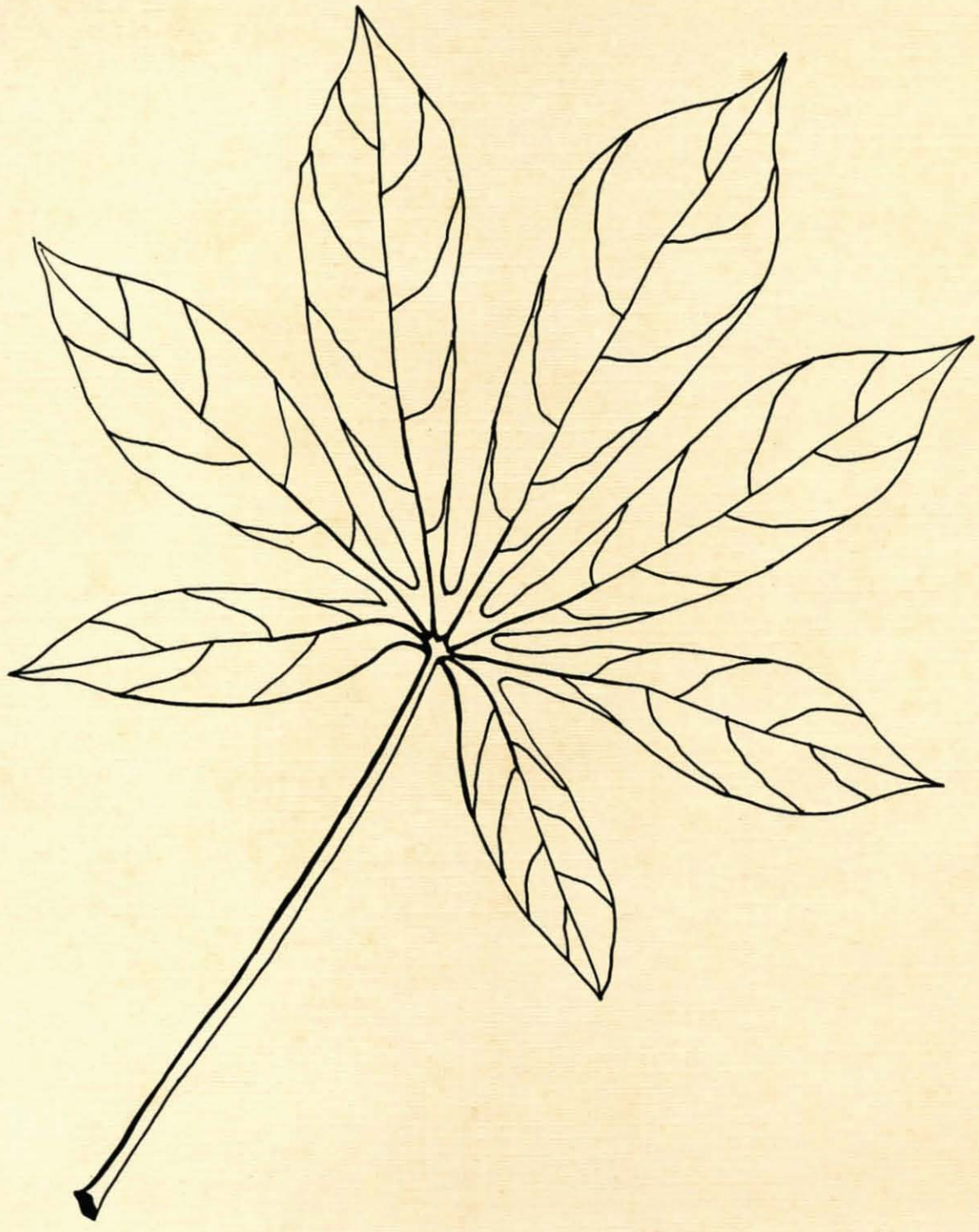
COSCA
Collaborative Study of Cassava in Africa
Working Paper No. 8

8

Socio-economic Aspects of Cassava Cultivation and Use in Africa: Implications for the development of appropriate technology

Sara S. Berry



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PREFACE

THE Collaborative Study of Cassava of Africa (COSCA) is an inter-institutional effort. The aim is to provide baseline information on cassava over a wide area. Such information is needed to improve the relevance and impact of agricultural research on the crop in Africa in order to realize the potential of cassava in increasing food production and the incomes of the people of Africa.

The COSCA working paper series is published informally by COSCA to disseminate its intermediate output. Publications in the series include methodologies for, as well as preliminary results of, the various components and phases of the COSCA surveys. The series is aimed at scientists and researchers working with national agricultural research systems in Africa (NARS), the international research community, policy makers, donors and members of international development agencies that are interested in cassava. As these papers are not in their final form, comments are welcome. Such comments should be addressed to the respective authors or to the COSCA project leader.

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1. Cassava's Role in Achieving Economic Policy Objectives

Since cassava is a major staple food in much of tropical Africa, changes in total output or costs of production could have significant effects on food security and economic development at the national as well as the local level. This section will briefly review cassava's potential in relation to several major policy objectives of African governments — namely: increasing low-cost staple food supplies to urban consumers; guaranteeing a regular source of income as well as cheap carbohydrates to rural households in areas where the crop is already cultivated; and increasing food production and food security in semi-arid areas which are particularly vulnerable to drought.

Urban food supplies

Cassava is a major source of dietary energy for low income consumers in many parts of tropical Africa, including major urban areas (Cock 1985, Phillips 1983, Nweke 1981, Goering 1979). The question is whether, with appropriate changes in technology, policy and price, cassava could play an even greater role in improving urban diets and increasing supplies of low-cost staple foodstuffs to urban consumers. The answer depends on several factors: production costs, marketing costs and the price of cassava relative to prices of other staple foods.

Precise data on labor input and yields of cassava is not always available, but the cultivation of cassava is thought to require less labor per unit of output than most other major African staples (Jones 1959, Cock 1985). Most cassava is processed before it is eaten, however, and processing is laborious and time consuming, sometimes requiring up to five days per batch (see table 1). Processing usually involves some combination of soaking and drying both of which serve to remove most of the cyanide from the cassava roots. Processing costs therefore depend on the availability of processing water, fuel and labor as well as the opportunity cost of labor. In present areas of cassava cultivation, improvements in processing technology could make a substantial contribution to reducing costs, increasing locally produced food supplies, and increasing real incomes for producers and consumers, even without any change in yields.

