propelled growth in cassava production to roughly 6% per year over the past decade (Table 1). Base on our adjusted data for the 1990s, we project that about three-fourths of the increase has come from area expansion and the remainder from rising yields due to improved varieties (Table 7). However, in the future, the pullback in maize will soften area expansion and we anticipate that yield gains will increasingly drive output expansion of cassava.

Most growth to date has occurred in the Zambia's traditional cassava zones in the north and western parts of the country. In the populous central and southern provinces, where cassava is less well known, farmers have been slower to switch (Bangwe, 1998), though nontraditional areas such as Eastern Province, which borders Malawi, have grown rapidly, albeit from a low base (Table 4).

As a result, the role of maize has diminished considerably in Zambia's post-reform years. Total cropped area devoted to maize has fallen from nearly 80% in 1982 to around 60% in 1999 (Zulu et al., 2000). Though maize area has risen in some maize-producing areas (Bangwe, 1998), yields have fallen drastically, and therefore so has output (UNZA, 1999). As a share of total food calories, maize production has fallen from nearly three quarters to just over one half between 1994 and 1999, while the corresponding share for roots and tubers (primarily cassava and sweet potato) has risen from 20% to 30% (Zulu et al., 2000). By 1991, crop diversification – away from maize – had become official government policy.

Malawian cassava production witnessed seemingly even more spectacular growth, though it began a little later, from the mid-1990's onward (Figure 2). Given changes in data collection methodology, some of this remarkable is gain most likely overstated.[4] Unlike Zambia, where the most rapid growth occurred in the staple cassava-producing zones, Malawian cassava production has grown rapidly in all regions of the country (Table 4). High population density, coupled with dramatically increasing maize and bread prices following liberalization, led to the rapid emergence of an urban fast food market for prepared cassava in central Malawi, a traditionally maize consuming region (Box 4; Moyo et al, 1998; Phiri, 2001). As a cash crop, cassava in some years is now two to three times as profitable as tobacco, groundnuts and maize in central Malawi (Akoroda and Mwabumba, 2000). As one

[4] In particular, the officially reported average yield growth from 2 to 15 tons per hectare appears overstated (Table 6).

recent study has concluded, "The cassava revolution in central region has been driven by the growth in the fresh cassava market." (Phiri, 2001).

Food security concerns have played a larger role in the equally rapid cassava growth in northern and southern Malawi. Overall, cassava expansion in central and southern Malawi has occurred primarily at the expense of maize and tobacco while in the less densely populated northern regions it has come from cassava expansion onto virgin land (Phiri, 2001; Table 5).

B. Seed Multiplication

In Malawi, small distances have enabled rapid distribution of improved planting material through a network of primary, secondary and tertiary seed multiplication centers. The early focus of the 1992/3 drought relief on accelerated distribution of improved cassava and sweet potato cuttings has launched a rapid adoption by Malawian farmers. Adoption surveys indicate that farmers in central Malawi planted between 60% and 70% of total cassava to improved varieties (Akoroda and Mwabumba, 2000). A 1995 review of these efforts concluded that, "the only constraint to 100% adoption of the technologies was inadequate supply of planting materials" (Teri et al., 2000).

Similarly in Zambia, in the face of declining maize subsidies and recent recurrence of drought, farmer demand for cuttings of the recommended high-performing local cassava varieties far exceeds available supply. The Ministry of Agriculture and Cooperatives (MAC) operates 8 hectares of primary sites for production of disease-free improved cassava varieties at their Mansa and Mutanda Research Stations. In addition, through SIDA funding of cassava multiplication activities, ZAMSEED currently produces cassava for planting material at various sites throughout Zambia, sometimes directly and in some cases through contracts with local farmers. In all, these sites include 23 hectares of improved cassava cuttings. With support from the Programme Against Malnutrition (PAM) and a battery of NGO's, this network supports about 100 hectares of tertiary plots producing planting materials through farmer and community managed nurseries. Given a ratio of about 7:1, these sites will permit distribution of planting material sufficient to plant 700 hectares of cassava each year. Given the 300,000 hectares currently planted in cassava, present formal seed multiplication capacity offers prospects for rejuvenating less than 1% of currently planted area each year.

To fill the large gap between farmer demand and availability of improved cuttings, many small commercial farmers have emerged to produce cassava planting material (Boxes 3 and 4). Though their efforts surely accelerate the diffusion of new varieties, they require supervision and certification in order to ensure that only disease-free, improved varieties are distributed. Following the research successes in mass selection trials, the current bottleneck has become one of bulk distribution of improved cuttings. The resulting shortage, what one observer refers to as a "massive shortage of planting material," stands as eloquent testimony to researcher success in providing attractive alternatives for a radically altered incentive environment (Masambu, 2002). Consequently, a small army of government and NGO agencies are currently working to bulk up systems for distribution of improved planting material.

In addition, many farmers continue to rely on informal farmer-to-farmer transfer of new genetic material. Given current estimates of about 22% adoption rate of improved varieties in Zambia, the bulk of this expansion of improved varieties has probably come from farmer-to-farmer transfer of planting materials (FSAZ, 2001).

C. Breeding

Breeding work in Zambia has continued under RTIP at their Solwezi and Mansa research stations. Following closely on the heels of the mass selection trials of existing varieties of cassava, RTIP began hybridization trials from 1989, in order to explore prospects for development of entirely new clones. In randomized block trials, they developed 1,952 hybrid clones by 1990. Through a dozen years of research station trials and screening, they have reduced these to 11 yielding 30 tons or more. Following on-farm trials, the researchers whittled this number down to 4 new varieties which they released in the 2001/2002 season. Named by convention after local lakes, the four new varieties will be called Mweru, Chila, Tanganyika and Kampolombo. All combine 25 to 30 ton yields, with early bulking and resistance to mosaic virus and major pests. Farmer probably achieve yields in the range of 12 to 15 tons per hectare.

A similar sequence played out in Malawi. After initial crash programs to identify, clean and multiply cuttings of the best local cassava varieties, Malawian breeders began a second wave of research aimed at developing new, more resistant and higher yielding varieties. The resulting hybridization trials and introduction of exotic germ plasm led to field trials with promising imported and locally produced hybrid clones during 1994/5 to 1996/7 cropping seasons. Ultimately, Malawian researchers released three new clones in May of 1999 – Mkondezi, a bitter variety, Silira, categorized as semi-sweet, and Maunjila, a bitter variety. This second wave of new varieties increases yield by about 50% from the already high 13 tons per hectare for the best local varieties (Gomani and Mbundumali) to 20 tons per hectare (Benesi et al., 1999).

D. Marketing and processing

Cassava marketing has grown far more rapidly in Malawi than in Zambia. Small distances permit large-scale trade in fresh cassava transported primarily by bicycle. Particularly in central Malawi, cassava has emerged as a highly profitable cash crop for the urban market. The marketed share of production in central Malawi now reaches 75% to 90% of total production (Moyo et al, 1998; Phiri, 2001). In southern zones, that share falls to about 60%, as food security motivations loom larger (Phiri, 2001). Though precise figures are not available for northern Malawi, anecdotal evidence from these staple cassava-consuming regions suggest that farmers market a much smaller fraction of their output in the north.

The situation in Zambia differs considerably, given the large distances between production centers and urban agglomerations. The surge in cassava production has nonetheless resulted in an increasing share of marketed production, though from a much lower base than in Malawi. The RTIP baseline survey of cassava production estimated that farmers marketed only 9% of total cassava production in 1996 (van Otterdijk, 1996, p.135), though this share appears to be growing rapidly. District officials in Luapula Province indicate that Zambia now exports substantial quantities of cassava to Congo. Several small processing plants exist in Zambia, though none in the major producing areas of Luapula and Northern Provinces.

