Global Cassava Trends

Reassessing the Crop's Future

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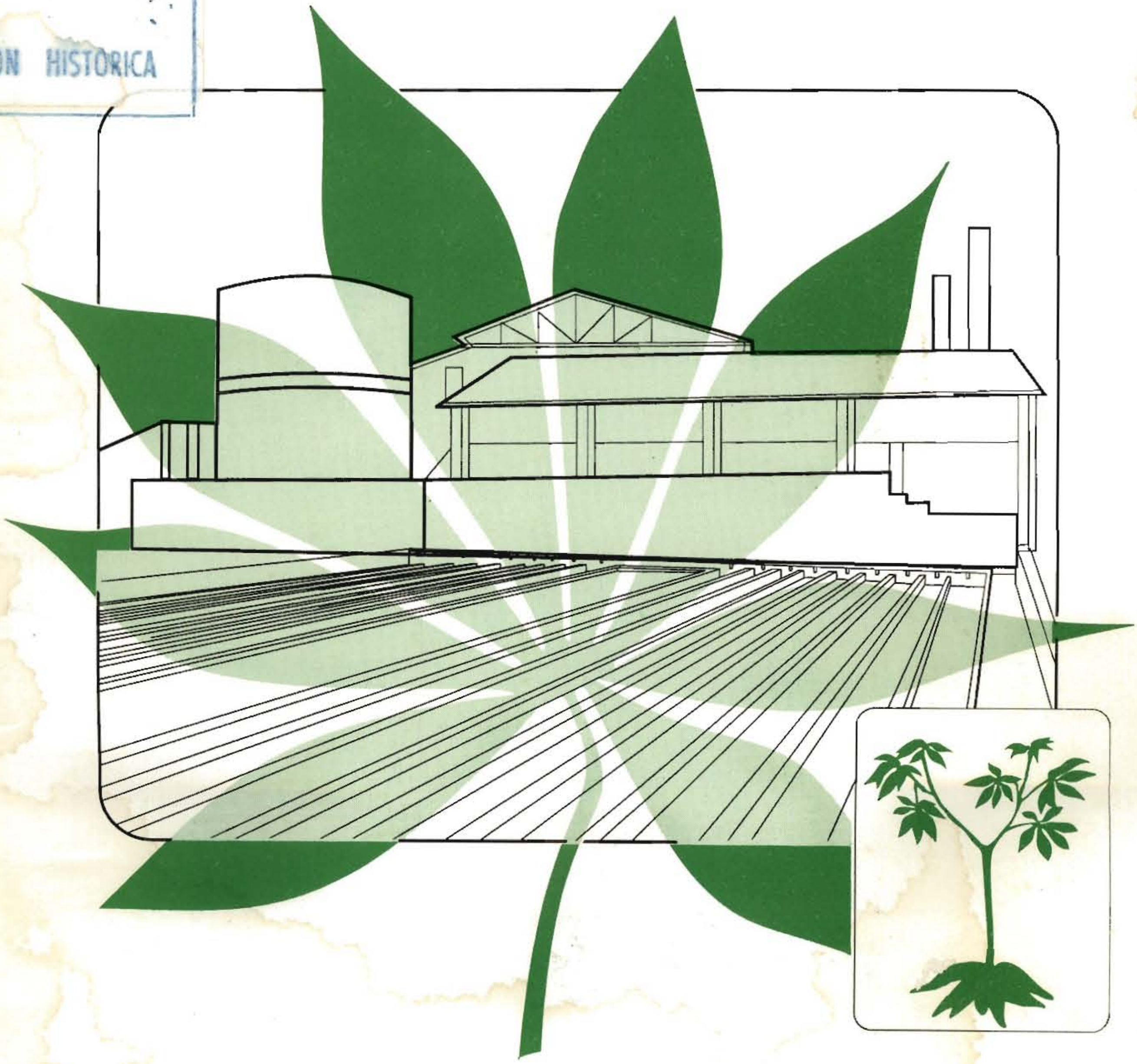

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Introduction

In the mid-1980s, Lynam (1987) carried out a series of socioeconomic studies of the cassava sector in Latin America and Asia, analyzing historic trends (up to 1985) in production, processing, marketing, consumption, and trade. On that basis the author assessed the crop's potential for utilization in the future. Those studies reached the following conclusions:

1. The decline in consumption of fresh cassava in Latin America has resulted principally from urbanization. In urban areas high marketing costs have increased the price of cassava relative to that of grain staples. Consumption of fresh cassava has a positive income elasticity and is expected to grow modestly. New technology for conserving fresh cassava is likely to reduce marketing costs and accelerate this growth.

2. Where human consumption of processed cassava has declined, this has probably resulted from government subsidies on competing cereals. The trend is already being reversed, however, as subsidies are removed, so demand for processed cassava is expected to grow. Such products will continue to provide an important source of inexpensive calories for the poor.

3. Increasing production of starch, much of it used in various foods, is expected to raise the demand for cassava, especially in Asia.

4. There is an increasing demand for dried cassava as animal feed, chiefly for domestic use in Latin America and for both domestic use and export in Asia.

5. Asia's market for cassava has already expanded to the point where production is not keeping up with demand.

Based on these observations, Lynam concluded that "cassava is indeed a crop whose time has come."

Since 1985 cassava supply, demand, and utilization have changed considerably in many countries and regions. So have patterns in the trade of cassava-based products. Moreover, much new information is available now, for example, from the Collaborative Study on Cassava in Africa (COSCA), which was conducted in the early 1990s.

The objective of this study is to assess global cassava trends over the last 10 years (1986-1995) but in less detail and less extensively than did Lynam. To provide a basis for making future projections, we identify the most significant trends and offer explanations for them. The study also identifies and quantifies global and regional constraints in the cassava sector. This information should help the staff of organizations involved in research and development, including private companies, to better understand both the dynamics of the cassava sector and its major challenges. It also provides them useful reference information on the crop in general.

Annex 1 presents data on cassava production, area, yields, and annual growth rates, by continent and selected countries, for 1961-1995.

World Cassava Trends

Global aggregated data, though not altogether reliable, indicate that world cassava production continued to increase over the last decade. As shown in Figure 1, however, it grew at a slower pace (1.9%) than in 1961-1986 (2.6%). During this earlier period, the cassava growth rate exceeded that for population in developing countries, whereas during the last decade it was lower. Since 1985 world production has increased by more than 30 million tons, reaching a record of 154 million tons in 1993.

The increase has differed from one continent to another. In the early 1980s, Africa accounted for 40% of production, Latin America 24%, and Asia 36%. But by 1994 these proportions had changed to 48, 20, and 32%, respectively, indicating significant growth in Africa's production (see the map showing global distribution of cassava area in Annex 2).

The increase in world production over the last decade was achieved mainly through expansion of area at an annual rate of 1.8% (Figure 2). Rates of growth in average yield have dropped, partially because of adverse climatic conditions, especially in Latin America and Africa (FAO, 1994a). In 1994 Asia had the highest average yield at 13 t/ha, followed by Latin America with 11.5 t and Africa 7.7 t.

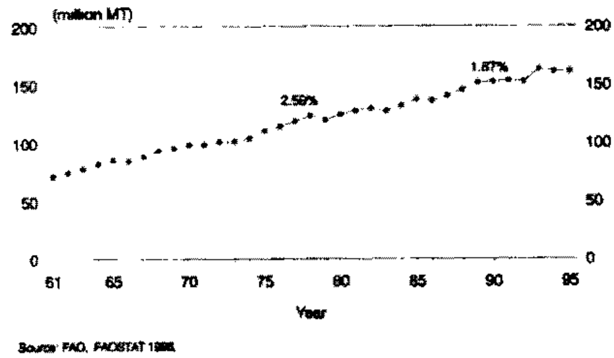


Figure 1. World cassava production and annual growth rates, 1961-1995.

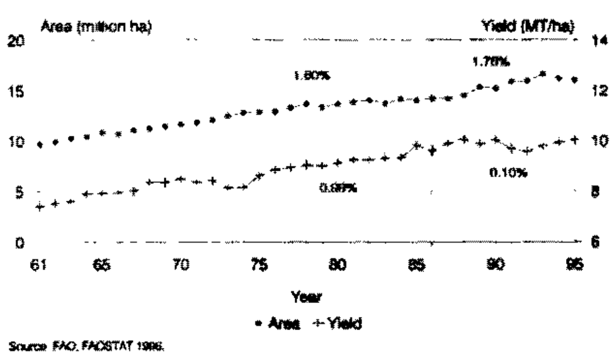


Figure 2. World cassava area, yield, and growth rates, 1961-1995.

Latin America

Trends in Latin America are heavily influenced by Brazil, which contributes 77% of the region's cassava production. Over the last decade, production remained relatively constant, with slight yearly fluctuations (Figures 3 and 4). There were similar fluctuations in area, while yield was fairly stable. Yields recovered from their all-time low in 1983 but were reduced significantly by a 3-year drought at the beginning of the 1990s in northeastern Brazil (Figure 5). Growing conditions are expected to improve beyond 1995. However, the country's cassava area will expand slowly due to a lack of planting material, especially in the Northeast (FAO, 1994a).

Cassava utilization in Latin America has begun to show important changes in the last decade. The overall trend is toward processed products and animal feed. In addition, the absolute volume and relative share of cassava going to starch production is increasing.