Table 1. Labor requirements for processing cassava

Gari (21 kg)	7	hours (b)
Flour (20 kg)	8	hours (a)
	6.5	hours (b)
Chickwangue (20 kg)	31	hours (a)

Source: (a) Adam (1980), estimate for flour includes time spent carrying dried cossettes to a mill for crushing.
(b) Oyewole et al. (1986).

In Africa, most cassava is consumed after going through several days of processing which renders the root into a paste, flour or granulated product — convenient to prepare and comparatively easy to store and transport (Cock 1985).[1] Dried cassava chips, also referred to as *cossettes* in Zaire, are an important intermediate product throughout West and Central Africa, where the final consumer grinds or pounds these dried pieces of cassava into flour.

[1] Africans consume at least 80 different processed cassava products (see Ugwu and Ay, COSCA Working Paper No. 6, 1992). Some of the most popular being *gari* (a gelatinized granule which can be reconstituted with hot water into a thick paste or soaked in water and drunk with sugar), fermented and unfermented flours, cassava *fufu* (a fermented paste, which is cooked and eaten with a variety of soups), and chickwangue, a fermented paste which is wrapped in leaves and steamed.

Consumption of fresh cassava is limited by the rapid perishability of the roots which may begin to deteriorate within 36 to 48 hours after harvesting. With present facilities for storage and transport, it is difficult to market cassava any distance from the place where it is grown. Processed cassava, on the other hand, is less bulky to transport and far less perishable than fresh roots. Perhaps for this reason, most cassava is eaten as a processed food product, especially in urban areas, although there are important regional differences in consumption patterns. In Western Kenya, for example, cassava is consumed only as fresh roots.

From a nutritional point of view, cassava's chief advantage is that it is a cheap source of carbohydrate. The roots contain negligible amounts of protein, although, in Central Africa, some protein is derived from cassava leaves which are a popular vegetable (Cock 1985). Other nutrients, such as vitamin C, are normally lost in processing and cooking (Cock 1985, Hahn 1983).

Most of the cassava grown in Africa is classified as *bitter*, containing varying levels of hydrocyanogenic glucosides.[2] The various stages of processing (soaking, fermenting and drying), eliminate most of these toxins, making cassava safe for human consumption (Hahn 1983, Oke 1983). Toxicity is a problem only in regions where cassava makes up the bulk of the diet (Delange and Ahluwalia 1983). It is not clear why African farmers apparently prefer to cultivate bitter cassava, since sweet varieties could also be similarly processed.[3]

Despite consumer preference for processed over fresh cassava, marketing is a major constraint to the expanded use of cassava as a low-cost food in urban areas. This is partly a problem of infrastructure which, in many parts of tropical Africa, has deteriorated in recent years. There is scattered evidence that both the technology and the economic organization of cassava processing and marketing is undergoing rapid changes in areas where overall economic conditions have also been subject to enormous fluctuations. In the urban areas of southern Nigeria, for example, some steps in cassava processing have been mechanized, and commercial transactions are occurring at many stages of production and marketing. (Okuneye and Igben 1981, Phillips 1983, Oyewole et al. 1986, personal observation). Cassava crops are sold in the ground, for example, to buyers who harvest the crop and may process it as well. More information is needed on the changing structure of cassava production and marketing to pinpoint areas of potential improvement.

Would cassava compete effectively with other staple foodstuffs, if costs of processing storage and marketing were reduced? In Africa, unlike parts of Latin America where humans only consume fresh cassava, increased sales do not necessarily depend on changes in the processing technology or the development of alternative uses. In Colombia, for example, farmers located at any distance from market centers could not sell surplus cassava before the introduction of small-scale processing plants, at the village level, to produce cassava chips for animal feed (Lynam 1986, Cock 1985, cf. Phillips 1978, 1983). In Africa, by contrast, there is little evidence that markets for processed cassava for human consumption are near saturation. Income elasticity of demand is thought to be low but positive (Phillips 1983). Moreover, incomes of many African consumers have declined in recent years, due to overall economic stagnation, so that there is no reason to think that economic recovery and expansion would lead to a

[2] The levels of hydrocyanic glucosides (HCN), in fresh cassava varies from one variety to another, however, the composition of the soil also influences the HCN level. Bitter cassava is preferred in many parts of Africa for its taste; because animals do not eat the roots; because it is thought to contain more starch; and because it stores for longer periods after processing.

[3] Explanations range from consumer preference for the taste of sour gari or flour made from bitter roots to the argument that rodents and other animals do not eat the bitter roots in the field. However, little systematic research has been done on the matter.

reduced demand for cassava in the near future. Indeed, the demand for cassava could increase if the present trend to reduce government subsidies for imported cereals continues (Commins and Lofchie 1985).

The possibility that cassava products could be substituted for imported staples, thus saving foreign exchange and reducing the vulnerability of African economies to fluctuation in world market conditions is a point which should be explored. The extent to which such benefits are realized depends, of course, on government policies with respect to trade, foreign exchange rates, and market prices. In Kinshasa, for example, imported rice is cheaper than cassava meal (gari) partly because of high internal transport costs, but also because government subsidizes domestic purchases of imported rice (Tshibaka, personal communication).

Food security in drought-prone regions

Evidence that cassava cultivation has increased in recent years in the savannah and semi-arid areas (e.g., in Tanzania, northern Ghana and Nigeria's middle belt) suggests that it may have an increasingly important role to play as a reliable source of staple food supplies in areas where the risk of drought is high. Cassava's well known tolerance for drought, poor soils, and irregular labor input are clearly advantages in such areas.[4] On the other hand, (excluding sweet cassava) processing cassava requires ample supplies of fresh water, which can constitute a serious constraint, especially in periods of drought. In fact, the need for water to process cassava suggests that developing the crop as a source of food security in semi-arid areas may depend on farmers' willingness to cultivate sweet varieties (low in HCN) or to consume fresh roots rather than processed forms of cassava. Consumption of fresh roots is, however, also likely to be constrained by marketing problems, since fresh roots are highly perishable and therefore difficult to store, as well as bulky to transport. Finally, possibilities of expanding cassava cultivation in semi-arid areas may also be limited by problems of declining soil fertility or pest and disease attack (see pages 8-9).