Given the high water content and perishability of cassava roots and given the long distances prevailing in Zambia, the majority of traded cassava appears to take place in the form of dried chips or flour (Tembo and Chitundu, 2000).[5] As with the cassava transformation in West Africa, processing becomes the next constraint to overcome in sustaining further expansion in cassava production and marketing (Nweke, Spencer and Lynam, 2001; Nweke, 2003).

[5] Between 60% and 70% of farmers sell dried cassava chips or flour, while the remaining 30% to 40% sell fresh roots (Tembo and Chitundu, 2000). Without sales volumes, however, it is not possible to determine the exact marketed share of processed as opposed to fresh cassava.

6. MOTORS OF THE CASSAVA SURGE

A. Declining maize subsidies

Both Malawi and Zambia dismantled large maize subsidy systems at the tail end of the 1980's (Smale and Jayne, 2002). In Zambia, the withdrawal of fertilizer subsidies resulted in a 260% increase in the price of fertilizer relative to that of maize (Bangwe, 1998) and about a 33% decline in maize profitability (Table 6). Rising cassava yields together with steep increases in fertilizer and maize seed prices have led to clear financial incentives to switch from maize to cassava. Cassava, generally more profitable per unit of labor than maize suddenly yielded higher returns to land as well (Table 6). In Malawi, returns to hyv maize production appear to have fallen into negative territory, at least in some years, (Smale and Jayne, 2002) while cassava became a more profitable cash crop (Akoroda and Mwabumba, 2000).

As a result of declining profitability and severe contraction in rural credit and input supply systems for maize, farmers in both countries cut back on maize production significantly. In the heavy cassava producing regions of northern Zambia, area planted to cassava has roughly doubled over the past decade, while maize area has declined by 30% to 40% (Zulu et al., 2000). In Malawi, area allocation remained roughly constant over the 1990's, though falling input and hyv use has led to a reduction in per capita production over the decade.

B. Improved varieties

The improved cassava varieties released over the past decade in Zambia and Malawi roughly double cassava yields on the farm. With the same labor, land and without purchased inputs, the new varieties simply produce more output. They roughly double returns to both labor and land (Table 6).

In addition, they bulk early and enable harvesting 6 to 18 months earlier than traditional varieties. In Zambia, farmers traditionally harvest 18 to 36 months. With new varieties, farmers can begin harvesting at 12 months in Zambia and even earlier with the Malawian varieties. More resistant to pests and disease, the new varieties likewise reduce risk and volatility of cassava production.

Fragmentary adoption studies in central Malawi suggest that 60% to 70% of cropped area is now planted in improved varieties (Akoroda and Mwabumba, 2000). Because of this, time series data suggest that yields have roughly doubled since the 1960's, from 7 to 14 tons per hectare (FAOSTAT and Ministry of Agriculture). Though cassava yields are notoriously difficult to measure (Akoroda, 1999), given irregular and partial year-round harvesting, the tight land constraints coupled with available adoption studies in Malawi suggest that yield increases account a majority of production increase there (Table 7), unlike Zambia where area gains have predominated over the past decade.

In Zambia, the 1996 RTIP baseline survey suggested that 30% of farmers grew Nalumino and Kapumba, two the three recommended high-performing local varieties (van Otterdijk, 1996, p.101). But these figures do not indicate what share of cropped area or production these constitute. A more recent investigation found that 60% of farmers in northern regions of Zambia, the principal cassava growing zones, were growing improved varieties (MAFF, 2000). Calculations based on their average plot sizes suggest that the three recommended local varieties account for about 22% of cassava area in these zones. Monitoring studies suggest that the new varieties double on-farm yields (FSSD, 2001). Overall, these data suggest that Zambia's cassava growth has come more from area expansion than from yield gains (Table 7).

C. Drought

The Malawian drought of 1991/2 triggered government investment in rapid cassava and sweetpotato multiplication which has continued throughout the 1990's. Similarly in Zambia, the drought of 2002 has spurred interest by farmers, government and donors in cassava distribution in the southern more drought-prone zones of the country where it now figures as a key component of food security packs distributed by the Programme Against Malnutrition (PAM).

D. HIV/AIDS?

Cassava has long held a reputation as less labor-using crop than maize or other food crops (Marter, 1978). Though land preparation labor remains comparable to maize, many cassava farmers weed only once or twice in the first year and not at all in the second (Soenarjo, 1993). They likewise save labor input applications like fertilizer. Based on an 18-month cropping calendar and given two weedings in the first year, rough estimates suggest that cassava requires 25% to 50% less labor per hectare per year than maize.[6] Moreover, where peak-season labor constrains output, as it does among most rainfed smallholder farms in Malawi and Zambia, cassava offers the considerable advantage of a flexible planting and harvesting calendar. Where maize and cotton suffer yield losses of 1% to 2% for every day late they are planted (Haggblade and Tembo, 2003), cassava proves more forgiving. It demands less purchased inputs, less labor and permits more flexible timing of labor applications.

With national HIV prevalence rates above 25% in both Zambia and Malawi, and roughly half that level in rural areas, both governments and farmers worry about potential labor shortages in agriculture (Ministry of Health, 1999). With elevated mortality rates, particularly among working age males, and a weakened labor force, the efficiency of labor allocation becomes a paramount concern.

Has the rise of pervasive HIV/AIDS played a role in the rapid expansion of cassava in Malawi and Zambia? Some observers state categorically that there is a "strong association between increased production and consumption of cassava and the rising incidence of HIV/AIDS" (Chiwona-Karlton, 2001). Likewise, during the influenza epidemic of 1918-19 in Nigeria contemporaries noted a similar large-scale movement to cassava from the more labor-using yam in a response to the abrupt decline in male labor availability (Ohadike, 1981). Intuitively, we expect that labor shortages will lead farmers to reallocate labor and land to less labor-using crops.

[6] Note that cassava processing can be highly labor-intensive. In places like Nigeria where the bulk of cassava production has become commercialized and where thousands of rural processing plants convert cassava roots into dried convenience food, heavy labor constraints emerge requiring new, less-labor-intensive processing technologies (Nweke, 2003).

To test this proposition, we have examined Zambia's 2001/2 national Post-Harvest Survey (PHS) of agriculture. Using the 6,500 nationally representative farms, these data permit us to examine differences in land (although not labor) allocation across crops. In addition, the 2001/2 PHS specifically examined the HIV/AIDS question by asking each household how many adults had been chronically ill for the past three months. Using that self-reported proxy to estimate HIV/AIDS prevalence generates an estimate of 11.4% for rural adults in the 15 to 49 year age group (Table 8), not far different from the official estimates of 13.6% (Ministry of Health, 1999).

HIV/AIDS could theoretically affect farm labor supply in two ways. First, by increasing mortality rates, it would decrease adult labor available for farm work. This we measure by the number of working age adults per capita in each household. Second, HIV/AIDS affected adults should be weaker and less productive than healthy adults. This we capture by the proxy "number of adults chronically ill for the past three months," also expressed in per capita terms.

The regression equations in Table 9 examine area allocation to cassava and maize to see if HIV/AIDS affects farmer allocation decisions. We consider cropping decisions to be affected by agroecological region, total land cropped, household income (which affects ability to hire labor and animal traction equipment), livestock ownership (which affects draft power), and household labor availability, both number of adults per capita and number of chronically ill (HIV/AIDS infected) adults per capita.

The results suggest a clear impact of HIV/AIDS through both labor supply mechanisms (Table 9). To the extent that HIV/AIDS reduces a household's adult labor supply, it increases cassava area and reduces area farmed in maize. Thus, lower adult labor supply induces farm households to move out of maize and into cassava. In addition, higher HIV/AIDS prevalence (as measured by the proxy of chronic illness for the past three months), increases the area devoted to cassava and decreases the area devoted to maize. Thus households with weaker labor gravitate to cassava. These results suggest that HIV/AIDS has indeed played a small but statistically significant role in growth of area planted to cassava in Zambia. Cassava, particularly the new more productive varieties, offer households new alternatives as they attempt to adjust to the labor constraints imposed by HIV/AIS.