In ***Brazil*** yields vary significantly. In the semiarid northeastern states, they fluctuate between 4 and 10 t/ha, while in the South average yields are 20-25 t/ha. Three major factors account for the difference. First, edafoclimatic conditions in the South are more favorable than in the Northeast. Second, cassava farms are larger and the production system more intensive in the South. And third, strengthening demand for roots to produce industrial and fermented cassava starch ("sour" starch) induces farmers to adopt improved production technologies.

Changes in cassava utilization in Brazil are evident from increases in the share used for starch and animal feed (Figure 6). This phenomenon is most pronounced in the southern and southeastern states, i.e., Paraná, São Paulo, Minas Gerais, and Santa Catarina. In addition, since the late 1980s, cassava chipping for animal feed has been established through the

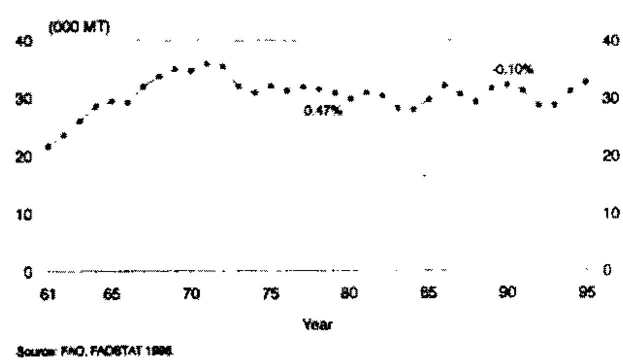


Figure 3. Cassava production and annual growth rates in Latin America, 1961-1995.

development of small-farmer cooperatives in the state of Ceará (Ospina et al., 1994). In the northeastern states, starch is a by-product of *farinha* processing, so only minor quantities are produced. In these states, farinha is still the traditional cassava product, representing more than 75% of cassava utilization.

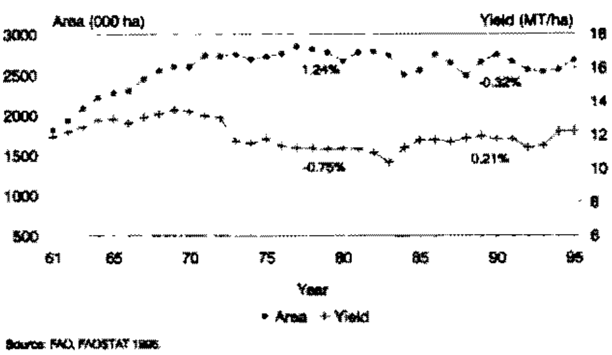


Figure 4. Cassava area, yield, and annual growth rates in Latin America, 1961-1995.

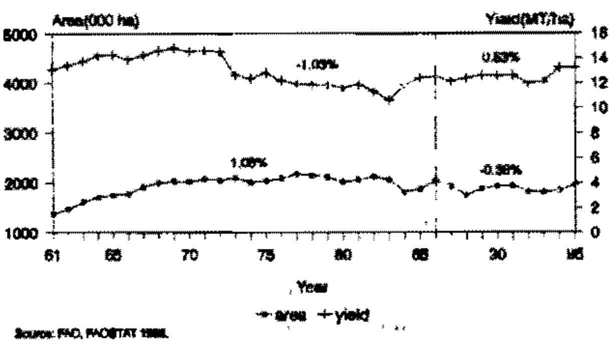


Figure 5. Cassava area, yield, and growth rates in Brazil, 1961-1995.

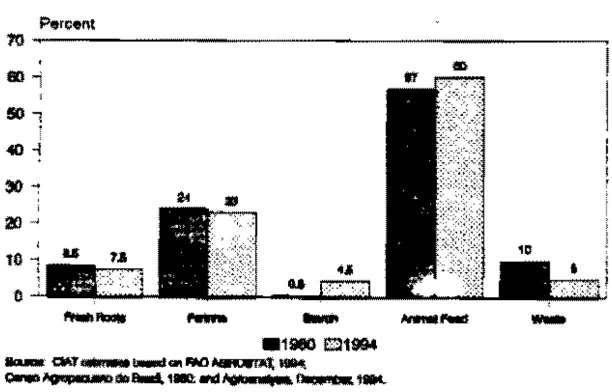


Figure 6. Trends in domestic utilization of cassava in Brazil, 1980 and 1994.

Colombia stands out as an exception to the overall trends in Latin America. During the last decade, yield has increased at an annual rate of 2.1% and area at 2.6%, generating an annual growth rate of 4.7% in production (Figures 7 and 8). These increases have occurred mainly on the seasonally dry north coast, the country's traditional cassava-growing area. Despite a 2-year drought and widespread incidence of cassava bacterial blight, improved production technologies, including improved varieties, have kept productivity on the rise. Similarly, improved cassava utilization and market improvements have reduced price fluctuations and boosted the expansion of area (Henry et al., 1994).

The consumption of fresh roots still represents the major form of cassava utilization (70.5%) in Colombia (Figure 9). However, the processing of fermented and industrial starch and cassava chipping and drying have significantly increased during the last decade. To a large extent, the processing of sour starch is expanding in the departments of Cauca and Valle del Cauca, while the production of industrial starch is increasing chiefly in the north coast region. In the traditional cassava areas of the Atlantic coast, cassava chipping and drying have expanded since the mid-1980s as a result of the development of small cassava processing organizations, which have penetrated new markets and adopted new processing technologies (Henry and Gottret, 1993).

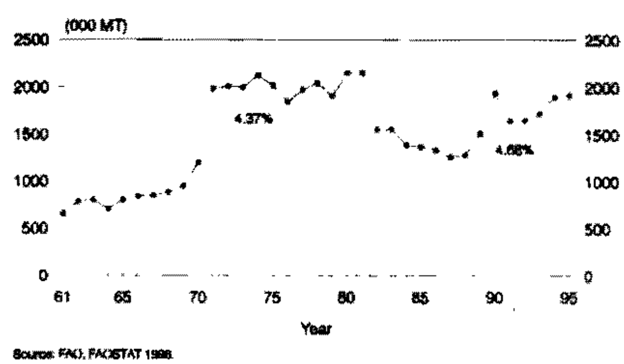


Figure 7. Cassava production and annual growth rates in Colombia, 1961-1995.

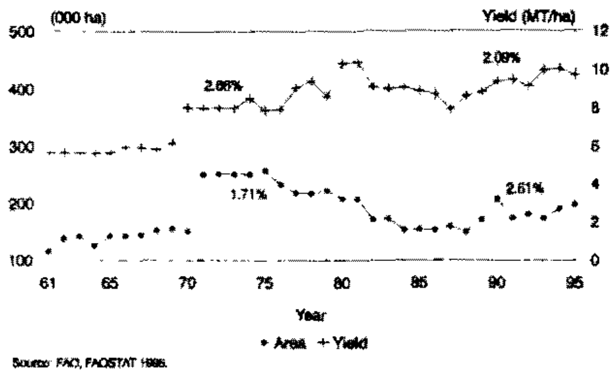


Figure 8. Cassava area, yield, and annual growth rates in Colombia, 1961-1995.

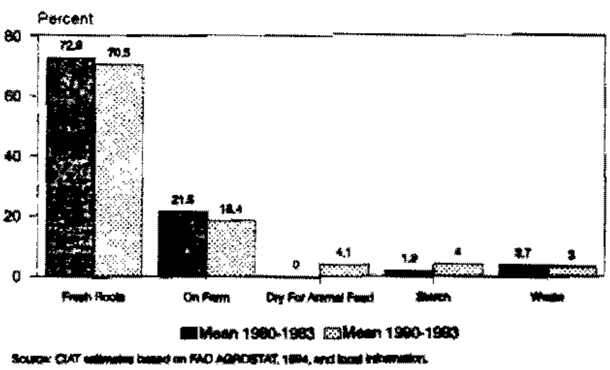


Figure 9. Trends in cassava utilization in Colombia during the 1980s and 1990s.

Asia

This continent occupies second place (50 million tons) in terms of global cassava production and first place in yield (13 t/ha). From the early 1960s to the mid-1980s, Asia saw a strong expansion in cassava production (4.8%), as indicated in Figure 10. This was stimulated mainly by opportunities to export cassava chips and pellets to the European Union (EU). The main exporters have been Thailand and, to a lesser extent, Indonesia. Currently, these countries account for 75% of Asian production and 90-95% of export volumes. Nevertheless, the early high rate of growth has not been sustained during the last decade, with the expansion in production slowing to almost 0.27%. Previously, production growth was based almost equally on yield and area increases. But in the past 10 years, yield improvement has been the main driving force, though at a much slower rate than before (Figure 11).

During 1961-1986, cassava area in ***Thailand*** increased from a mere 100,000 ha to 1.1 million hectares at an annual growth rate of 13%, providing 40% of Asian production (Figure 12). Although cassava area expanded at a similar pace until the end of the 1980s, it gradually decreased at the beginning of the 1990s, and the annual growth rate over the last decade has been negative. The earlier dramatic increase in production was based almost entirely on area expansion and very little on improved productivity. Moreover, during the 1960s average yields were higher than they are currently.