Rural incomes

In areas where cassava is already cultivated, the crop is important as a source of income (as well as providing household food security) to the large numbers of people who grow, process, and\or market it. The potential for increasing farmers' returns from these activities, or enhancing the relative importance of cassava as a source of increased rural income depends on the possibility of reducing biological and agronomic constraints to increased output and productivity, as well as on expanding sales and\or decreasing the cost of processing and marketing. A further issue of considerable importance is the extent to which changes in techniques or costs of production are compatible with cassava's present role as an instrument of income stabilization in rapidly changing environmental and economic conditions.

Production constraints. Compared to other tropical root crops and many cereals, cassava is relatively tolerant to drought and poor soils (Cock 1985, Onwueme 1978). The roots also can survive underground for anywhere from nine to twenty-four months or more after bulking (Onwueme 1978, Goering 1979). Thus, small amounts of cassava can be harvested as needed for home consumption, and are often available when other crops have declined due to drought. In areas of deteriorating soil fertility, cassava has been substituted for other crops both to maintain total output of staple foodstuffs, and to reduce seasonal fluctuations in food supply (Fresco, forthcoming; Jones and Egli 1984, Newbury 1984, Ruthenberg 1980). However, the increasing reliance on cassava to offset effects of drought and\or declining soil fertility may

[4] I owe much of my understanding of the labor requirements of cassava cultivation and the effects on output and yield of different patterns of labor input to Louise Fresco. I am of course responsible for any errors in the interpretation of her work.

have adverse environmental consequences in the long run. The role of cassava in creating sustainable cropping systems (to counteract declining soil fertility) or in intensifying cultivation (to cope with increasing population density) varies in both the ecological and socio-economic context. These points will be elaborated in Section 3 below.

Household food security. Much has been made of cassava's role in guaranteeing food security — especially in subsistence, i.e., self-sufficient rural households (Hahn 1983, USDA 1981). In fact, cassava is also an important source of cash income for poor farmers, as well as prosperous ones. There are no reliable aggregate data on the total quantity of cassava sold in most African countries, but micro-level evidence indicates that even very poor farmers often sell a significant proportion of their crop. Women farmers in southern Zaire sold 20-40 per cent of their cassava (Fresco 1982). In the more prosperous rural economy of southwestern Nigeria, sales ranged from two-thirds to 90 per cent of women's cassava output (Spiro 1980). In addition, in Nigeria, Zaire, and elsewhere, there are both large- and small-scale farms on which cassava is grown entirely for sale, by both full- and part-time farmers (Okuneye and Igben 1981, Adam 1980, Kayser et al. 1981).

Both large- and small-scale farmers often sell a higher proportion of their cassava than other crops and\or derive more cash income from cassava than from any other crop or income-earning activity (Adam 1980, Fresco 1982 and forthcoming, Strauss 1983). This fact, together with the likelihood that income-elasticity of demand is positive in major consuming regions, suggests that increased production could contribute significantly to raising total income from agriculture, even in areas where the crop is already widely cultivated. Income is likely to increase, especially if production expands as a result of increases in yield per hectare and the adoption of cultural practices which sustain soil fertility over time, without relying on purchased inputs such as fertilizer.

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

In southeastern Nigeria, for example, during the 1920s and 1930s, men withdrew from yam production to concentrate on palm oil, leaving the women to maintain local food supplies by increasing production of 'their' crop — cassava. As regional markets for cassava expanded, however, young men began to engage in cassava processing, in order to capture some of the profits to be made in local markets (Martin 1984). More recently, the emergence of large-scale cassava farming in Nigeria and Zaire raises questions about the future trends in control over income from cassava. As a famine reserve crop, cassava can mitigate the human and economic costs of drought or of economic crises. However, cassava's resistance to drought and its in-ground, self-storing capability can, ironically, also contribute to rural impoverishment and\or environmental degradation. Cultivation of cassava is not invariably beneficial to the poor.

Deteriorating economic conditions. In the last ten to fifteen years, African economies have faced deteriorating and highly volatile economic conditions. Farmers' energies and resources have been increasingly stretched to make *ends meet* in the face of rapid and unpredictable changes in income and the costs of living. In this context, it is especially important that cassava's tolerance for drought, poor

soils, and low labor input, together with its self-storing capacity, not only make it an important source of food security for farmers, but also contribute to income stability. This is so for several reasons:

a. Cassava may be harvested and sold in small amounts at frequent intervals. Compared to other crops which must be harvested in a short period of time and either sold, when supplies are plentiful and prices low, or stored, with the risk of spoilage, pest damage, etc., cassava can provide a steady flow of cash income over many months. This characteristic of cassava can serve to raise farmers' real income by reducing the costs of financing household expenditures in the face of seasonal fluctuations in income and cash flow. Even in low-income households, the 'daily' income from cassava obviates the need to borrow to buy basic consumer items, such as soap, matches, kerosine, cooking oil, or condiments (Fresco 1982, Newbury 1984).

b. The fact that cassava can be harvested piecemeal also means that it is relatively easy to combine with domestic chores and other income-earning activities on a daily or weekly basis. This is an advantage, especially for rural women, who may find it difficult to specialize, even temporarily, in harvesting, processing, and\or marketing a single crop, and who lack the working capital or social position to mobilize the labor of others (Guyer 1980). In more formal economic terms, the opportunity cost of rural women's labor is partly a function of the timing of tasks to be performed. Work which can be performed a few hours at a time on a regular basis is likely to be easier to combine with other domestic, social, and income-generating tasks — and is, therefore, cheaper in terms of opportunities foregone — than work which must displace other tasks (Okali and Berry 1985).