7. IMPACT OF CASSAVA GROWTH

A. Income

Farmer income appears to have grown as a result of the rapid growth of improved cassava varieties in Zambia and Malawi. With identical inputs of labor and land, farmers roughly double their output. Subsistence farmers can ensure their food security with fewer resources while farmers who market their crop double their cash returns (Table 6).

Given lower marketed shares in Zambia and in northern Malawi, the gains have accrued mainly in the form of improved household food security. But in central and southern Malawi, where farmers sell the majority of their cassava crop, cash returns have grown dramatically making cassava one of the most profitable cash crops in country. One recent study suggests that cassava returns three times those of maize, groundnuts and tobacco (Akoroda and Mwabamba, 2000).

B. Equity

In both countries, small farms dominate cassava production. Though a handful of commercial farmers have begun to experiment with large-scale cassava production (100 hectares or more), the vast majority of cassava producers are small, hand-hoe farmers. In Malawi, the very smallest farms, those under 1 hectare per family, allocate 17% of their cropped area to cassava, while farms in the 5 to 20 hectare range allocate only 3% (Table 10). In Zambia, where farms are larger on average even among smallholders, farmers devote on average 9% of cropped area to cassava, slightly less among the smallest (7%) and slightly more among the mid-sized smallholder farms in the 2 to 5 hectare range.

Perhaps more revealing, cassava plots under half a hectare account for 79% of area farmed in cassava in Malawi, while farmers planting under 1 hectare account for 96% of cassava area (Table 11). In Zambia, larger farm sizes alter these figures slightly, as farms growing less than half a hectare in cassava account for 61% of total cassava cropped in cassava, while allocations under one hectare account for 89% of all cassava area.

In Malawi, gender influences cassava cropping patterns as well. Female-headed farm households, poorer on average than their male counterparts, farm about 25% less land per household but devote more to cassava. While female-headed households allocate 14.4% of their land area to cassava, male-headed households devote 9.7% (Table 12).

C. Sustainability

Because they apply virtually no purchased inputs on their cassava plots, farmers can continue to grow cassava as long as they wish. They need not rely on seed suppliers, fertilizer distributors or rural credit programs to continue growing high yielding cassava.

Environmentally, low-input cassava production generates no acidification or pesticide residues that may occur in other crops. Yet because of its low input use and because it grows well on even marginal lands, some observers accuse cassava of depleting soil fertility. Long term trials over twenty years on the same plot in Ibadan, Nigeria found that cassava yields stabilized at 20 tons per hectare from year five onwards suggesting that cassava yields are sustainable under continuous cultivation. Based on these findings, leading other cassava experts to consider the soil mining charge a myth (Nweke, Spencer and Lynam, 2002).

8. KEY ISSUES LOOKING FORWARD

Cassava production appears to have surged dramatically in both Zambia and Malawi, growing at between 6 and 8% per year over the past decade. In part, the abnormally low production levels of the 1980's, a byproduct of the devastating mealybug and cassava green mite invasions, artificially magnify the steepness of this ascent. Nonetheless, growth rates have impressive and clearly increased production above normal trend rates (Figures 1 and 2).

Insect invasions -- coupled with successive droughts and consequently erratic maize production -- have spurred policy and research interest in cassava where none existed before. Research investments in cassava breeding, spurred by the natural disasters of the 1980's, have paid off handsomely in the 1990's.[7] They have undoubtedly cushioned what would have been an otherwise difficult transition by farmers to the abrupt withdrawal of maize input subsidies in the early 1990's. And in doing so, the new cassava varieties offer HIV affected and labor-constrained rural households more flexible options for deploying labor to meet basic food security needs.

Looking forward, three key issues will dominate future cassava development. Together, these issues will largely govern the sustainability of the initial, decade-long cassava surge.

- *Seed multiplication and distribution:* Currently, an acute shortage of improved planting material constrains cassava expansion, particularly in Zambia (FSAZ, 2000; Masomba, 2002). In Malawi, where distances are smaller, distribution of improved material has proceeded more rapidly. Yet even there shortages of planting material constrains diffusion of the improved clones (Moyo et al., 1999; Teri et al., 2000).

- *Marketing and processing:* Marketing and processing will need to improve dramatically if the highly perishable cassava crop is to continue to grow rapidly. In Malawi, most marketing takes place in the central region, where high population density facilitates bicycle transport to large urban centers. But in other regions of Malawi, and throughout Zambia, distances are larger. Hence drying and processing become central to any strategy for expanded marketing of cassava. Southern Africans can surely learn from the cassava mechanization and processing technology that has been developed over many decades in West Africa. Indeed, some of the interesting experimental cassava processing work in Zambia today is being undertaken by private Nigerian businessmen who grew up on gari. Yet considerable resources and efforts will still be required to master cassava processing and marketing in Malawi and Zambia. And without such efforts, the cassava boom will stall.

- *Sustained funding for cassava research:* SIDA funding for Zambia's RTIP lapsed in 1998 after a decade of support. Their follow-on funding has focused on the important next steps of seed multiplication and distribution. But government funding has not filled the gap left by the donor withdrawal. Consequently, RTIP has lost several key staff as their numbers of professionals has fallen from 6 in 1995 to 3 in 2002. Malawi remains likewise dependent

[7] Optimistic estimates in Zambia place returns to cassava research at 78% (FSAZ, 2000). More conservative global estimates estimates returns in the range of 9% to 22% (Johnson et al., 2003). Whatever the exact numbers, most observers on the ground – farmers most especially – consider that investments in cassava research and seed multiplication have yielded impressive returns in the form of improved food security and income for smallholders.

on donor financing, particularly the USAID funds channeled through IITA's regional SARRNET research program. Tightly stretched government budgets appear ill-equipped to fill the gap when donor funds inevitably dry up.

Meanwhile, the mosaic virus continues to mutate, and new pests will undoubtedly emerge as they have in the past. So the cassava research establishment cannot rest on its laurels. Surely one of the main lessons of the past is that agricultural systems continually evolve. In modern agricultural systems, where humans have assumed responsibility for plant survival and defense mechanisms, sustained government investment in agricultural research will be a sine qua non for sustained agricultural growth in cassava as well as other key crops.

Box 1. A Small Farmer Benefits from New Cassava Varieties

John Tilimba supports a family of 12 in the district of Samfya in Luapula Province of northern Zambia. He has been farming since 1975, though he supplements his farm income with piece work as a painter.

When he began in 1975, Mr. Tilimba initially farmed 1.5 limas of land (one lima is .25 hectares). Like most farmers in Luapula Province, he devoted most of his land to cassava. He supplemented his 1 lima of local cassava with .5 lima of groundnuts and cabbage. In 1980, with the advent of the government sponsored Lima Pack program supplying subsidized maize seeds and fertilizer to farmers, Tilimba added a lima of maize to his cropping system. He continued with his 1 lima of cassava and small plot of groundnuts.

After government withdrew their maize subsidies, in the early 1990's, Mr. Tilimba was forced to reduce his maize production. He could not afford hybrid seeds or fertilizer at the free market price. So he reduced his maize production from one lima down to .25 lima. And since he has limited cash, he plants only local varieties without fertilizer. As a results, his maize yields have fallen drastically.

To fill the gap left by his diminished maize production, Mr. Tilimba turned once again to cassava. His neighbors told him of an improved cassava variety, called Bangweulu, that yielded more than double what his local varieties could achieve. And instead of waiting 30 months to harvest, he could begin eating roots after only 12 months. In 1999, Mr. Tilimba was able to obtain Bangweulu cuttings from one of his neighbors. He has added one lima per year since then, so he now farms 3 limas of cassava, which he intercrops with groundnuts in the first year. He has also added one-half a lima of rice in the dambo (low lying wet area) nearby.

Mr. Tilimba's family consumes half of his annual cassava production. He uses one-fourth to pay for labor in kind to help with his weeding, and one-fourth he sells for cash. Mr. Tilimba wonders how he would feed his family without the improved cassava. "Cassava is now a cash crop," he marvels, "and I can harvest after only 12 months."