There are three main reasons for this. First, the Thai cassava boom was based on a single cassava variety, Rayong 1. Introduction of improved higher yielding varieties began at the end of the 1980s (Henry et al., 1994b). Second, cassava area expanded in the Northeast where soils are less fertile. Third, repeated cassava plantings on the same land has gradually

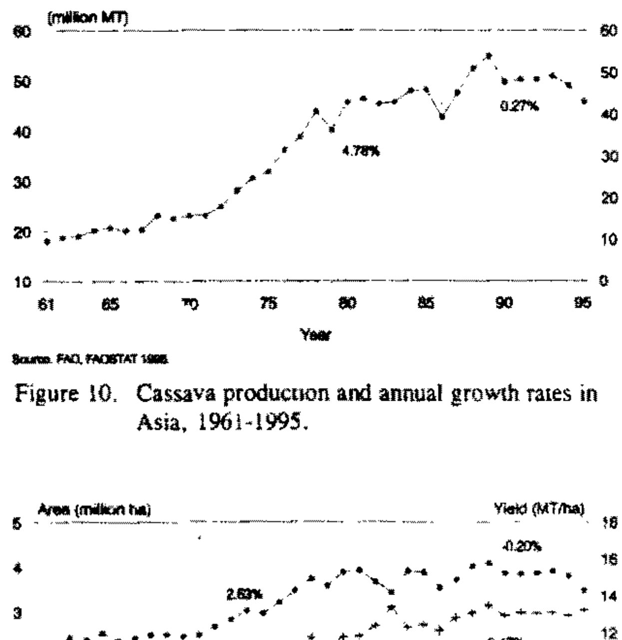


Figure 10. Cassava production and annual growth rates in Asia, 1961-1995.

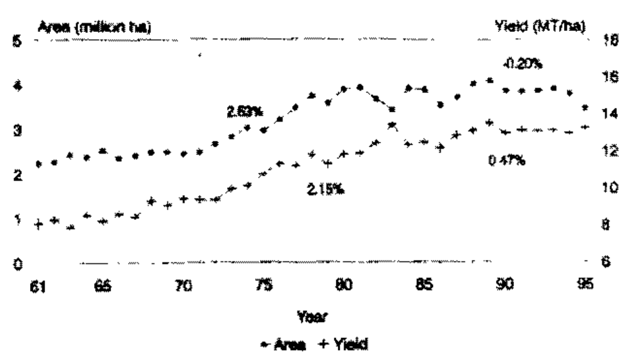


Figure 11. Cassava area, yield, and annual growth rates in Asia, 1961-1995.

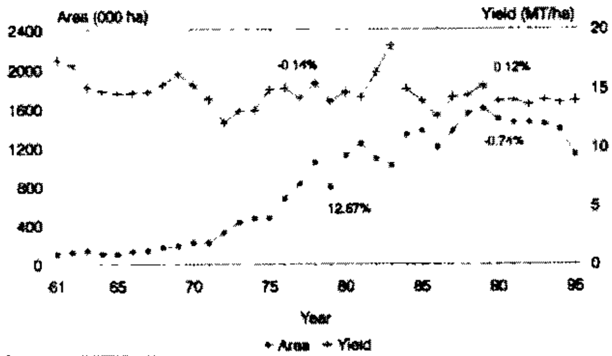


Figure 12. Cassava area, yield, and annual growth rates in Thailand, 1961-1995.

reduced yields. Fertilizer use and subsequent productivity response have mirrored the price paid for roots by the processing industry.

During the 1980s and at the beginning of the 1990s, three additional factors affected cassava productivity and plantings. First, EU export-quota restrictions led to government-induced schemes for cassava substitution,[1] whereby more fertile cassava areas were planted to rubber, maize, and other crops. Second, strong industry-led economic growth pushed cassava production onto more marginal areas, with lower opportunity costs. Third, eroding chip and pellet prices in the EU put further pressure on root prices, reducing cassava farm revenues and lowering fertilizer use (Henry et al., 1994c). However, it is expected that with the increased adoption of improved cassava varieties(such as Rayong 3, 60, 90, and 5, Kasetsart 50, and Sri Racha 1)[2] productivity will improve (Henry et al., 1994b).

1 Under the Agricultural Production System Restructuring Programme (APSRP), farmers have received encouragement and financial assistance to reduce cassava plantings by a projected 1 million rai (152,000 ha) and to switch to more remunerative products, such as rubber, fruits, maize, flowers, vegetables, and livestock (FAO, 1994a).

2 As Klakhaeng et. al. (1995) indicate, government expenditures on the multiplication and distribution of cassava varieties has significantly increased. This and the availability of good varieties from Thai scientists (who have more in the pipeline) increase the potential for raising productivity in the future. Moreover, Thailand's cassava processing industry is playing a significant role as an alternative agent of technology transfer through variety multiplication and diffusion (Henry et al., 1994b).

Cassava utilization in Thailand is changing on two fronts: product and market diversification. In 1982 cassava chips and pellets represented 88% of total cassava utilization. But by 1992 this share had decreased to 70%. Most of the difference went to cassava starch, which represented 12% in 1982 but had increased its share to 28% by 1992. In addition, the proportion of native starch that is further processed into modified starch has increased.

Thailand's market mix has undergone significant changes as well. During the 1970s the EU was the principal market for exported chips and pellets, and very little cassava was consumed domestically. With the signing of the Voluntary Cassava Export Agreement between Thailand and the EU in 1982, pressure was put on Thai exporters to open new non-European markets. They penetrated traditional feed grain markets in a number of countries by selling cassava pellets at up to 30% below the price paid under the EU quota. It is estimated that the share of cassava pellet exports to the EU has decreased from 98% in 1982 to 67% in 1992 (TTTA, various issues). The domestic market, principally for starch, now absorbs 14% of total cassava supplies, up from 3.5% in 1982.

Thailand's cassava sector depends almost entirely on export opportunities, and only a fraction of production is used domestically. The cassava sector in ***Indonesia*** seems to have just the opposite orientation. The country is a more traditional cassava producer (Bottema and Henry, 1992), where domestic utilization accounts for most of the demand (Henry et al., 1994c). During the 1960s and 1970s, cassava production increased slightly (Figure 13) based on yield increases, with a contraction of the area planted (Figure 14). Since the mid-1980s, however, cassava area has expanded (1%), and productivity has increased slightly (0.4%), giving an annual production growth rate of 1.4%. Increasing demand for cassava starch, fueled by a strong economy and rising incomes, and the adoption of improved cassava varieties in areas supplying starch factories account mainly for the growth in production (Dimyati, 1993).

From 1978 to 1987, the share of products for direct human consumption increased from 52% to 64%. Meanwhile, the exportation of chips increased from 7.6% to 9.2%, and the share of starch and flour used for further processing decreased from 34% to 26% (Damardjati et al., 1991; Lynam, 1987). These shifts imply that human consumption of traditional cassava products increased during that period. More recently, the use of starch and flour has diversified, with increasing volumes of cassava flour being produced for the food industry and for further processing of native starch into modified starches (Henry et al., 1994c).

Although ***Vietnam*** and ***China*** possess only about 5% of Asia's total cassava area, these countries merit special attention because of their dynamic cassava markets. Both countries began to open up their economies in the late 1980s, with major effects on the cassava sector. Elastic domestic and international markets for starch have attracted strong interest in cassava processing, which in turn has boosted the demand for roots at the farm level. As a consequence, on-farm cassava utilization has evolved toward the sale of fresh cassava or dried chips to processing factories (Binh et al., 1992; Henry et al., 1994c). There has also been a tendency toward larger scale processing and more advanced technology, with strong evidence of product diversification toward modified starches (Ha et al., 1994; Henry and Howeler, 1995). Reflecting these political and economic changes, the cassava area in Vietnam has reversed its strong downward trend and currently shows signs of expansion (Figure 15).

India presents a somewhat different picture. Since the mid-1970s cassava area has steadily contracted. During the last decade, this occurred at an annual rate of more than -2.4%. However, the decline in area has been entirely offset by continuing increases in productivity (at a rate of 3.4%). Thus, India can still boast of having the world's highest average yield at 22.5 t/ha (1993). Area has decreased mainly as a result of eroding market demand. The use of cassava for direct human consumption has contracted, mainly because of changing economic conditions and eating habits and preferences, but the demand for sago and starch has strengthened.

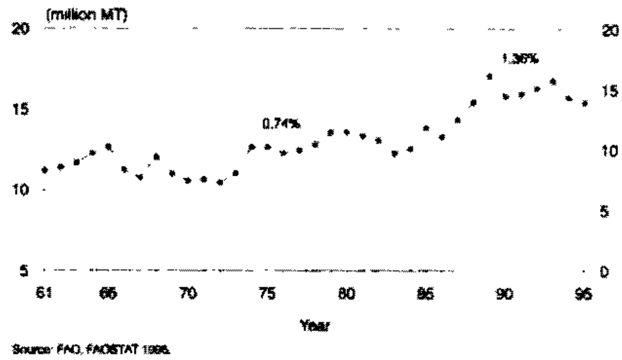


Figure 13. Cassava production and annual growth rates in Indonesia, 1961-1995.

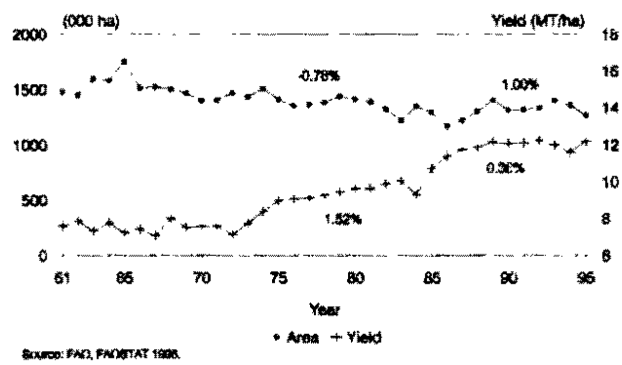


Figure 14. Cassava area, yield, and annual growth rates in Indonesia, 1961-1995.