   The importance which African farmers attach to a regular, if low, income flow is underscored by the evidence that they often choose techniques of cultivation which prolong the 'harvest life' of a cassava field, even at some sacrifice of yield. In Nigeria, farmers intercrop early and late maturing varieties of cassava on the same plot for this reason — even though traditional, late maturing varieties may have lower overall yields than improved, early maturing varieties (Hershey 1986). In the Kwango-Kwilu region of Zaire, women faced with declining real income have spread cassava planting over longer periods of time in order to lengthen the period of potential harvest. This often means planting either at the end of the rainy season or well before the end of the dry season, both of which may deprive stakes of adequate moisture at the time of sprouting and thus reduce overall yield (Fresco, forthcoming; IITA 1983, 1984; Ezeilo 1979; Toro and Atlee 1980; Ezumah and Okigbo 1980).

c. Cassava may be harvested and sold in bulk to take advantage of favorable prices or provide producers with liquidity to finance lumpy consumption or investment outlays. The in-ground, self-storing capacity of cassava permits flexibility in harvesting and marketing which can be advantageous to specialized, fully commercial producers, as well as to smaller, diversified, and\or partially commercialized ones.[5] In Nigeria, for example, in the mid-80s, rising food crop prices and the oil recession reduced economic opportunities outside of agriculture, and many people (including wage

[5] It has been suggested that cassava discourages saving, since piecemeal harvesting tends to produce low and regular rather than lumpy increments to income. This statement is not supported by the facts: cassava can be harvested at once and sold in bulk when prices are advantageous; it appears, therefore, that farmers use cassava's in-ground storability to take advantage of supply and demand situations in the market. As a source of cheap food, cassava can also contribute to higher aggregate rates of saving by keeping down real wages and raising profits of enterprises which hire labor. It is the low profit margin under which most farmers operate, not cassava which limits the farmers ability to save and invest.

and salary earners, professionals, traders, etc.) established cassava farms. Such investors used working capital from other sources to hire labor for land preparation, planting, and initial weeding; then sold the crop in the ground to buyers who assumed full responsibility for further weeding, harvest and sale. Buyers might, in turn, sell the tubers to processors in rural areas, transport them directly to urban markets, or undertake to process and market the final product themselves.

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

2. Cassava and the African Agrarian Crisis

Current literature on the state of economic development in Africa often takes the view that government policies, combined with the global economic recession, have created adverse conditions for agricultural growth and rural development, especially in the post-independence era of the late sixties and early seventies. Overemphasis was placed on the industrial sector and protection of urban consumers at the expense of agricultural production. The rural areas were largely ignored, in terms of infrastructure, inputs and new technology. In the 1960s, staple foodstuffs, often highly subsidized by the exporting governments, were readily available on world markets as 'food aid' at low prices. This meant that African governments were able to increase staple food imports, without incurring large balance of payments deficits or domestic food shortages. In the 1970s, however, world market conditions, especially the huge increase in oil prices, dramatically worsened the economies of many African economies, with the small exception of the major petroleum exporters.[6] Import bills for fuel and other staple foodstuffs soared. At the same time, protectionism practiced by developed countries, increased competition from new suppliers, and adverse terms of trade placed severe limits on the ability of developing countries to expand export earnings. Consequently, foreign debts rose and credit tightened. To cope, African governments resorted to controls on foreign exchange transactions, and domestic prices which often aggravated the balance of payments deficits, promoted rent-seeking activities and further depressed incentives for domestic agriculture. The result was increased dependence on food imports and aid, both to offset declining domestic output (or output per capita) and to cope with non-economic crises, such as the droughts of 1968-73 and 1982-84, the disruptions of war, etc. (Commins and Lofchie 1985, World Bank 1981, 1984).

In the case of cassava, the effects of the agrarian crisis are hard to document[7] but important to trace, none the less. The declining terms of trade for agriculture, led in many cases to rural-urban migration, especially of young men in pursuit of more profitable economic activities. Lack of male farm labor could have resulted in the substitution of cassava (a women's crop), for other crops which require more labor input. Growing more cassava would have promoted household food security and generated a regular if low, year-round source of income.

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[6] However, even this advantage was shortlived, as prices fell before the end of the decade. The major oil exporting countries from sub-Saharan Africa include: Nigeria, Gabon and Angola.

[7] Since 'there have been no clear trends in terms of increased yields . . . the bulk of the expansion has come from increasing the land designated for cassava production. . . .' (Phillips 1983). Case studies discussed below suggest that this has been true in some areas. The poor quality of aggregate data on cassava production makes it difficult to generalize for entire countries, let alone Africa as a whole.

Since the mid-eighties, continuing economic decline and instability have apparently induced people to return to food production (often on a part-time basis) to supplement declining income from other sources. Patterns range from the reported recent upsurge of local self-sufficiency in Ghana, for example (Chazan 1984), to elite[8] investment in food crop production in Nigeria (Lawson 1977), Ghana (Shepherd 1981), Zaire (Kayser et al. 1981), and elsewhere. Evidence from such sources is not sufficient to warrant generalizations about increased production of cassava, however, it does imply (contrary to popular expectations) that production of all food crops has *not* invariably declined or stagnated in recent years. In some regions, it appears that the output of cassava may, in fact, have remained constant or even increased.

Unfortunately, it is difficult to document trends in output or yield. Aggregate production data for cassava in Africa are, in the words of one senior economist at USDA, 'horrible'. Yields of cassava are difficult to measure accurately, given the farmers' practice of harvesting little by little, and published data rarely state the method of measurement used (Fresco, forthcoming; World Bank 1985a). Moreover, even if reliable data on yield were available from sample surveys, accurate aggregation depends on the availability of reliable census data on the acres planted, or on the number of farmers and size distribution of farms. In practice, few African governments have the resources to carry out a comprehensive agricultural census, let alone update it at regular intervals. The alternative is to deduce production from estimates of per capita consumption, multiplied by population. Apart from the obvious disadvantage of assuming that consumption needs are met over time, such figures may also be based on inaccurate estimates of consumption and/or population census data.

Given these problems, it is not surprising that production data are inconsistent. Different sources may give quite different figures for the same country. For both Nigeria and Cameroon, the FAO not only gives different levels of cassava output from those provided by national sources, but also shows different trends over time. In Nigeria, the Federal Office of Statistics is the only source to use data from field surveys, but their figures are considered low, even by the Nigerian Central Bank. The Bank has adjusted the FOS data upward, to take account of 'commercial' farms and of unpublished information supplied by agents of the Federal Department of Agriculture. These figures have been criticized, in turn, by the FAO and the USDA, both of which derive their production figures from estimates of per capita consumption, which range from 75 to 386 kg. However, as population censuses in Nigeria have been the subject of intense political conflict since independence, it is not clear how much confidence can be attached to these figures either.