Box 2. Small-Scale Commercial Cassava Farming in Zambia

Emmanual Kafusha's farm, in Samfya District in Zambia, supports a household of six adults and four children. He began farming in 1980, planting half a lima of local cassava, 2 limas of maize, a lima of groundnuts and 2 limas of bambara groundnuts.

With the demise of maize input subsidies in the region, he has scaled back maize production and expanded his cassava holdings dramatically, from half a lima to 3 hectares (12 limas). He has also added one lima of soybeans and one lima of sweet potato. He plants primarily the new Bangweulu variety of cassava in pure stands, rather than intercropping, since he finds the intercrop reduces his cassava yields.

Because of its high yield, early maturing and resistant to disease, many neighbors have asked to buy cuttings. So in addition to selling one-thirds of his cassava roots, he sells cassava cuttings as well. With three hectares of improved cassava, he has become a small-scale commercial supplier of cuttings in his district. This season, selling at 100 kwacha per cutting, he made 208,000 Kwacha (about $50) from cassava cuttings alone.

Box 3. Hedging Against Cassava Mosaic Virus

George Chipendano of Mwense District in northern Zambia began farming in 1990. In his early years, he grew equal areas of cassava and maize, 3 limas each. But a decade later, as maize subsidies have disappeared and both seeds and fertilizer have become more expensive, he has cut his maize area from 3 limas down to 1.

To compensate, he has drastically increased cassava production. From 3 limas of local varieties in 1990, he has expanded to 2.5 hectares (10 limas) of cassava in 2002. He consumes half his cassava crop to feed his six family members, but he sells the other half.

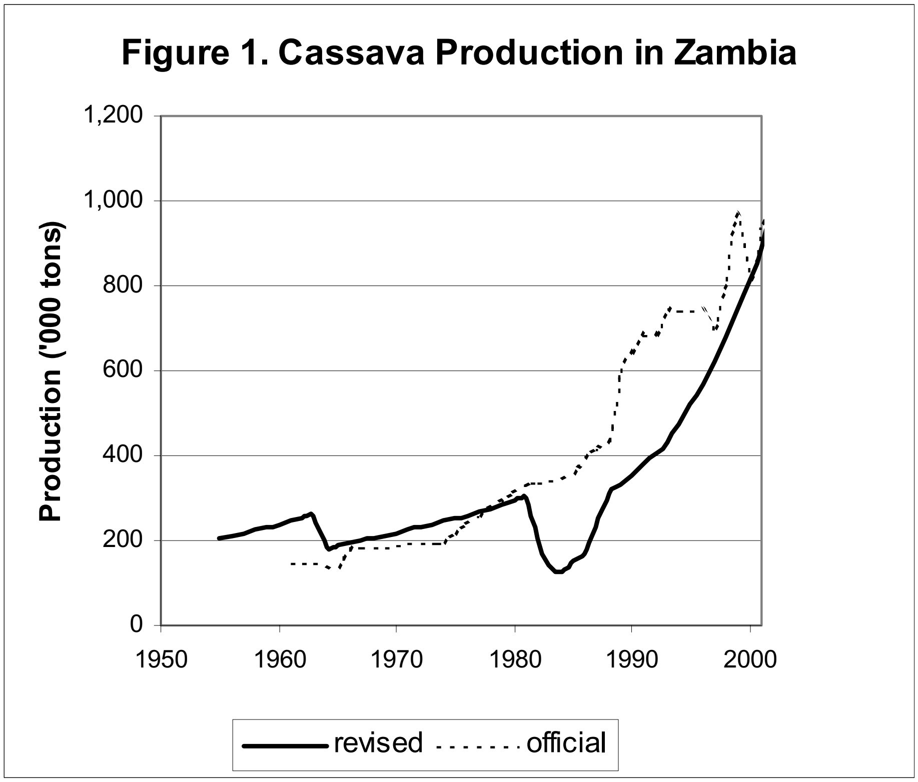
He devotes one hectare of his cassava to the improved Bangweulu variety. But the remaining 1.5 hectares, he plants with a mix of local cassava varieties, including Chiliber, Sailise, and Nakasone. Asked why, he explains that the mix of varieties serves as a hedge against the cassava mosaic disease which periodically infests his fields.

Box 4. Commercial Cassava Production in Central Malawi

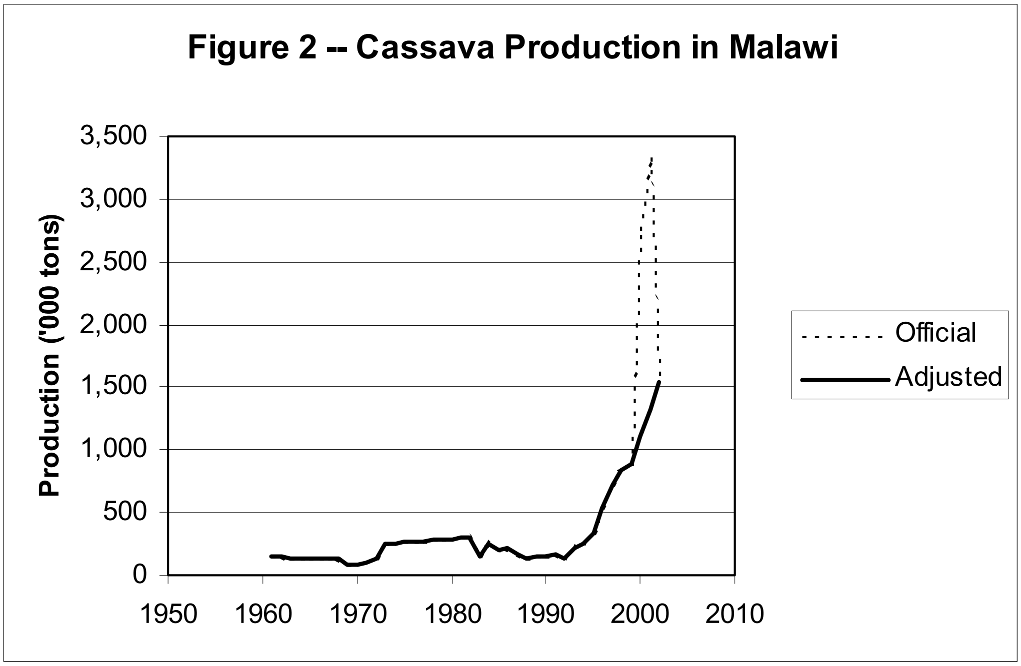
Wilson Masoambeta has become a serious commercial cassava farmer since he retired from his butchery business and began farming in 1994. Living only 50 kilometers from Lilongwe, in central Malawi, he has ridden a dramatic wave of increasing urban demand for boiled cassava roots as a morning meal and mid-day snack food. With the demise of maize subsidies in Malawi and the liberalization of foreign exchange markets, both mealie meal and bread (produced on imported wheat flour) have grown far more expensive than cassava. So urban demand for cassava has literally exploded over the past decade, as Mr. Masoambeta will readily attest.

From two acres in 1995, he has increased his cassava holdings steadily to 14 acres in 2002. Since he rents his cassava land, and sells the entire crop, he treats his cassava holdings like a business. Including land rental and labor costs, he figures that one acre of cassava costs him 10,000 Kwacha to produce. He sells the tubers for 30,000, netting him 20,000 Kwacha per acre in profits. And his cuttings are valuable as well. Because he plants improved, high-yielding, disease resistant varieties, his neighbors line up for cuttings when he is ready to harvest. Not only do they pay him 11,000 Kwacha for one acre's worth of cuttings, they provide harvesting labor in order to obtain first rights to the cuttings.