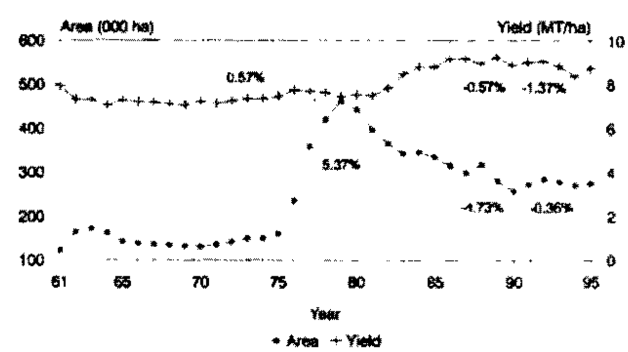


Figure 15. Cassava area, yield, and annual growth rates in Vietnam, 1961-1995.

Africa

The Food and Agriculture Organization (FAO) is the main source of statistics on cassava production in Africa. Dorosh (1989), Sarma and

Kunchai (1989), and Nweke (1994a) have all noted that FAO's cassava data may in some cases be too high or low by 30% (Dorosh, 1989). But despite their inaccuracy, these data are useful, especially for analyzing trends over time.

In Africa cassava supplies have grown at an annual rate of 3.8% over the last decade (Figures 16 and 17), compared to 2.5% during 1961-1986. In the latter period, area expansion and yield improvement contributed almost equally to growth in cassava production. But over the last decade, area expansion has accounted for 84% of the production increase.

According to FAO statistics, cassava yield in Africa during 1991-1993 fluctuated around 8.3 t/ha. However, Nweke (1994a) argues that cassava yields in the COSCA countries averaged 12 t/ha in 1991-1992, based on surveys in 275 representative villages. The same surveys show that cassava production is increasing in about 70% of the sample, replacing mainly fallow (40%) and pastures and crops (58%) (Nweke, 1994). The principal reason for the production increases are insufficient food supplies as a result of drought (30%), demographic pressure (25%), and improved markets (20%). The results also show that cassava production is increasing more in areas with a subhumid climate than in those with a dry climate and more at low altitudes than at mid- or high altitudes. This primary information is consistent with FAO data regarding the expansion of cassava area in most regions, but it differs considerably with respect to yields.

Nigeria and ***Zaire*** together account for 56% of Africa's total cassava production. During the last decade, production has grown at an annual rate of around 9.3% in Nigeria, up from 2% during 1961-1984. However, this has been due entirely to area expansion. Cassava yields fluctuated significantly over the last decade between 9.5 and 12 t/ha. Trends in Zaire present a somewhat different picture. There the annual rate of growth in production over the last decade has resulted from 0.07% in area expansion and 1.4% in yield improvement.

Cassava yield appears to have improved only marginally in Africa during the last 10 years. Nweke (1994a) observes that in Nigeria farmers grow improved varieties on 60% of the cassava area in the humid zones and on 40% in the nonhumid zones. He further reports that improved varieties yield substantially more than local varieties under a wide range of climatic and other conditions. Polson and Spencer (1992) have made similar observations. FAO (1992) reports yield increases in Nigeria as a result of increased use of "high-yielding and pest-resistant varieties."

Lynam (1991), on the other hand, states that yields have increased, not so much through the adoption of improved crop technologies, but because of other shifts in crop management. Similarly, Ky (personal communication, 1992) argues that in Nigeria cassava yields have improved largely because cassava is increasingly grown on more fertile yam plots and as a result of an influx of new traditional varieties brought by migrating populations. Thus, there is evidence suggesting that improved technologies

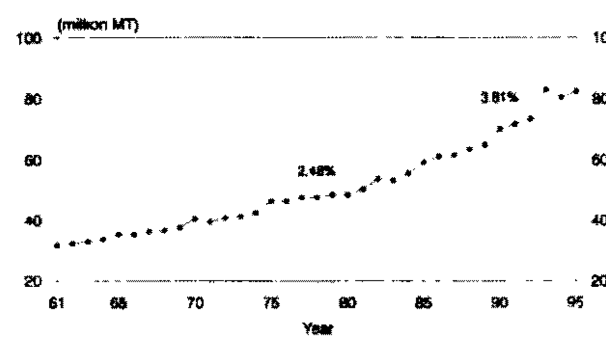


Figure 16. Cassava production and annual growth rates in Africa, 1961-1995.

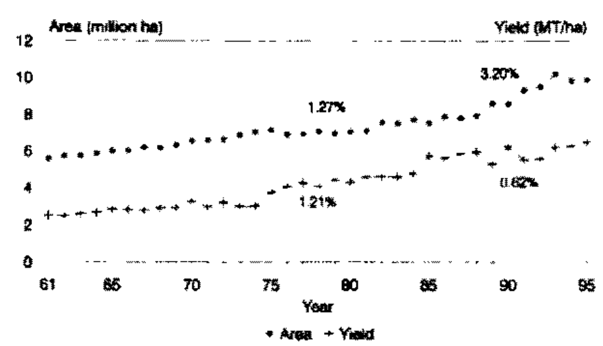


Figure 17. Cassava area, yield, and annual growth rates in Africa, 1961-1995.

are being adopted and that yields are increasing in some regions of Africa. But, oddly, we see little indication of sustainable yield increases at the country level.

This contradiction may be explained partly by recurring adverse climatic conditions, i.e., prolonged droughts in many parts of Africa, aggravated by major infestations of green mite and outbreaks of mosaic virus (especially in Malawi, Tanzania, Uganda, and Zaire), which have reduced productivity significantly. Moreover, civil strife has had a disastrous effect on yields in Angola, Burundi, Liberia, Mozambique, and Rwanda (FAO, 1992; 1994a). Thus, despite increased adoption of improved technologies, other factors have created strong pressures that depress productivity.

Based on FAO data for 1980-1984, Dorosh (1989) estimated that about 50% of cassava production in Africa was being processed, while 38% was destined for direct human consumption without processing. Results of the COSCA survey show that cassava processing currently absorbs 70% of supplies (Nweke, 1994a), suggesting that the share going to processing has increased by 30% over the last decade. This increase may be exaggerated, however, because of incompatibility between the two data series compared. Even so, Lynam (1991) also noted the trend toward increased volumes of processed product and argued that root crops, including cassava, are gradually being transformed from a subsistence to a market orientation.

Rapid urbanization and relative improvement of market channels are important factors in this development (Lynam, 1991). Processing tends to predominate more in isolated areas than in those close to markets. The introduction of improved processing technology, such as the partial mechanization of *gari* making, has also contributed to increased volumes of processed cassava. COSCA data and overall production trends suggest a strong demand for traditional cassava products. The production of fresh roots, pastes, and granules shows a significant increasing trend, while production of dried pieces and flours is decreasing (Nweke, 1994b).

Government policies, both direct and indirect, have had a significant impact on cassava area, supplies, prices, and consumption during the last decade. Several African countries have emphasized domestic food self-sufficiency through various policies. In Zaire and Nigeria, restrictions on cereal imports have been in force for several years. Other countries have at times lifted controls on domestic cereal prices, making cassava more competitive. On the other hand, in Cote d'Ivoire, real cereal prices fell in the early 1990s due to large imports, which made people switch from cassava products to bread and rice. Most of these policies affect the price of cassava products relative to cereals and prompt changes in demand, consumption, and area rather than yield improvement.

The Dynamics of Cassava Product Markets

As is evident from world trends, the dynamics of the cassava sector vary considerably between continents and even between different areas within a single country. The major forces behind the changes in this sector arise not so much from supply as from the demand for particular cassava products. Through a detailed analysis of the most important products, we provide a basis for discussion of future trends.

Fresh Roots for Human Consumption

Human consumption of fresh roots accounts for a major share of cassava utilization in Latin America. Most tropical countries in the region, except Brazil, have traditionally counted on fresh cassava as a source of dietary energy. There is a general belief that roots and tubers are "inferior goods" (Pakpahan, 1988; Overton, 1990), meaning that when incomes increase cassava consumption decreases.

This notion has been rigorously refuted by Sanint (1987), Lynam (1987), and Gottret and Henry (1995). Using time-series data, Sanint (1987) and Lynam (1987) show that urbanization, rather than rising incomes, has a negative effect on cassava consumption. Gottret and Henry (1995) further show that income elasticities for cassava are positive and significant for the low- and medium-income groups in urban populations and are not significantly different from zero for high-income groups. These authors explain that the lower levels of cassava consumption in urban than in rural areas is due mainly to higher marketing margins and subsequently higher retail prices. In addition, Gottret and Henry (1995) have provided data showing that, when relative cassava prices decrease as a result of market diversification and improved production technologies, per capita consumption of cassava rises (Figure 18). This suggests that the consumption of fresh cassava in Latin America will further increase but at a lower rate than population growth.

In Africa the consumption of fresh cassava is likely to decline as urbanization continues and the sale of processed cassava products increases. This is in line with the historical trend, which shows the consumption of fresh cassava decreasing over the last decade (Dorosh, 1989; Nweke, 1994a).