The World Bank (1985a: 9) notes that the 'regularity' of annual increases reported by FAO and USDA 'suggests that in lieu of reliable short-term food production indicators, those agencies may have resorted systematically to simple projections based on an assumed fixed relationship between the growth of population and the growth of production . . .'. However, 'there is also inconsistency between production series provided by the same agency.' The Bank report (1985a), concludes that 'measurement problems undoubtedly explain much of this discrepancy. What is not explained is why these institutions do not attempt to reconcile their production series.' While 'the chaos that exists in Nigerian production statistics' is perhaps exceptional, it is extremely difficult to judge from available data whether African production has risen, declined or remained relatively stable during the last ten or fifteen years.

In view of the uncertainty surrounding aggregate data, it is apparent that more could be learned about trends in cassava production and their implications for the development of appropriate technology from case studies than from post-mortem examinations of aggregate data. Case studies show variations both in

[8] *elite* is used here colloquially to represent *upper class, wealthy entrepreneurs.*

trend, from one area to another, and in the factors which give rise to similar trends in different areas. Performance and conditions of production vary among national economies and categories of producers, as well as among microenvironments.

3. Case Studies: Trends and Issues

Declining yields

Cassava yields are declining in many areas in Africa, but not everywhere for the same reasons. The International Institute of Tropical Agriculture (IITA 1983, 1984) has reported the increasing incidence of damage due to pests and diseases. In the 1970s, research focussed on developing high yielding varieties of cassava which were resistant to the most common diseases — bacterial blight and cassava mosaic virus. Recently, attention has turned to the damage caused by the introduction of new pests — cassava mealybug and green spider mite — into tropical Africa from other parts of the world, and to the development of biological methods of control.

It is beyond the scope of this paper to review the biological aspects of pest and disease control. The point to be emphasized here is that the damage inflicted by pests and diseases can be reduced — or aggravated — by changing the methods of cultivation which may, in turn, be affected by socio-economic factors unrelated to pest and disease control per se. The issue of declining yields raises questions on the degree to which the negative effects of existing cultivation methods on soil fertility or pest and disease incidence constrain increased cassava production. What, in other words, are the possibilities for increasing the output of cassava in the context of sustainable cropping systems? Within that framework, the effects of pest and insect damage must be studied in the context of the agronomic and socio-economic factors, which taken together, will affect the total output.

Rural impoverishment and declining population density

The agrarian crisis has certainly caused or prolonged the impoverishment of some rural areas, often increasing rates of rural emigration by people seeking alternative sources of income. Since labor is a major — sometimes the only — variable input in most African farming systems, an increase in rural emigration will create problems of adjustment for those who remain in farming. Rural emigrants are often preponderantly young men, who are likely to have performed the heaviest agricultural tasks (e.g., land preparation) even in societies where most farming tasks were traditionally performed by women. Thus, women are compelled to work harder, not to maintain previous levels of agricultural output, but merely to sustain the reduced population in the emigrants' households and communities. In some cases, these women also supply foodstuffs to their emigrant husbands and sons thus increasing the burden of their labor.

Emigrants' remittances can, of course, compensate for the withdrawal of their labor from agricultural production, however this scenario does not always work out in practice, because remittances are low and because the farmers have very limited access to hired labor or purchased inputs. In addition, these remittances are often invested in increasing the rural dwellers' ability to participate in labor outmigration itself, rather than in maintaining or expanding agricultural output in their home areas (see, e.g., Weigel 1982).

The effects of rural impoverishment and male outmigration on cassava production methods and yields have been analyzed by Louise Fresco for the Kwango-Kwilu region of Zaire.[9] Fresco describes a rural

[9] The following discussion is based primarily on two draft chapters from Fresco's forthcoming book on cassava.

economy in which women farmers have been struggling to maintain household incomes and food supplies in the face of declining male labor input, without access to working capital, except what they can generate from their own productive activities. In the absence of male labor, women have: (1) reduced fallow periods (to save labor needed to clear dense regrowth on long fallow plots); (2) increased reliance on burning to clear land and control weed growth; (3) established fields on savannah plateaux (where vegetation is much easier to clear than on forest fields) with poor soils, often located at some distance from farmers' homesteads.[10] All of these measures contribute to soil erosion and to lower yields (of all crops). Since women are not able to weed as frequently as in the past, especially on distant savannah fields, competition from weeds has further reduced yields.

To compensate for declining yields, farmers have made further adjustments in cultivation patterns which have also contributed to subsequent declines in yield. These include (1) substitution of cassava for other crops, (2) a switch to cassava monocropping on distant savannah fields; (3) less frequent or less careful performance of farming tasks — including selection and preparation of planting material, positioning of stakes when planting, weeding, mulching, ridging; and staggered times of planting. Cassava monocropping, careless planting, poor stake selection, and reduced weeding all tend to aggravate the incidence of pests and diseases — in part by promoting poor canopy growth, which also increases weed growth. Reduced fallow periods can have the same effect, especially when old cassava stems are left in a 'fallow' field, where they transmit pests and diseases to the next generation of plants, and may also delay regeneration of other plants which contribute to restoring soil fertility.

Staggered planting can also aggravate problems of yield decline and infestation by pests and diseases. Newly planted cassava stakes need adequate moisture to establish, although once cassava germinates it is relatively drought resistant. Cassava planted too far in advance of the rainy season may not receive adequate moisture in the first few weeks; likewise, stakes planted close to the end of the rainy season may suffer from the same problem if the rains stop abruptly and the soil dries out quickly (IITA, 1983, 1984).

An additional fundamental reason farmers give for stretching cassava planting into both ends of the dry season is not to save male labor or even to offset declining yields by bringing more land under cultivation, but rather to try to maintain household food security in the face of declining incomes. By staggering planting times, farmers hope to lengthen the period when something can be harvested from a cultivated field — to shorten the 'hungry season' at one end, and to provide a continued source of regular food supply for home consumption or sale after other crops have been eaten or sold. This particular example illustrates the fact that changes in general economic conditions can be as important as population movements or environmental change for farmers' choice of cultivation methods. It also underscores the point that the timing of output and income flows can be as important as their level for farmers' (and rural households') standards of living.[11]

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[10] Forested valley land was becoming increasingly scarce, but women responded by establishing savannah fields with cassava as a monocrop, rather than by intensifying cultivation on valley plots. Savannah fields themselves required less labor and yielded less output per cultivated hectare than forest fields. However, when time spent walking to and from the fields is included, total labor expended on the cultivation of savannah fields could be greater, relative to output.