Forty years old, Mr. Masombeta supports 3 wives and 7 children with his cassava earnings. After building a four-room house with corrugated roof, plus two small houses for his junior wives, he has purchased two oxcarts, 3 donkeys and a bicycle. At the beginning of the rainy season, he confied 120,000 Kwacha to a "friend" who offered to purchase a second-hand pick-up for him in South Africa. But, unfortunately, he has not seen his "friend" since last December. By Mr. Masombeta's reckoning, cassava has become a far more profitable cash crop than maize, cotton or even tobacco. The regular stream of boys that visit the cassava fields on bicycles with specially fitted racks for carrying cassava in to Lilongwe and surrounding towns attest to the ease of marketing this newfound cash crop.



Source: FAOSTAT (official), authors adjustments (revised).



Source: FAOSTAT (official), authors adjustments (adjusted).

Table 1 -- Official Cassava Production Data for Selected African Countries

Country	Cassava Production ('000 tons)								
	3-year centered averages*			1-year figure*		Adjusted values**			
	1990	2000	increase	2002	increase	1990	2002	increase	annual growth
Nigeria	20,817	32,431	56%	34,476	66%	20,817	34,476	66%	4.3%
Malawi	156	2,322	1391%	1540.307	889%	246	618	151%	8.0%
Uganda	3,406	5,035	48%	5300	56%	3,406	5,300	56%	3.8%
Zambia	641	912	42%	950	48%	641	1,239	93%	5.6%

Source: * FAOSTAT, ** author's adjustments

Table 2 -- Contrasts Between Malawi and Zambia

	Malawi	Zambia
Demographics		
Population (millions)	11	10
Population density (persons/sq km)	118	13
HIV/AIDS prevalance rates	18%	14%
Economy		
GNP/capita ($)	190	320
GDP share from agriculture	0.38	0.17
Agricultural productivity		
Arable land per capita (ha)	0.16	0.57
Maize yields (tons/ha in 2002)	1.1	1.5
Maize prodn/capita (kg)	136	83
Cassava production per capita (kg)	130	87

Sources: FAOSTAT, World Bank (2002).

Table 3 -- Cassava Research Chronologies in Malawi and Zambia

	Malawi	*Zambia*
Mealybug response		
mealybug incursion	1986	1981
biological control efforts	1989	1984-89
Mass selection trials of existing clones		
start date	1992	1987
	accelerated seed distribution as drought relief measure Gomani, local (bitter) Mbundumali, local (sweet)	
# varieties screened	170 local, 302 exotic	500 local, 200 exotic
release of "improved local" varieties & large-scale seed multiplication	released beginning in 1995 Manyopola CH 92/161 MK 92/478 MK 93/079	3 varieties released, 1992 Bangweulu (bitter) Kapumba (sweet) Nalumino (sweet)
Hybridization trials		
start date	1992	1989
research trials	1994/5-1996/7	1991-1993
release of new varieties & seed multiplication	3 varieties, 1999 Mkondezi (bitter) Silira (bitter) Maunjili (bitter)	4 varieties, 2001 Mweru (sweet) Chila (bitter) Kampolombo (sweet) Tanganyika (sweet)

Table 4 -- Regional Trends in Area Under Cassava ('000 hectares)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	trend growth rate
Malawi																		1990 to 2000
Northern Districts																		
Karonga	13	13	10	9	7	5	6	6	6	6	6	7	9	11	14	15	15	14.0%
Mzuzu	14	17	17	12	12	17	16	19	14	20	21	23	27	28	32	33	35	8.7%
Central Districts																		
Kasungu	3	2	2	2	3	4	4	3	4	3	2	4	5	7	7	9	13	7.6%
Lilongwe	4	6	5	6	5	7	6	7	5	5	4	5	6	7	11	16	17	11.1%
Salima	8	8	10	13	9	9	8	11	1	15	13	13	17	18	20	23	25	17.4%
Southern Districts																		
Machinga	17	21	12	11	11	13	16	14	13	14	13	16	22	23	29	38	41	11.5%
Blantyre	15	12	10	11	12	14	4	9	9	9	13	26	30	29	36	32	37	20.8%
Shire Valley	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	1	1	2.1%
Total Malawi	32	34	24	23	25	28	21	24	23	25	26	43	54	53	67	70	79	12.4%
FAOSTAT	81	80	73	65	62	73	62	72	64	75	72	95	117	126	152	166	181	15.3%
Zambia							Census		Post-Harvest Surveys									1992 to 2000
Northern							46		55	57	51	55	90	119	123	140	128	14.3%
Luapula							49		51	40	41	37	80	91	97	109	82	12.5%
Western							27		17	17	21	13	17	21	25	32	37	9.6%
Northwestern							38		19	26	22	22	26	29	29	28	30	4.7%
Central							16		7	6	5	6	6	6	6	8	9	4.1%
Eastern							1.0		0.7	0.7	0.3	0.3	0.7	0.5	0.9	1.1	3.4	17.7%
Copperbelt							1.8		2.1	0.8	1.5	1.3	0.5	0.8	0.7	1.0	2.2	-2.3%
Southern							0.6		0.5	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	-
Total Zambia - PHS							179		153	147	144	134	220	268	281	318	292	11.5%
FAOSTAT							103	110	110	120	120	120	120	113	132	170	165	4.7%

Source: Zambian Central Statistics Office (1992) and Post-Harvest Surveys 1992/3 through 1999/2000; Malawian Ministry of Agriculture and FEWS.

Table 5 -- Area Changes in Malawian Agriculture

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Area ('000 hectares)																			
Maize	1,169	1,174	1,145	1,193	1,182	1,215	1,271	1,344	1,392	1,368	1,327	1,129	1,226	1,243	1,234	1,293	1,369	1,435	1,446
Pulses	83	91	80	114	152	160	149	215	191	219	265	266	294	359	413	433	435	474	507
Cassava	59	81	80	73	65	62	73	62	72	64	75	72	95	117	126	152	166	181	198
Sweet potatoes	0	21	23	22	29	29	44	30	48	20	34	37	61	69	92	135	150	164	188
Tobacco	28	45	47	38	33	24	21	31	33	32	45	32	53	79	99	114	116	119	114
Rice	20	22	21	23	19	23	26	29	33	18	39	27	33	41	40	42	46	44	50
Sorghum	23	21	33	32	31	30	30	31	31	28	44	54	62	76	84	68	59	55	54
Cotton	33	51	61	52	35	44	48	49	59	58	54	38	52	79	71	45	53	40	47
Total of major crops	1,415	1,507	1,489	1,547	1,546	1,586	1,661	1,790	1,859	1,808	1,883	1,656	1,875	2,063	2,158	2,282	2,395	2,512	2,606
Share of cropped area																			
Maize	83%	78%	77%	77%	76%	77%	77%	75%	75%	76%	70%	68%	65%	60%	57%	57%	57%	57%	56%
Pulses	6%	6%	5%	7%	10%	10%	9%	12%	10%	12%	14%	16%	16%	17%	19%	19%	18%	19%	19%
Cassava	4%	5%	5%	5%	4%	4%	4%	3%	4%	4%	4%	4%	5%	6%	6%	7%	7%	7%	8%
Sweet potatoes	0%	1%	2%	1%	2%	2%	3%	2%	3%	1%	2%	2%	3%	3%	4%	6%	6%	7%	7%
Cotton & tobacco	4%	6%	7%	6%	4%	4%	4%	4%	5%	5%	5%	4%	6%	8%	8%	7%	7%	6%	6%
Sorghum & rice	3%	3%	4%	4%	3%	3%	3%	3%	3%	3%	4%	5%	5%	6%	6%	5%	4%	4%	4%
Total of major crops	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: Ministry of Agriculture

Table 6 -- Apparent Sources of Cassava Production Growth

	1990	2002	increase
Zambia			
FAOSTAT data			
area (ha)	103,159	165,000	59.9%
yield (kg/ha)	6.2	5.8	-7.2%
production (tons)	640,000	950,000	48.4%
Adjusted data*			
yield	6.2	7.5	21.0%
production	640,000	1,238,837	93.6%
Malawi			
FAOSTAT data			
area (ha)	61,506	102,938	67.4%
yield (kg/ha)	2.4	15.0	535.8%
production (tons)	144,760	1,540,307	964.0%
Adjusted data*			
yield	4	6	50.0%
production	246024	617628	151.0%

* Adjusted by authors based on probable hyv shares.
Source: FAOSTAT.