In Asia fresh cassava for human consumption has never played a large role in cassava utilization. In countries such as China and Vietnam, strong economic development and a clear preference for rice as a basic staple will further erode the small share of cassava production consumed fresh. Only in isolated (mountainous) areas will cassava still be eaten in

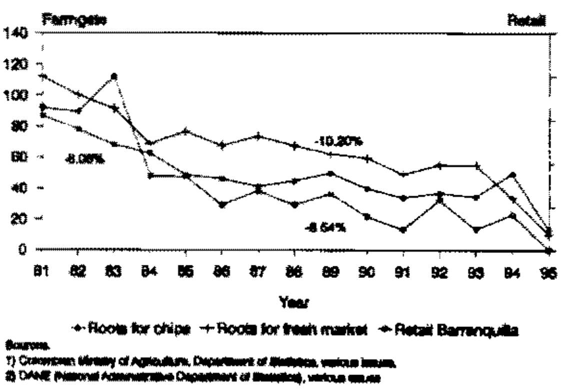


Figure 18. Prices of cassava products in Colombia (constant 1990 US dollars).

times of rice scarcity. Even then, cassava will most likely be consumed in the form of flour rather than fresh roots (Henry and Howeler, 1995), and the consumers will be mostly rural rather than urban people.

Flours

Cassava flours come in a large variety of forms and are used in different ways. Currently, flours are most commonly toasted for human consumption. In Africa traditional cassava products, such as gari, have an elastic demand among medium- to high-income groups, while other products are consumed largely by low-income people (Nweke, 1994b). Over the last decade, urbanization increased by only 1.6% in Africa. However, average household expenditures are still relatively low, so cassava consumption will still rise as income increases. As Nweke (1994b) argues, the potential for market expansion depends on the degree to which the quality of the various processed products can be improved to make them more attractive to consumers in higher income groups.

The 1994 devaluation of the common currency of countries belonging to the CFA-franc zone in West and Central Africa is likely to have a significant effect on cassava production and consumption. The costs of imports, especially wheat and rice, have increased considerably, raising the demand for cheaper alternative sources of dietary energy, such as cassava. Benin, Cameroon, the Central African Republic, Congo, and Cote d'Ivoire will be most strongly affected (FAO, 1994). Rising cassava prices in these countries will provide an incentive for increased planting. Another example of policy effects on cassava is the Nigerian government's 1994 decision to exempt cassava and its products from the value-added tax. Reduced consumer prices have strengthened demand and led to increasing consumption, which in turn has boosted cassava plantings.

In Brazil consumption of *farinha de mandioca* is higher among poorer consumers and decreases as their incomes rise. In the Northeast

58% of the urban farinha consumers surveyed responded that consumption has increased over the last years, while only 14% said it had decreased (Betancourt, 1994). In low-and medium-income groups, farinha shows a positive income elasticity. This situation is similar to that of fresh roots in Colombia. Furthermore, real farm-gate and farinha retail prices have decreased in the last decade (Figure 19). This would suggest that farinha demand will continue to expand, especially in rural and poorer urban markets.

In several countries of Asia and Latin America, a new trend has emerged toward utilization of high-quality cassava flour as a partial substitute for wheat in bakery and other food products. Damardjati et al. (1990) reported a strong commercial interest in the utilization of cassava flour in Java, although Dimyati (1995) notes several barriers to flour production. Bottema (personal communication, 1993) remarks that wholesalers and retailers regularly "cut" wheat with cassava flour to be sold at a lower price. Nghiem (personal communication, 1992) reports that in Vietnam makers of French bread have been experimenting with cassava flour, using an inclusion rate of up to a 40%, with good results. Similar progress has been reported at a pilot plant on Colombia's north coast (CIAT, 1993).

Although the volumes of cassava flour used in the food industry are still relatively small, interest seems to be growing. Depending on future developments in relative wheat and cassava prices, this potential market may strengthen.

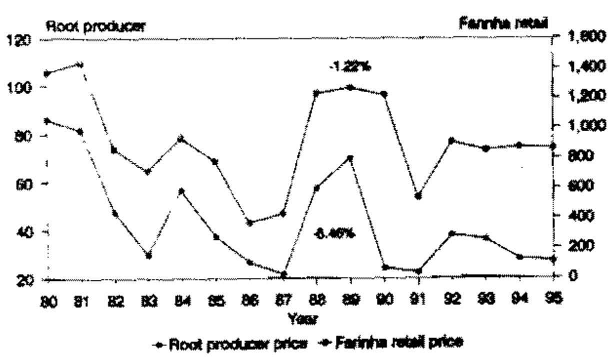


Figure 19. Constant 1990 cassava prices for the producer and farinha retail prices in south central Brazil.

Chips and Pellets

On-farm chipping and drying of cassava have been important in many Asian countries for some time, and more recently the practice has spread in several Latin American countries as well. In Indonesia, Vietnam, and China, dry chips are sold mostly as raw material for starch processing. Dry chips constitute an important source of raw material during the off-season for cassava, since they can be stored for a much longer time than fresh roots. This demand for chips is directly related to starch demand, which is discussed in the following section.

In China and Vietnam, a sizable portion of cassava chips is utilized on-farm to feed animals, mainly pigs. Henry and Howeler (1995) estimated that 30-40% of cassava in China is currently used in this manner. However, they also argue that this share will be further reduced as a result of strong demand for chips by the growing starch industry.

In Indonesia a major share of chips produced on-farm (*gaplek*) is used for human consumption in a large variety of traditional dishes. In times of rice scarcity (i.e., between rice harvests), gaplek partially substitutes for rice in rural daily diets. There is reason to assume that this practice will continue. Exports of gaplek, chips, and pellets for animal feed have traditionally amounted to less than 10% of total utilization. Given strong internal demand, Indonesia has often been unable to fulfill its EU export quota, and in future cassava exports will likely decline in favor of increased domestic utilization.

The largest share of chips and pellets produced in Southeast Asia, however, is destined for export. Following recent changes in GATT agricultural price policies in the EU, the pellet export market will continue to decline.[3] The total volume of pellet exports from Thailand has decreased since 1982 (Figure 20). Current policies will further erode pellet exports. Henry et al. (1994c) show that Thai pellet exports are projected to decrease 34% by the year 2001.

3 For a more detailed treatment of this topic, see TDRI (1992).

However, the initial shock of lower EU prices for feed grains has worn off somewhat, and current pellet prices in Thailand are in line with the EU's domestic barley prices (Figure 21). Reduced Thai pellet exports will be offset only slightly by an insignificant increase in domestic pellet utilization of 276,000 t by the year 2001 (Henry et al., 1994). In order for Thai pellets to remain competitive as grain substitutes in international markets, the cost of cassava roots in Thailand must be below US$20/t (TDRI,1992). As shown in Figure 22, domestic root and pellet prices in Thailand have indeed been decreasing in real terms, although during the last 2 years they have strengthened again. The achievement of further reductions in the cost of roots is being complicated by increasing demand from the starch industry, which can afford to pay as much as 40% more for cassava roots than can the pellet industry, given strong starch prices (Henry et al., 1994c).

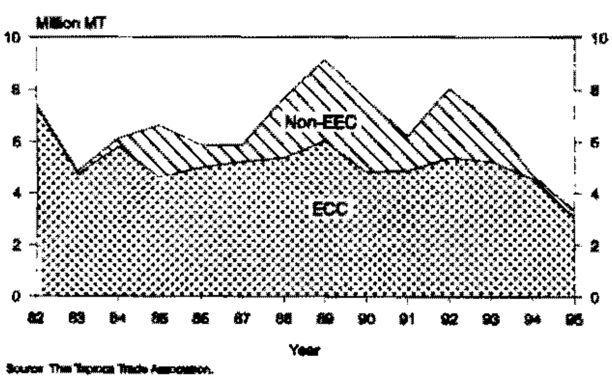


Figure 20. Thailand's cassava pellet and chip exports, 1982-1995.

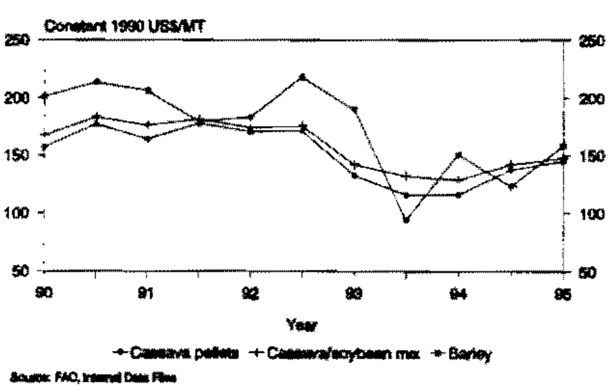


Figure 21. Prices of cassava pellets and barley, FOB Rotterdam, 1990-1995.

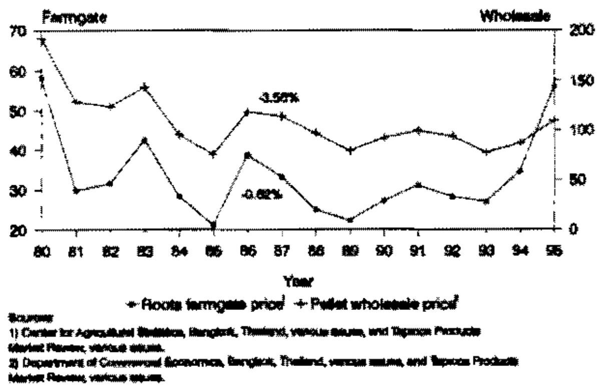


Figure 22. Farmgate prices of cassava in Thailand and wholesale pellet prices, constant 1990 US dollars, Bangkok, 1980-1995.

If the overall GATT philosophy of reducing government intervention is further implemented, cassava could become more competitive in world markets as a substitute for feed grains in animal rations. Doering et al. (1983) estimate that the true or total costs of US corn have been 15-48% higher than the costs actually incurred by US corn farmers. This does not take into account export subsidies and PL-480 programs. If subsidized feed grains entered world markets at prices reflecting total costs, cassava pellets or meal could have a cost edge, depending on the distance to market and transport costs. Hence, the future potential for exporting cassava pellets depends to a large extent on further reduction of government intervention in agricultural commodity markets as well as on progress in further reducing the cost of cassava roots through improved technology.