[11] In Kwango-Kwilu, the effects of declining yield described here were exacerbated by developments specific to Zaire—e.g., the government rural development program known as *cultures imposées* and the increased scarcity of forested valley land for farming. None the less, the case illustrates clearly the implications of rural impoverishment and labor outmigration (which have characterized many other rural areas in Africa) for methods of cultivating cassava and yields achieved (Fresco 1982, 1983; Newbury 1984).

Land scarcity and rural population growth

Declining yields, in association with reduced fallow periods, have also occurred in the context of increasing rural population density and land shortage. In such cases, the implications of decreasing yield for cultivation practices and for income and food security of rural households are different from those at Kwango-Kwilu, where reduced fallow periods on savannah fields are essentially caused by shortages of labor. If increasing scarcity of cultivable land reduces the length of fallow, farmers are likely to make efforts to *intensify* methods of cultivation — in the sense of applying more labor time per unit of land — rather than, as in Kwango-Kwilu, bringing more land under cultivation. Farmers' ability to increase yields through intensification depends in part on their access to additional, improved inputs and\or the means to buy them. However, there may also be some room for adjustment in traditional farming methods, without additional inputs. In southern Congo and the Central African Republic, farmers adjusted to major fluctuations in market conditions without significant changes in the level or methods of production, basically by adjusting quantities of female labor input (Adam 1980. Fresco, personal communication).

A classic demonstration of the effects of rural population density on farming methods is Lagemann's (1977) monograph on traditional farming in southeastern Nigeria. Lagemann compared three villages, of varying population densities, and three field types located at different distances from farmers' homesteads within each village. The field types were distant fields, nearby fields, and compound gardens. In general, higher population density was directly associated with shorter fallow periods, more intensive methods of cultivation, and lower yields of cassava. The reasons for reduced fallow periods and cassava yields were, however, different from the case of Kwango-Kwilu. In Kwango-Kwilu, shorter fallow periods and declining cassava yields resulted from increased monocropping of cassava, increased cultivation of savannah fields, and declines in quality of land preparation and quantity of weeding and mulching — all designed to stretch scarce labor over larger areas and to compensate for declining soil fertility by substituting cassava for other crops.

In Lagemann's study, by contrast, farmers compensated for land scarcity by intensifying intercropping and devoting more energy to gardens within their compounds. The latter are characterized by the dense planting of a great variety of crops: to produce a multi-storied leaf area and root system; to preserve moisture and soil fertility; to increase nutrient uptake from different soil depths by careful mulching and manuring. One similarity with Fresco's study area was that the planting of cassava was staggered on distant fields — in this case, to spread labor requirements evenly over the year. Lagemann does not discuss the effect of staggered planting on yield. In the densely populated village, outer fields were also mulched and manured, and farmers used dense intercropping — including tree crops in order to check soil erosion and suppress weeds.

Thus, while yields of cassava on the outer fields decline as one moves from the low to the high density village, total yields of all crops increase (Lagemann 1977: 63-64). In addition to intercropping and intensification, farmers in the high density village also sought to compensate for land scarcity by substituting crops which have a higher market value, such as yam and oil palm, for cassava, within intercropping systems. Income per hectare increases even more than total yield as one compares less with more densely populated villages.

Lagemann argues that his findings support Ruthenberg's (1980) thesis that intensification of traditional farming systems postpones, but does not avert involution and eventual impoverishment due to population growth. However, he does not place the Igbo farming system in a wider economic context, or relate land scarcity to the availability of capital in farming or to people's overall capacity to generate income. Lagemann did his fieldwork in 1973-74, when southeastern Nigeria was still recovering from the civil war and many people still depended heavily on farming for the bulk of their income. Ten years later, U. Latzke Begemann (1985), found that methods of cultivation and yields of compound gardens were much

the same, but that the practice of compound gardening itself had declined since the days of the war, when it was a major source of food security for rural households in the besieged Biafran economy. In other words, intensification of cultivation methods in southeastern Nigeria occurred as much in response to commercialization and civil war, as to changes in the relative rural factor supplies.

A rapid survey of local farming systems in the densely populated highlands of East Central Africa (Jones and Egli 1984) also found enormous variation in both the importance and yields of cassava from one locality to another. Cassava accounted for half the staple food output in some localities, but was not grown at all in others, while yields ranged from 0.6 to 12 tons\ha. Even allowing for the problems of measurement of cassava yields (noted above), these studies indicate that the place of cassava in intensive farming systems varies too much to permit generalizations about the effects of increasing population density on yields or methods of cultivation. Indeed, there is no clear evidence that increasing population density leads to an overall decline in yield (Richards 1985). What is clear is that the *flexibility* of traditional farming systems is a fundamental feature which allows farmers to survive in the face of overcrowding, erratic and/or low income as well as outmigration. Intercropping and the rearrangement of field types are key elements in the flexibility of the traditional farming systems; availability of labor and the timing of inputs and outputs have been important constraints on successful adaptation to a variety of conditions.

Commercialization

Cassava production has frequently increased where market access has improved. Commercialization can, also affect access to inputs, and the capacity to adjust to other changes. There are several patterns described in the literature.

1. *Cash cropping and cassava production*

In some areas, farmers have increased the production of cassava relative to other food crops to release labor (especially male), for cash cropping. As we have seen, the growth of palm oil production in the Ngwa area of southeastern Nigeria in the 1920s and 1930s absorbed male labor, leaving food crop production increasingly to women. It is interesting to note, however, that while Ibibio farmers used part of their proceeds from palm oil to buy food, Ngwa men spent theirs on more wives to grow it (Martin 1984). As in Kwango-Kwilu, women switched to cassava to maintain output by cultivating more land. In this case, however, the growth of towns and rural incomes throughout the region also created a greater demand for staple foodstuffs. This, in turn, attracted young men into cassava processing, enabling them to capture part of the profits from the growing demand for gari.