Table 7 -- Changing Incentives for Cassava Producers in Zambia

	Pre-liberalization (1985)		Post-Liberalization (2002)		
	Cassava + groundnuts	Maize, HYV	Cassava + groundnuts	Maize	
				HYV	local
Output					
Production (tons/ha)	6	3	12	2.5	1
Years to harvest	3	1	2	1	1
Value ($/ha)	$375	$375	$675	$313	$125
Input costs ($/ha)	$0	$77	$0	$107	$0
Labor (persondays/ha)	157	175	165	175	157
Gross margin ($/ha)	$375	$298	$675	$206	$125
Financial returns					
Returns to labor ($/person/day)	$2.4	$1.7	$4.1	$1.2	$0.8
Returns to land ($/ha/year)	$125	$298	$338	$206	$125
Calorie returns					
Returns to labor (cal/person/day)	0	0	0	0	0
Returns to land (cal/ha/year)	0	0	0	0	0
Subsidy cost ($/ha/year)	$0	$0	$0	$0	$0
Investment costs ($)	$5	$5	$5	$5	$5

Source: Annex Table A.1

Table 8 -- Proxy Estimates* of AIDS Prevalence in Rural Zambia

	Agro-ecological Regions				
	AER 1	AER 2a	AER 2b	AER 3	All Zambia
Percent of households affected	14.6%	10.4%	9.9%	11.0%	11.4%
standard deviation	35.0	31.0	30.0	31.0	32.0
Estimated HIV/AIDS prevalence	7.5%	5.9%	5.7%	6.2%	6.5%
standard deviation	24.0	21.0	23.0	22.0	22.0

* Adults between 15 and 49 years of age listed as chronically ill for the past three months.

Source: Post Harvest Survey 1999/2000.

Table 9 -- Impact of Household Labor Availability and HIV/AIDS on Cassava Production

	Cassava		Maize	
	share of cropped area	ha/capita	share of cropped area	ha/capita
Agroecological Region				
AER 2a. Moderate rainfall, heavy soils	0.017 ***	-0.004	-0.132 ***	-0.031 ***
	(-4.5)	(-1.4)	(-12.0)	(-4.3)
AER 2b. Moderate rainfall, sandy soils	0.067 ***	0.026 ***	-0.334 ***	-0.118 ***
	(14.3)	(7.6)	(-25.0)	(-13.0)
AER 3. High rainfall	0.181 ***	0.062 ***	-0.548 ***	-0.193 ***
	(50.5)	(23.3)	(-53.0)	(-27.6)
Land cropped (ha/capita)	0.014 ***	0.142 ***	-0.081 ***	0.364 ***
	(4.8)	(64.3)	(-9.5)	(62.9)
Household income (million Kwacah/capita)	-0.021 ***	-0.007 ***	0.108 ***	0.036 ***
	(-5.5)	(-2.5)	(9.6)	(4.8)
Livestock ownership (million Kwacha/capita	-0.018 ***	-0.057 ***	0.049 ***	0.153 ***
	(-3.3)	(-13.6)	(3.0)	(13.8)
Household labor availability				
Adults per capita	-0.008	-0.014 ***	0.062 ***	0.049 ***
	(-1.3)	(-3.0)	(3.3)	(3.8)
Aids "prevalence" per capita	0.032 ***	0.011	-0.062 *	-0.052 ***
	(2.6)	(1.3)	(-1.8)	(-2.2)
Constant	0.006	-0.029 ***	0.771 ***	0.085 ***
	(1.3)	(-8.2)	(56.9)	(9.3)
Sample size	6732	6732	6732	6732
Adjusted R squared	0.38	0.46	0.38	0.48

*** significantly different from zero at 99% confidence level
** significantly different from zero at 95% confidence level
* significantly different from zero at 90% confidence level
( ) t ratios listed in parentheses under regression coefficients

AIDS "prevalence" estimated as number of adults chronically ill for the past three months.

Source: Post Harvest Survey 1999/2000.

Table 10 -- Cassava Production by Farm Size in Malawi and Zambia

	Farm Size					
	very small	small		medium	All	Area (ha)
	< 1 ha	1-1.9	2 to 4.9 ha	5 to 20 ha		
Distribution of farm sizes						all crops
Malawi						
Northern	15%	40%	42%	3%	100%	2.1
Central	26%	47%	26%	1%	100%	1.5
Southern	50%	36%	14%	0%	100%	1.2
All Malawi	37%	41%	22%	1%	100%	1.4
Zambia						
Northern (AER 3. High rainfall zones)	32%	36%	28%	5%	100%	1.8
Western (AER 2b. Moderate rainfall, sandy soils)	43%	34%	21%	2%	100%	1.4
Central (AER 2a. Moderate rainfall, heavy soils)	37%	37%	23%	3%	100%	1.5
Southern (AER 1. Dry zones)	43%	31%	21%	5%	100%	1.6
All Zambia	37%	35%	24%	4%	100%	1.6
Share of farmers growing cassava						cassava*
Malawi						
Northern	41%	61%	88%	70%	69%	0.52
Central	10%	10%	27%	3%	14%	0.40
Southern	44%	29%	57%	40%	40%	0.36
All Malawi	35%	24%	49%	29%	33%	0.41
Zambia						
Northern (AER 3. High rainfall zones)	65%	83%	86%	87%	78%	0.46
Western (AER 2b. Moderate rainfall, sandy soils)	17%	34%	62%	65%	34%	0.42
Central (AER 2a. Moderate rainfall, heavy soils)	5%	13%	18%	14%	11%	0.35
Southern (AER 1. Dry zones)	0%	0%	1%	2%	0%	0.20
All Zambia	24%	39%	48%	46%	36%	0.45
Cassava share of cultivated area						
Malawi						
Northern	16%	17%	18%	6%	17%	
Central	5%	4%	5%	0%	4%	
Souther	22%	9%	9%	0%	16%	
All Malawi	17%	7%	9%	3%	11%	
Zambia						
Northern (AER 3. High rainfall zones)	20%	21%	20%	19%	20%	
Western (AER 2b. Moderate rainfall, sandy soils)	4%	7%	13%	12%	7%	
Central (AER 2a. Moderate rainfall, heavy soils)	1%	2%	3%	2%	2%	
Southern (AER 1. Dry zones)	0%	0%	0%	0%	0%	
All Zambia	7%	9%	10%	9%	9%	

* Average cassava area farmed by households who cultivate cassava.

Source: Malawi: IFPRI/APRU 1998 Smallholder Farm Survey; Zambia: Post Harvest Survey 1999/2000.

Table 11 -- Size Distribution of Cassava Area in Malawi and Zambia

Region	Cassava area cultivated (ha per household)					
	0	< .5	.5 to .99	1 to 1.99	2 to 4.99	total
Malawi						
northern	30.6%	45.5%	18.0%	4.8%	1.2%	100%
central	85.6%	10.9%	2.4%	1.1%	0.0%	100%
southern	59.5%	34.1%	5.6%	0.6%	0.2%	100%
all Malawi	66.5%	26.2%	5.7%	1.3%	0.2%	100%
all Malawi, growers only		78.5%	17.1%	3.8%	0.6%	100%
Zambia						
northern (AER 3)	22.6%	44.8%	23.5%	7.5%	1.4%	100%
western (AER 2b)	67.2%	22.8%	7.4%	1.8%	0.8%	100%
central (AER 2a)	89.2%	8.4%	1.7%	0.8%	0.0%	100%
southern (AER 1)	99.6%	0.4%	0.0%	0.0%	0.0%	100%
all Zambia	64.9%	21.4%	9.9%	3.2%	0.6%	100%
all Zambia, growers only		61.0%	28.2%	9.1%	1.7%	100%

Source: Malawi: IFPRI/APRU 1998 Smallholder Farm Survey; Zambia: Post Harvest Survey 1999/2000.