Starches

In Latin America and Asia, cassava starch industries are expanding. In the former this trend is evident in Brazil, Colombia, Paraguay, Ecuador, Venezuela, and even Argentina. Vilpoux et al. (1994) and Chuzel et al. (1994) provide evidence that the sour, native, and modified starch industries are expanding in Brazil, especially in the southern and southeastern states. This growth is principally the result of increased demand from a wide variety of manufacturers of foods and industrial products, especially those near large urban centers, such as São Paulo and Rio de Janeiro. Preliminary results from on-going market studies indicate a growing and sustainable demand for domestic cassava starch, based on market and product diversification (Vilpoux, personal communication, 1995). However, as indicated in Figure 23, the price for cassava starch in Brazil is high, compared to that in Thailand. So, Brazilian starch seems limited to the domestic market, at least for the time being. This market may even be endangered by cheaper starch imported from Thailand.

In Colombia both the industrial (native) and sour starch industries are expanding. Data gathered in 1995 by the CIAT Cassava Program through a Rapid Rural Appraisal in Cauca Valley indicate that both the number of small sour starch industries and production have increased. Production of industrial starch in medium-scale, fully mechanized processing plants has expanded on the country's north coast. Some starch industries are currently diversifying into modified starch products (Reyes, personal communication, 1994). These developments indicate a strong and increasing domestic demand for various cassava starches by the expanding paper, cardboard, plywood, textile, fast- and snack-food, and petroleum industries.

Future developments in Thailand's cassava sector will also be based on starch processing. Henry et al. (1994c) show that projections of cassava utilization in Thailand indicate

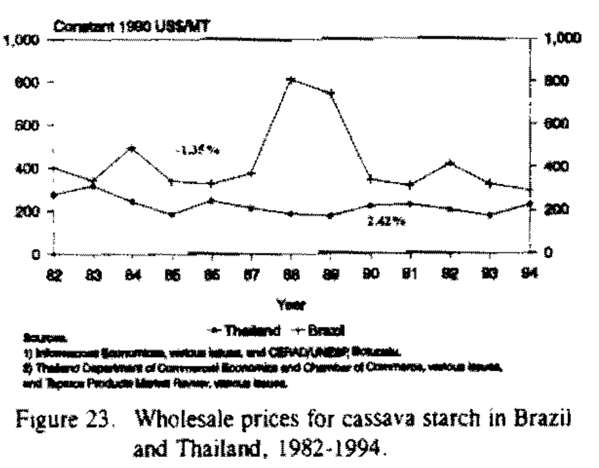


Figure 23. Wholesale prices for cassava starch in Brazil and Thailand, 1982-1994.

production increases of 132% for domestic and 100% for export starch by the year 2001. Although most of this expansion will take place in native starch, modified starch is expected to contribute a growing share of total production. The volume of production is being increased through expansion of capacity in existing factories and through construction of new large-scale plants in northeast Thailand (Titapiwatanakun, personal communication, 1994). Whether starch exports expand beyond current projections depends largely on future developments in the trade liberalization of countries, such as Japan, whose demand for starch is high.

Although Thailand is clearly Asia's leader in the starch market, other countries, including China and Vietnam, are also experiencing rapid expansion in cassava starch production. In these countries the expansion is driven primarily by strong domestic demand. Ha et al. (1994) observe that cassava starch production in Vietnam is expected to increase by 127% (to 200,000 t) by the end of the century. A large part of this expansion (45%) will be based on expected demand from manufacturers of monosodium glutamate (MSG). In recent years at least five foreign (Japanese, Taiwanese, and French) MSG companies have invested in large-scale plants in Southern Vietnam. Two more factories are planned for construction in Northern Vietnam in the immediate future.

Jin and Henry (1994) and Henry and Howeler (1995) have observed similar developments in southern China. In Guangxi province, for example, significant foreign (Thai, Taiwanese, Hong Kong, and Korean) investments have been aimed at upgrading outdated processing factories and constructing new large-scale plants. A strong drive toward further diversification of cassava products is evident.[4] As in Vietnam, significant demand from the domestic market for MSG is a major factor in future market potential. A market like Taiwan, where consumption of MSG is high, can absorb about

4 For a more detailed report on the different cassava products being manufactured in China, see Jin and Henry (1994)

1,000 g per capita per year (ORSAN, personal communication, 1995). The potential annual demand for MSG in Vietnam is estimated at 500 gm per capita. If the same assumption were made for China, a conservative but rough estimate would place MSG production at 600,000 t per year. Currently, most of the MSG manufactured in China is based on corn starch. However, depending on the production zone, MSG based on cassava starch seems to be the cheaper option (Jin, personal communication, 1994).

Comparison of Product Prices

So far, we have discussed general trends in the cassava product markets of particular regions and countries. The demand for these products is closely related to their prices, which in turn depend to a large extent on the price of raw material and on processing costs.

Table 1 gives the costs of cassava production and the prices of processed cassava products for selected countries. From this information we can draw several important conclusions.

First, production costs in Colombia, for example, are significantly higher (71%) than in Thailand (or Brazil). This is related to differences in cassava yields and production technologies and to a lesser extent to differences in factor prices. In Colombia the generally higher price of roots for human consumption (the traditional market) puts further upward pressure on the price of roots for the drying and starch industries.

Table 1. Cassava production costs, farmgate prices, and product prices in three major producing countries, 1990-1995

	Cassava production costs	Farmgate price of cassava		Domestic cassava chip price	Cassava starch price
		For industrial use	For fresh consumption		
	(Average for 1990-1994, US$/MT)				
Thailand	20.34[a]	28.67[d]	-	85.70[g]	233.34[i]
Brazil	27.80[b]	31.63[e]	128.18[e]	-	357.17[j]
Colombia	34.85[c]	42.20[f]	85.30[f]	177.77[h]	522.95[k]

SOURCES:
a. Center for Agricultural Statistics, Office of Agricultural Economics (OAE), various issues, 1990-1994.
b. Production costs in Brazil are for the Estado de São Paulo and were taken from Informacoes Economicas, Secretaria de Agricultura y Abastecimiento, Coordinacion Socio-Economica, various issues, 1990-1994.
c. Production costs are for Colombia's Atlantic coast and were estimated by CIAT economists based on Fundiagro reports and some interviews with farmers.
d. Center for Agricultural Statistics, Office of Agricultural Economics (OAE), up to 1992, and Tapioca Products Market Review, various issues, for 1993 and 1994.
e. Prices are for the Estado de São Paulo and were taken from Informacoes Economicas, various issues.
f. Colombian producer prices are for the Atlantic coast and were taken from CIAT statistics, based on data from ICRDP and CECORA.
g. Department of Commercial Economics, for 1990-1992, and Tapioca Products Market Review, various issues, for 1993-1994.
h. Prices paid in Medellín, Colombia, by Solla S.A., including transport costs, 1995.
i. FOB Bangkok Prices, Thai Tapioca Trade Association, Tapioca Products Market Review, various issues, 1990-1994.
j. Wholesale price, CERAT/UNESP, Botucatu, Brazil, 1995.
k. Placed in Cali or Medellín, information from Colombian private industry, 1995.

Second, the ratio of starch price divided by root price is 8.1 for Thailand, 11.2 for Brazil, and 12.4 for Colombia. These significant differences reflect the size and scale of the industry and the level of technology and infrastructure in these countries. The same point also applies to differences in chip prices.

Finally, Table 1 shows who has a relative comparative advantage in cassava production and processing. Thailand, despite eroding markets for cassava pellets and chips (entirely as a result of foreign policy interventions), clearly has a edge in cassava starch processing. To a lesser extent so do Indonesia and China.

The Constraints of Cassava Development

Historic trends in cassava production, utilization, and markets are governed principally by economic, technical, biological, and institutional or political factors, many of which have quite direct implications for cassava yield and area. In this section we identify problems and opportunities in cassava development at the regional and global levels. Such information is essential as a basis for appropriate assessment of needs, which in turn is fundamental for establishing a research and development agenda. This agenda must be oriented to clients, reflecting the constraints faced by producers, processors, intermediaries, and consumers or users.

To identify constraints and opportunities, CIAT's Cassava Program conducted a Delphi survey[5] that included the following steps:

1. Sources of information (or target audiences) were identified, and two sets of questionnaires were developed for each level of the cassava sector. Cassava scientists and extensionists in national programs and international networks and institutes (such as IITA and CIAT) were targeted as sources of information.

2. The first questionnaire, aimed at producers, solicited estimates of the possible yield gains from reducing production constraints. The units of these estimates were percent yield gain and percentage of target area affected, which together give an estimate of the total production improvement from alleviating a specific constraint. The constraints were divided into seven groups: soil, management, intrinsic varietal traits, climate, diseases, pests, and market aspects. The questionnaire also requested an estimate of potential yield with no increase in fertilization.

   The second questionnaire addressed the constraints faced by cassava processors. The units of measurement were percent cost reduction, percent price premium (received in the market), and the percent share of the total product group. Cassava utilization was classified according to various product groups, including fresh roots, dried chips, flour, starch, etc.