Similarly, in eastern Zaire, the incorporation of the Tembo area into the colonial economy led to the introduction of peanuts as a major cash crop and the substitution of cassava for plantain as the principal staple. Women would plant cassava on their husbands' peanut plots, and do all the work of cultivating, processing and transporting it to market. They would also do much of the work of peanut cultivation. However, men control the income from peanuts and claim certain rights over the income from the cassava their wives produce (Newbury 1984: 38).

In both cases, expansion of agricultural production for the market was achieved primarily through changes in crops grown and in the division of labor between men and women. The number of tasks women performed increased, while men controlled the bulk of cash earnings from crop sales. As these examples suggest, control over income and the allocation of tasks can have an important bearing on changes in agricultural production patterns and on farmers' responses to new techniques.

2. *Declining opportunities for non-agricultural employment and cassava production*
Declining opportunities to earn income outside agriculture have pushed people into growing more food crops, especially cassava. In southwestern Nigeria, Yoruba women have traditionally specialized in trade and food processing, rather than farming (though wives and daughters do work on the farms of their husbands and fathers). In the last decade, however, there have been increasing reports of Yoruba women farming on their own account (Spiro 1980). In part, this has been a response to increased competition in trade and processing from larger, often male-dominated businesses (Cashman 1986, personal communication); and in part, a result of the oil recession which reduced opportunities for income and employment in non-agricultural sectors of the economy. Women have not been the only people moving into farming in the 1980s. Men have also invested in cassava production, contributing to the temporary glut in cassava markets observed in 1985-86 in Nigeria (World Bank, 1985a).

The choice of cultivation methods depends partly on the farmers' access to working capital (to hire labor or purchase inputs) and partly on cropping patterns (Ashraf nd, Palada et al. 1985). Similar mechanisms may account for reported increases in domestic food crop production in Ghana, where economic collapse and virtual bankruptcy of the public sector in the 1970s and early 1980s led to widespread decentralization, and an increasing emphasis on self-sufficiency (Chazan 1984, Posnansky 1981).

3. *Large-scale commercialized farms*
In recent years, high prices for food crops in Nigeria and Zaire have led to the establishment of large-scale, fully commercialized farms. These large farms are generally set up by people who have access to government credit, subsidized inputs and\or foreign exchange (IITA 1983, 1984; Okuneye and Igben 1981; Kayser et al. 1981). Such enterprises often use mechanized tractors and purchased inputs, such as fertilizers and pesticides, and may devote large areas to the specialized production of a single crop. Since they can afford to hire labor, such farms do not always use capital-intensive methods of cultivation. For example, large-scale cassava growers in western Nigeria intercrop maize with cassava; the maize is harvested and sold after two to three months and part of the income so generated is used to pay for the labor needed for cassava planting and weeding (Ashraf nd, Palada et al. 1985, personal observation). Specialized, large-scale commercial farms face entirely different constraints from those confronting the majority of small-scale, low-income farmers, and each group of farmers is likely to respond very differently to new technology. In western Nigeria, for example, commercial farms have made up a large part of the clientele for IITA's improved cassava varieties. Large-scale farmers also benefit from the flexibility of harvest time allowed by cassava, and may continue to plant traditional varieties, or intercrop them with improved varieties, to lengthen the harvest life of a farm, much as small-scale farmers do.[12]

Commercial cassava production in Nigeria has also entailed changes in contractual arrangements and market structures. People who plant cassava as a commercial investment often sell the crop in the ground (after it has been established) to buyers who assume the risks and costs of managing the farm, and of harvesting and marketing the tubers. Similarly, as some steps in the processing of cassava have become mechanized, new possibilities have emerged for subcontracting or for other commercial transactions at the different stages of processing and marketing the final product (Okuneye and Igben 1981, Oyewole et al. 1986, personal observation). The changing structure of the cassava 'industry' in southern Nigeria has

[12] There is considerable confusion over the 'harvest life' of early and late maturing varieties of cassava. For example, during a visit to IITA in March 1986, I was told by farmers planting IITA improved variety 30572 that it matured earlier than traditional varieties, but deteriorated underground after about 12 months.

not been systematically studied, but it is clear that in this area at least, cassava can no longer be classified as a 'subsistence' crop.

On the whole, the documentation on the effects of commercialization is even more scanty than statistics on the effects of increasing population density or rural outmigration and impoverishment. Research is needed to clarify the implications of commercialization for changing cultivation methods and yields, as well as for the distribution of income from cassava production, processing, and marketing. At present, there is evidence of divergent patterns of change, and the accompanying instability of economic, technical, and environmental conditions. For farmers, this places a premium on flexibility and access to mechanisms of insurance procedures to avoid situations of food/income scarcity. Farmers frequently adjust crops grown, methods of cultivation, combinations of agricultural and non-agricultural income, and asset management to protect themselves against (or take advantage of) unstable conditions. Increased cultivation of cassava is one such strategy which, like others, carries its own risks. Making sure there is adequate household income and food security is an important consideration to farmers before adopting new techniques or responding to agricultural policy.

4. Research Agenda

Policy objectives

Each of the broad policy objectives outlined at the beginning of this paper raises different issues for research.

1. To increase cassava's role as a source of cheap urban food supply, we need better information on existing marketing and processing systems. Alternative processing technologies already exist, in Asia and Latin America, as well as in Africa. The problem is not so much how to adapt these to local factor supply conditions in specific African rural economies, but to gain a better understanding of patterns of urban demand, marketing costs, linkages between urban sales and changes in rural production and consumption, and the structure of cassava production and marketing. For example, rapid increases in urban sales need not come primarily from very large farms.

Questions for further research include: How have sales and prices changed with changing market conditions? Who participates in cultivation, processing and marketing? At what points in the chain of activities between planting and final consumption does the crop change hands? What are the patterns of competition, vertical or horizontal integration, and specialization at different stages in the production and distribution process? As we have seen, the answers to these questions are likely to be quite different in, e.g., southern Nigerian or Ivory Coast, from those in south central Zaire, Tanzania or Mozambique — with different implications for appropriate technical and policy interventions.