Table 12 -- Gender Distinctions among Cassava Producers in Malawi, 1998

	Gender of Household Head		
	male	female	all
Total cropped area (ha/household)	1.59	1.15	1.43
Expenditure quintiles			
lowest	17.3%	27.8%	20.0%
2nd	18.8%	21.8%	20.0%
3rd	21.6%	13.7%	20.0%
4th	21.1%	20.5%	20.0%
highest	21.1%	16.2%	20.0%
	100%	100%	100%
Cassava			
households growing cassava	31.8%	36.6%	33.4%
average cassava area per capita	0.09	0.11	0.09
as share of total cropped area	9.7%	14.4%	11.4%

Source: IFPRI/APRI Smallholder Farm Survey, 1998.

REFERENCES

Akoroda, M.O. 1999. "Study of the Contribution of Cassava and Sweetpotato to Total Food Availability in Malawi." Lilongwe: SARRNET.

Akoroda, M.O. and Mwabumba, M.L. 2000. "Sweet Success: Cassava in Lilongwe East RDP." Lilongwe: SARRNET.

Akoroda, M.O. and Teri, J.M., editors. 1998. Food Security and Crop Diversification in SADC Countries: The Role of Cassava and Sweetpotato. proceedings of the scientific workshop of the Southern African Root Crops Research Network (SARRNET) held at Pamodzi Hotel, 17-19 August, 1991, Lusaka, Zambia.

Bangwe, Lewis M. 1998. "Will the Dominance of Maize Ever Diminish: Constraints to Crop Diversification in Zambia." Occasional Working Paper No.2 paper prepared for presentation at the Sixth SAAFSR-E Regional Conference, 204 February 1998, Mulungushi International Conference Centre, Lusaka, Zambia.

Bangwe, Lewis and Rukandema, M. 1990. "Cassava Production and Utilization Under Traditional Technology in North-Western Province Zambia." Technical Report No.10 Solwezi: Mutanda Regional Research Station.

Benesi, I.R.M.; Moyo, C.C.; Mahungu, N.M.; Mkumbira, J.; Soko, M.M.; Sauti, R.F.N.; and Sandifolo, V.S. 1999. "Progress in Developing Improved Cassava Varieties in Malawi." In M.O. Akoroda and J.M. Teri editors Food Security and Crop Diversification in SADC Countries: the Role of Cassava and Sweetpotato. Ibadan: IITA.

Chiwona-Karltun, Linley. 2001. "A Reason to be Bitter: Cassava Classification from the Farmers' Perspective." Stockholm: Karolinska Institutet.

Chitundu, Davies C. 1999. "Accelerated Multiplication and Distribution of Cassva and Sweetpotato Planting Material sin Luapula Province of Zambia." In M.O. Akoroda and J.M. Teri editors Food Security and Crop Diversification in SADC Countries: the Role of Cassava and Sweetpotato. Ibadan: IITA.

Chitundu, D and Soenarjo. 1997. "Cassava Field Production Guide." Mansa: Luapula Livelihood and Food Security Programme.

Cooperative League of the USA (CLUSA). 2002. "Two Farmers that Succeeded in Producing Enough Cassava Root to Give Away in a Year of Hunger." (mimeo). Chipata, Zambia: CLUSA Natural Resources Management Programme.

Department of Agriculture. 1992. "Review of Agronomic Work on Cassava: 1970 to 1990." Chilanga: Mt. Makulu Research Station.

Engelmeyer, Christa. 1987. "Cassava Experiments in Zambia: 1941-1986." Research Memorandum No.30 Chingala: Mt. Makulu Research Station.

Fresco, Louise O. 1989. Cassava in Shifting Cultivation: A Systems Approach to Agricultural Technology Development in Africa. Amsterdam: Royal Tropical Institute.

Graffham, Andrew J; Ababio, James T.; Dziedozoava, Nanam; Day, George; Andah, Abigail; Ayernor, G.S.; Gallat, Stephanie and Westby, Andrew. "Market Potential for Cassava Flours and Starches in Africa: A Case Study in Ghana." Tropical Agriculture ½ (75):267-270.

Haggblade, Steven and Tembo, Gelson. 2003. "Conservation Farming in Zambia," (Conference paper no.11).

International Institute of Tropica Agriculture (IITA). 1998. "Proposal for Transfer of Post-Harvest Based Processing Technologies and Multiplication and Distribution of Improved Cassava and Sweetpotato Planting Materials as a Food Security Measure in Zambia." A proposal submitted to USAID/Zambia. Lilongwe: SADC/IITA/SARRNET.

Johnson, N.L., Manyong, V.M., Dison, A.G.., and Pachico, D. 2003. "The Impact of IARC Genetic Improvement Programmes on Cassava." In Evenson, R.E. and Gollin, D., editors. Crop Variety Improvement and its Effect on Productivity: The Impact of International Agricultural Research. New York: CABI Publishing.

Jones, William O. 1959. Manioc in Africa. Stanford University: Food Research Institute.

Kokwe, Gun Mickels. 1997. Maize, Markets and Livelihoods: State Intervention and Agrarian Change in Luapula Provice Zambia, 1950 to 1995. Helsinki: Institute of Development Studies, University of Helsinki.

Legg, J.P.; Sseruwagi, P.; Kamau, J.; Ajanga, S.; Jeremiah, S.C.; Aritua, V.; Otim-Nape, G.W.; Muimba-Kankolongo, A.; Bigson, R.W.; and Thresh, J.M. 1999. "the Pandemic of Severe Cassava Mosaic Disease in East Africa:Current Status and Future Threats." In M.O. Akoroda and J.M. Teri editors Food Security and Crop Diversification in SADC Countries: the Role of Cassava and Sweetpotato. Ibadan: IITA.

Mahungu, N.M. 1999. "Cassava Germplasm Enhancement in Southern Africa." In M.O. Akoroda and J.M. Teri editors Food Security and Crop Diversification in SADC Countries: the Role of Cassava and Sweetpotato. Ibadan: IITA.

Malambo, Codrine; Chakupurakal, J.; Sakala, M.K.; Kunda, S. and Meelo, M. 1999. "Biological Control as and Integrated Pest Management Strategy Against Cassava Mealybug and Cassava Green Mite in Zambia." in Akoroda and Teri, editors Food Security and Crop Diversification in SADC Countries: The Role of Cassava and Sweetpotato.

Marter, Alan. 1978. "Cassava or Maize: A Comparative Study of the Economics of Production and Market Potential of Cassava and Maize in Zambia." Lusaka: University of Zambia.

Masambu, Hudson. 2002. "Status of Cassava Production in Zambia, February 2002." (mimeo). Lusaka: USAID.

Minde, Isaac Jl; Ewell, Peter T. and Teri, James M. 1999. "Contributions of Cassava and Sweetpotato to Food Security and Poverty Alleviation in the SADC Counties: Current Status and Future Prospects." In M.O. Akoroda and J.M. Teri editors Food Security and Crop Diversification in SADC Countries: the Role of Cassava and Sweetpotato. Ibadan: IITA.

Ministry of Agriculture. 1989. "National Biological Control Programme for the Control of Cassava Mealybug and Cassava Green Mites in Zambia: Progress Report for the Period July 1986 to December 1989." Lusaka: Ministry of Agriculture.

Ministry of Agriculture, Food and Fisheries (MAFF). 2000. "Impact Assessment of Root and Tuber Research in Northern Zambia." Soils and Crops Research Branch, Farming Systems and Social Sciences Division. Chilanga: Mt. Makulu Central Research Station. Phiri, Maziko. 2002. "Cassava Market Assessment and Demand Study – Lusaka." Lusaka: Zambia Agribusiness and Technical Assistance Centre.