3. World cassava production was divided into five principal agroecosystems (see Table 2) occurring in Latin America, Asia, and Africa.[6] Since Asia's tropical highlands have little cassava production, the resulting matrix of continents by agroecosystems includes 14 cells [(3x5)-1]. Global cassava production and processing zones were stratified according to two levels of demand for cassava products to facilitate the estimation of benefits from cassava research and development.[7] Market demand was divided into 1) traditional markets with relative "inelastic" demand and 2)

5 This type of survey has been used in similar studies, for example, by Herdt (1991) for prioritizing the research of the Rice Biotechnology Network (Rockefeller Foundation), by Sarma and Kunchai (1991) for estimating global cassava yield potential (IFPRI), and by Henry (1991) for preliminary prioritization of cassava biotechnology research in the Cassava Biotechnology Network (CBN).

6 In this classification the difference between the subhumid and semiarid tropics remains debatable. These zones overlap to a large extent. Some have rightly argued that the two environments belong to the single category of "lowland seasonally dry tropics."

Table 2. Global cassava area, by continent and agroecology, 1993.

Climate zone	Latin America		Asia		Africa		World	
	%	000 ha	%	000 ha	%	000 ha	%	000 ha
1. Lowland humid tropics[1]	15	417	18	690	34	3,033	27	4.14
2. Lowland subhumid tropics[2]	33	918	41	1,604	38	3,390	38	5,912
3. Lowland semiarid tropics[3]	8	222	26	1,029	8	714	13	1,965
4. Highland tropics[4]	15	417	0	0	10	892	8	1,309
5. Subtropics[5]	29	807	15	598	10	892	14	2,297
Total	100	2,781	100	3,921	100	8.921	100	15,623

1. Rainfall $\geq$ 1,000 mm; altitude $\leq$ 1,000 m; dry period $\leq$ 3 months (e.g., West Java, Sumatra, and Amazon basin).
2. Rainfall 700-1,000 mm; altitude $\leq$ 1,000 m; dry period 3-5 months (e.g., Colombian north coast, northeast Brazil, and northeast Thailand).
3. Rainfall $<$ 700 mm; altitude $\leq$ 1,000 m; dry period $>$ 5 months (e.g., Guajira, interior northeast Brazil, and Tanzania).
4. Altitude $>$ 1,000 m (eg. Andean zone, central Brazil, and eastern Africa).
5. Latitude $>$ 20° North and South (e.g., southern Brazil, China, and southern Africa).

SOURCE: Carter et al., 1992; Carter et al., 1986; and R. Howeler from country data in Asia (1989, 1991).

diversified markets with a relative "elastic" demand (Table 3).

4. The information gathered through the survey was discussed by scientists at a workshop[8] held from 31 August to 4 September 1993. A preliminary paper was presented at an internal review of the CIAT Cassava Program in December of 1993, during which additional comments and data were received. The data sets resulting from this review, together with further comments from external experts, provided the basis for the analysis presented in this document.

The complete set of constraint estimations resulting from the workshop is given in Annex 3; the data are aggregated by continent and on a global basis[9]. When interpreting this information, specifically that on pests and diseases, one should bear in mind the following points. First, since pests may not strike every season at the same site or cause the same degree of damage, data on this constraint are highly dynamic. Second, it may not be appropriate to estimate losses from a single pest species but rather from pest complexes; therefore, you should not simply sum the damage levels caused by individual pests. Third, even though certain agroecozones or continents may currently be free of particular pests or diseases, they may have the necessary conditions for outbreaks in the future. For example, certain whitefly species that are known vectors of African cassava mosaic virus (ACMV) have been identified in the southern USA and Central America. There is thus a potential threat of ACMV introduction into South America. Because of this and similar situations, the data given here probably underestimate losses from pests and diseases.

Another possible shortcoming of the analysis is that the methodology did not allow for increases in cassava area resulting from alleviation of a particular constraint or combination of constraints. For example, in Africa the area planted to cassava in the semiarid zone is relatively small, mainly because of severe and prolonged drought. If this constraint could be reduced (e.g., through the introduction of well-adapted, drought tolerant germplasm), relatively large areas of the semiarid zones would be potentially suitable for growing cassava (El-Sharkawy, 1993). This would significantly expand the potential area and strengthen the importance of cassava for that agroecosystem. Furthermore, regarding the postharvest constraints, we have not taken into account explicitly the future potential of new products and markets.

As shown in Figure 24, which indicates the absolute and relative importance of cassava constraints across continents, Africa's significantly larger cassava area, compared to that of Asia or Latin America, results in absolutely larger constraints. The figure also shows that Africa accounts for more of the relative importance of soil and management constraints. The importance of pests and diseases differs greatly among continents as well. While representing a large share of the constraints in Africa (29%), they are almost insignificant in Asia (5%). Postharvest constraints, on the other hand, represent 11% of the total constraints in Africa but as much as 18% in Asia.

More significant for the purposes of cassava research and development is the relative importance of constraints by agroecosystem across continents (Figure 25). Most constraints are far more pronounced in the humid and subhumid tropics than in other zones. As mentioned earlier, the distinction between these environments is not very pronounced, and it might be useful to combine them under the name "seasonally dry tropics." This

7 For a more detailed discussion on stratification of worldwide cassava markets, see Henry and Best (1993). Note that African markets were classified as traditional, but the demand for cassava products on this continent is significantly more elastic than for traditional products in Latin America, for example.

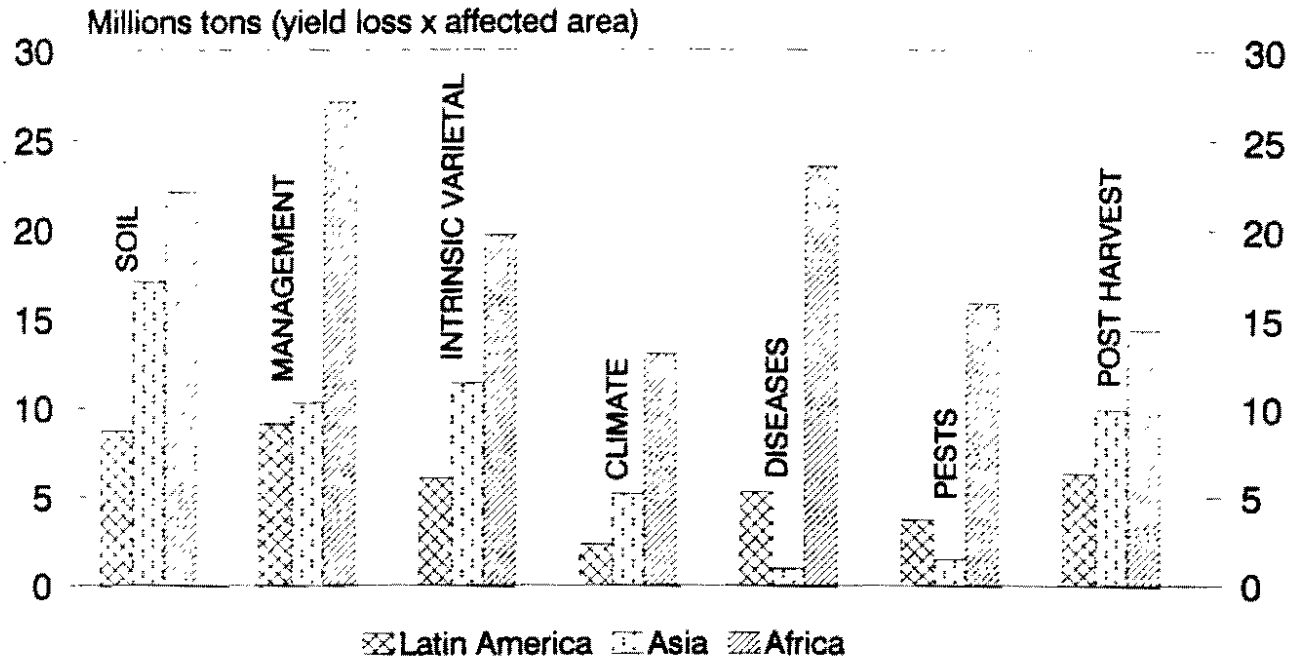
8 This internal workshop was led by an external consultant to increase the impartiality of the exercise.

9 Although the division and classification of constraints is straightforward (see also Annex 3), note that "intrinsic varietal traits" means the potential primary productivity of cassava.

Table 3. Cassava production areas, by agroecosystem and type of market.