It is also important to clarify the nature and effects of government policies on cassava production and marketing. If the present contribution of cassava to urban food supplies and potential for import substitution are constrained by government policies towards prices and foreign trade, then the best designed improvements in infrastructure or in technology may have little actual impact on the level or distribution of staple food items or of consumers' real incomes.

2. To assess cassava's potential for increasing food production and food security in semi-arid areas, it is important to know how far the advantages of cassava's tolerance of drought, poor soils, and irregular labor input may be outweighed by the difficulties of incorporating cassava into sustainable cropping systems in specific agro-economic regions and\or by the fact that processing is dependent on availability of water. The importance of water for processing is potentially a serious constraint for increased reliance on cassava both as a source of local food security in times of drought, and as a source of steady real

income for rural households. In areas where water is available for only a few months out of the year, the possibility of relying on piecemeal harvesting and processing of cassava to even out seasonal variations in income and food supply may be significantly reduced.

Apart from ecological constraints on increasing production, developing cassava as a source of food security in semi-arid and\or drought-prone areas may depend in part on people's willingness to grow and consume fresh roots of cassava varieties which are low in HCN. This does not imply that research should focus immediately on extending the shelf-life of fresh roots or breeding new low cyanide varieties. Before it will be possible to evaluate such research objectives, it is necessary to learn more about why farmers prefer to grow bitter cassava, and how cassava is being integrated into low rainfall farming systems (e.g., in Tanzania), and the consequences for yields, soil fertility, cropping patterns and cultivation practices.

3. Enhancing cassava's importance as a source of rural income, in cash or in kind, depends on a number of factors. Cassava does not present such an obvious potential for a major technological breakthrough, as was experienced in the development of high yielding varieties of wheat and rice. Rather, improvements in income derived from cassava are likely to occur through complex interactions through minor changes in cultivation practices and economic conditions, which will vary from one locality to another. Thus, research will have to pursue many issues simultaneously, and focus as much on interactions among technical, ecological, and socio-economic conditions, as on defining single research objectives and strategies.

For farmers, maintaining or increasing net income from cassava depends on the timing and opportunity cost of labor and other inputs, as well as on unit costs, selling price, and market access. Where producers are coping with declining incomes, adverse terms of trade, or decreasing availability of labor, it may be necessary to raise income as a precondition for the adoption of improved inputs and cultivation practices. This may depend, in turn, on possibilities of raising yields under conditions of intercropping, staggered planting, declining fallow, limited weeding, and of reducing the labor required for cultivation and processing. In some areas, there may be greater scope for raising cassava-based incomes through improvements in cultivation and farm management practices than through the development of new varieties or the adoption of new inputs.

Whatever the initial conditions affecting the response of African farmers to improved techniques in a given area, they are likely to change before appropriate technical improvements can be developed and disseminated. Hence, another essential condition for successful dissemination of improved technology is that it does not compromise the flexibility permitted by traditional cassava varieties and cultivation practices for coping with changing market and\or environmental conditions.

Such flexibility often hinges on the sensitivity of cassava yields to the timing of inputs and\or diversification of farm output (e.g., through intercropping); on the 'harvest life' of a cassava farm (i.e., the period of time over which it is possible to harvest some roots); and on the cost of processing, storage, and transport. To define and develop improved technology and effective policy interventions, it is necessary to have a clear understanding of (a) cassava's role in developing sustainable cropping systems, which do not reduce soil fertility or intensify pest and disease incidence over time; (b) the degree to which present cultivation practices and methods of farm management constrain increased output and incomes; (c) the relative importance of production, processing and marketing in determining the incomes and opportunities available to low income people in rural areas.

Finally, as we have seen, labor is often a key constraint in both densely and sparsely populated areas. Technical improvements which save labor during cultivation and processing, or increase returns to labor currently employed, will tend to increase farmers' capacity to earn income from cassava and to reduce the cost of production. However, labor-saving innovations also have a price and their costs must be

carefully weighed against farmers' resources, especially access to working capital, and alternative demands on their time. Lower overall input of labor may not help if the timing of labor inputs to cassava cultivation or processing conflicts with domestic obligations or other productive activities.

5. Research Strategies

Increasing cassava's contributions to food security, economic development and raising the incomes of poor people in Africa is likely to require changes on several fronts — cultivation practices, farm management systems, processing, marketing, infrastructural facilities — as well as (or instead of) the development and dissemination of improved plant varieties and new input packages. As we have seen, there are major gaps in knowledge on many fronts. To build a more effective knowledge base from which to design strategies of intervention, it may be necessary to use more than one frame of reference for posing research questions and collecting evidence. Specifically, it seems advisable to begin by studying variations in cassava cultivation and use, not only in different agro-ecological zones, but also in different socio-economic contexts.

To this end, it will be necessary to describe and classify different agro-ecological zones in which cassava is grown in Africa, and to accumulate systematic evidence on variations in cultivation practices, cropping systems, and ecological change among them. Such an effort could begin with a thorough review of existing literature and environmental data as well as the strategy for adding to them. Existing data are, in turn, likely to be located in national archives or institutes within Africa and\or in former colonial powers.

However, it is important not to assume that a program of research based on geographical criteria will necessarily answer all the relevant questions. If, for example, policies or marketing systems are not conducive to increased sales, or if farmers' main concern is with higher yields, then improved technologies may have little impact on actual output and incomes, no matter how carefully they are tailored to environmental conditions. In other words, research on cassava's place in existing agricultural and economic systems should seek to illuminate the intersections between environmental and socio-economic conditions — and not simply assume that one or the other is determinant.

As we have seen, it is important to understand cassava's role in relation to variations in both environmental and socio-economic conditions. Also, given the volatility of both socio-economic and environmental conditions in Africa, it is important both to define contexts of study in dynamic rather than static terms and to design research programs which collect data on changing patterns of cassava cultivation and use. To this end it is important to supplement large surveys with detailed case studies of changing practices in different contexts. Such case studies should treat production, processing, and marketing as interrelated parts of local food supply systems. They should also reflect regional differences in income and use, such as the difference between densely populated, relatively commercialized areas (such as southern Nigeria or Ivory Coast); in areas of long-term rural impoverishment (such as central and southern Zaire); and in semi-arid areas where cassava is a recent introduction (as in parts of Tanzania or Nigeria's middle belt).

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