Ministry of Agriculture, Food and Fisheries. 2001. "Annual Planning Draft Report, 2000-2001." Farmin Systems and Social Sciences Division.

Ministry of Health. 1999. HIV/AIDS in Zambia: Baseline Projections and Impact Interventions. Lusaka: Ministry of Health.

Moyo, C.C.; Benesi, I.R.M.; and Sandifolo, V.S. 1998. Current Status of Cassavan and Sweetpotato Production and Utilization in Malawi. Lilongwe: Ministry of Agriculture and Irrigation.

Muimba-Kankolongo, A.; Chalwe, A.; Sisupo, P. and Kanga, N.C. 1997. "Distribution, Prevalence and Outlook for Control of Cassava Mosaic Disease in Zambia." Solwezi: Root and Tuber Improvement Programme.

Muimba-Kankolongo, A.; Mahungu, N.M.; Legg, J.P.; Theu, M.P.; Raya, M.D.; Chalwe, A.; Muondo, P.A.; Abu, A.A.; Kaitisha, G. 1999. "Importance of Cassava Mosaic Disease and Intervention Strategies for its Control in Southern Africa." In M.O. Akoroda and J.M. Teri editors Food Security and Crop Diversification in SADC Countries: the Role of Cassava and Sweetpotato. Ibadan: IITA.

Nakhumwa, Candida Kaunda; Phiri, M. Alexander R.; and Chapasuka, Evans. 2001. "Cassava and Sweet Potato Literature for Malawi." Lilongwe: SARRNET.

Ngoma, Harry W.; Miti, F.; and Mbunju, M. 1999. "Multiplication and Distribution of Improved Cassava and Sweetpotato Planting Materials in Zambia." In M.O. Akoroda and J.M. Teri editors Food Security and Crop Diversification in SADC Countries: the Role of Cassava and Sweetpotato. Ibadan: IITA.

Nwekw, Felix I. 2003. "New Challenges in the Cassava Transformation in Nigeria and Ghana," (Conference paper no.8).

Nweke, Felix I.; Spencer, Dunstan S.C. and Lynam, John K. 2002. The Cassava Transformation: Africa's Best-Kept Secret. East Lansing, Michigan: Michigan State University Press.

Ohadike, D. 1981. "The Influenze Pandemic of 1918-19 and the Spread of Cassava Cultivation on the Lower Niger: A Case Study in Historical Linkages." Journal of African History 22:379-391.

Pelletier, David L. and Msukwa, Louis A.H. 1990. "Intervention Planning in Response to Disasters: A Case Study of the Mealy Bug Disaster in Malawi." Cornell Food and Nutrition Policy Program Monograph No.6. Ithaca, New York: Cornell University.

Phiri, Alexander R.; et al. 2001. "Applying a Sub-Sector Analysis Approach to Studying the Marketing of Cassava in Malawi: A Qualitative Assessment of the Subsector." Lilongwe: SARRNET.

Phiri, Maziko. 2002. "Cassava Market Assessment and Demand Study, Lusaka." Lusaka: Zambia Agribusiness Technical Assistance Team.

Pongolani, Catherine and Kalonge, Sylvester. 1999. "Re-Introducing Crop Diversity in Zambia: The Case of Cassava." In M.O. Akoroda and J.M. Teri editors Food Security and Crop Diversification in SADC Countries: the Role of Cassava and Sweetpotato. Ibadan: IITA.

Root and Tuber Team. 1992. "Root and Tuber Improvement Program Annual Report 1992." Mansa: Luapula Regional Research Station.

Root and Tuber Team. 1993. "Root and Tuber Improvement Program Annual Report 1993." Mansa: Luapula Regional Research Station.

Root and Tuber Team. 1995. "Root and Tuber Improvement Program Annual Report 1995." Solwezi: Mutanda Research Station.

Root and Tuber Team. 1996. "Root and Tuber Improvement Program Annual Report 1996." Solwezi: Mutanda Research Station.

Root and Tuber Team. 1998. "Root and Tuber Improvement Program Annual Report 1998." Solwezi: Mutanda Research Station.

Rukandema, Mwita and Bangwe, Lewis. 1990. "Factors Determining Productivity in Traditional Cassava Cultivation in North-Western Zambia." Technical Report No.11 Solwezi: Mutanda Regional Research Station.

Scott, Gregory; Best, Rupert; Rosegrant, Mark and Bokanga, Mpoko. 2000. Roots and Tubers in the Global Food System: A Vision Statement to the Year 2020. Lima: International Potato Center.

Scott, Gregory J.; Rosegrant, Mark W.; and Ringler, Claudia. 2000. "Roots and Tubers for the 21st Century: Trends, Projections and Policy Options." Food, Agriculture and the

Environment Discussion Paper 31. Washington, DC: International Food Policy Research Institute.

Silvestre, P. and Arraudeau, M. 1983. Le manioc. Paris: Etitions Maisonneuve et Larose.

Soenarjo, Roberto. 1988. "Program for Research and Development of Root and Tuber Crops, 1988/89 to 1992/93." Mansa: Luapula Regional Research Station.

Soenarjo, R. 1993. "Research Review of Root and Tuber, 1983 to 1992." Mansa: Luapula Regional Research Station.

Southern African Root Crops Research Network (SARRNET). 1994. "Progress of Multiplication and Distribution of Cassava and Sweetpotato Planting Material in Malawi: Progress Report No.5." Lilongwe: SARRNET.

Taye, Mlulugeta and Biratu, Fsldndir. 1999. "Effect of Storate and Cooking Practices on the Total Cyanide Content of Two Cassava Cultivars." Ethiopian Journal of Science 22(1):55-66.

Tembo, Stephen P.M. and Chitundu, Davies C. 2000. "Applying a Subsector Analysis Approach to Studying the Marketing of Cassava and Sweet Potato in Southern Africa: The Case of Zambia." Lusaka: Southern African Root Crops Research Network.

Tembo, Stephen P.M. and Chitundu, Davies C. 2000. "Applying a Subsector Analysis Approach to Studying the Marketing of Cassava and Sweet Potato in Southern Africa: The Case of Zambia; A Qualitative Assessment of the Sub-Sector Draft Report." Lusaka: Southern African Root Crops Research Network.

Teri, et al. 2000. "Root Crops Revolution in Malawi: Lessons Learned." Lilongwe: Southern African Root Crops Research Network.

van Otterdijk, Robert. 1996. "Baseline Survey: Production and Field Management, Post Harvest and Marketing of Root Crops in Zambia." Mutanda Regional Research Station: Root and Tuper Improvement Programme.

Van Otterdijk, Robert L.M. 1999. "The Importance and otential of Cassva and Sweetpotato for Household Food Security in Rural Zambia." In M.O. Akoroda and J.M. Teri editors Food Security and Crop Diversification in SADC Countries: the Role of Cassava and Sweetpotato. Ibadan: IITA.

Westby, Andrew; Henry, Guy; Porto, Marcio. 2000. "The Global Cassava Development Strategy: Methods, Ownership, Clients and Promotion." paper presented at the Twelfth Symposium of the International Society for Tropical Root Crops, 10-16 September 2000, Tsukuba, Japan.

Westby, Andrew; Henry, Guy; Best, Rupert; Kapinga, Regina; Sourang, Cheikh; Bokanga, Mpoko. 1998. "Progress Towards a Global Strategy for Cassava Development." Tropical Agriculture 75(1/2):111-114.

Wood, Adrian P.; Kean, Stuart A.; Milimo, John Tl; and Warren, Dennis Michael, editors. 1990. The Dynamics of Agricultural Policy Reform in Zambia. Ames, Iowa: Iowa State University Press.

Zulu, Ballard; Nijhoff, J.J.; Jayne, T.S.; and Negassa, Asfaw. 2000. "Is the Glass Half-Empty or Half Full? An Analysis of Agricultural Production Trends in Zambia." Working Paper No.3 Lusaka: Food Security Research Project.