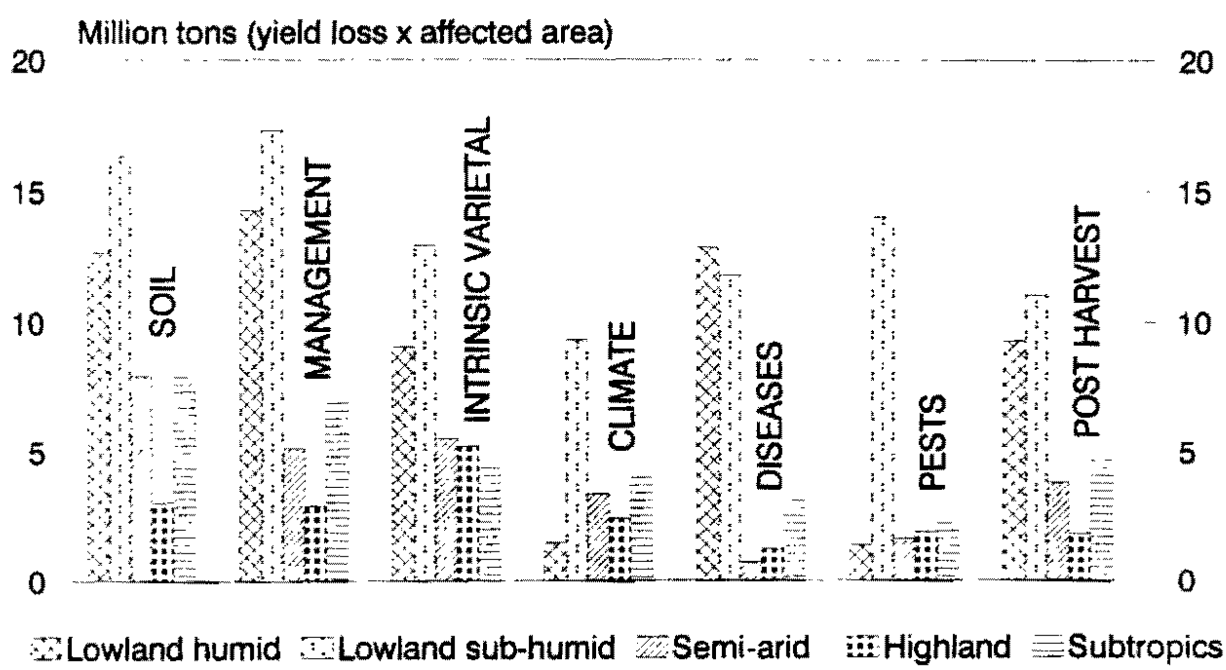
Ecosystem	Latin America		Asia		Africa	
	Constrained market (%)	Diversified market (%)	Constrained market (%)	Diversified market (%)	Constrained market (%)	Diversified market (%)
1. Lowland humid tropics	100	0	48	52	100	0
2. Lowland subhumid tropics	90	10	30	70	100	0
3. Lowland semiarid tropics	100	0	10	90	100	0
4. Highland tropics	90	10	-	-	100	0
5. Subtropics	75	25	37	63	100	0
Total (%)	88	12	30	70	100	0
Total (000 ha)	2,558	222	1,176	2,744	8,922	0

SOURCE: Henry and Best, 1993.



Source: Cassava Economics Data Base, 1994

Figure 24. Constraints of the global cassava sector, by continent, 1993.



Source: Cassava Economics Data Base, 1994

Figure 25. Constraints of the global cassava sector, by agroecosystem, 1993.

agroecosystem would embrace large cassava production areas in northeastern Brazil, northern and northeastern Thailand, and southern India. The aggregation of humid and subhumid tropics would make the relative importance of their constraints seem even more pronounced. The constraints of the highlands and subtropics would seem almost insignificant. This ought to have implications for the allocation of research and development resources by agroecosystem.

Survey data on cassava constraints in Latin American (Figure 26) also suggest that constraints are relatively more important in the lowland humid and subhumid systems. In addition, the data underscore the considerable constraints of cassava in the subtropics. Soil and management problems predominate across ecosystems, together representing 43% of the region's cassava constraints. Pests and diseases show more importance in the subhumid ecosystem than in others. Postharvest constraints seem equally important across the humid, subhumid and subtropical ecosystems. These constraints include problems with product quality and with processing and marketing.

Cassava yield potential is an estimate of what the crop would yield if all constraints were alleviated or removed. For Latin America this was estimated at 23.8 t/ha, from a 1993 base of 11.2 t/ha.

From the data on cassava constraints in Asia (Figure 27), it is clear that pests and diseases are relatively unimportant. Soil, management, and intrinsic varietal constraints are the main problems across agroecosystems. Together, they represent 68% of the continent's cassava constraints, while postharvest constraints constitute 18%. The latter are of roughly the same importance as management or intrinsic varietal constraints. Also note the importance of soil related constraints in the semiarid system. Yield potential in Asia is estimated at 24.1 t/ha, from a 1993 base of 12.3 t/ha.

In Africa the lowland humid and subhumid tropics encompass the major cassava areas and thus have the largest share of constraints (Figure 28). With the exceptions of pests and climate, which are important only in the subhumid agroecosystem, all other constraints

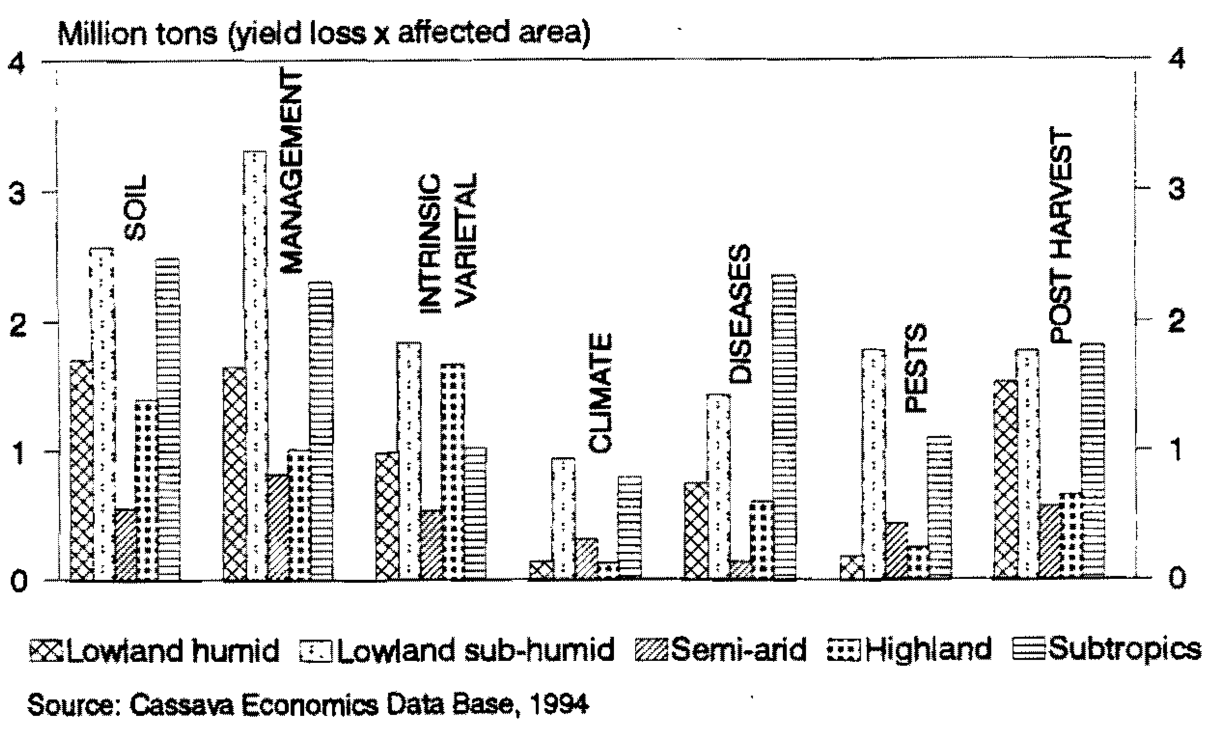
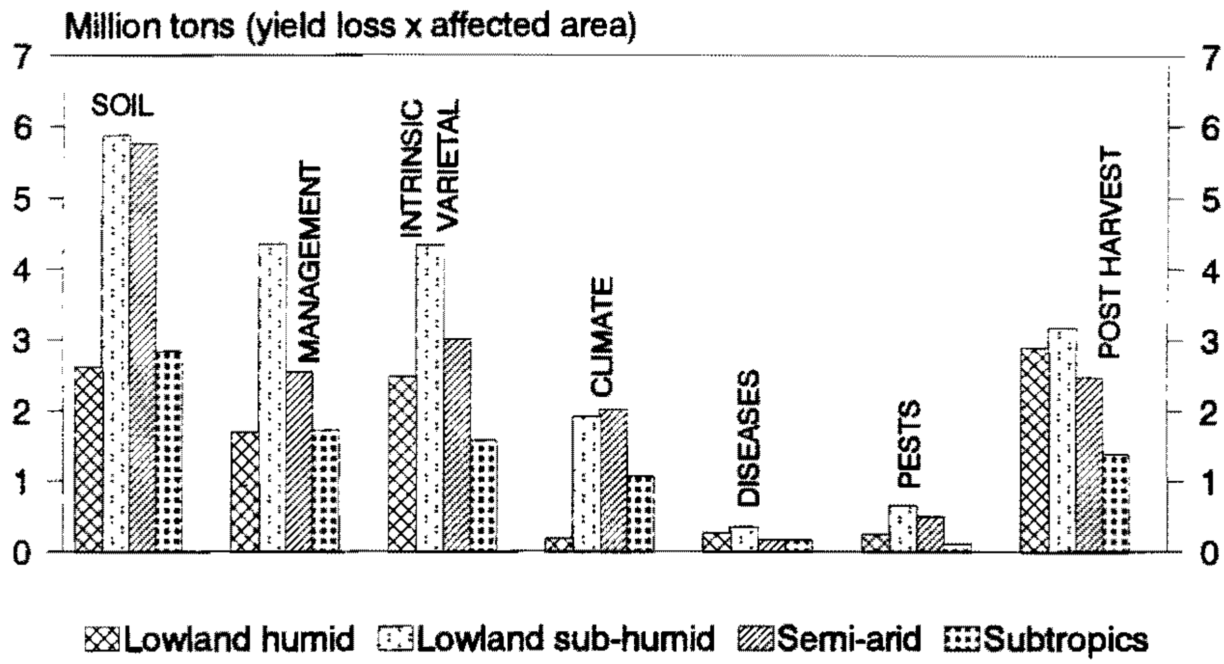
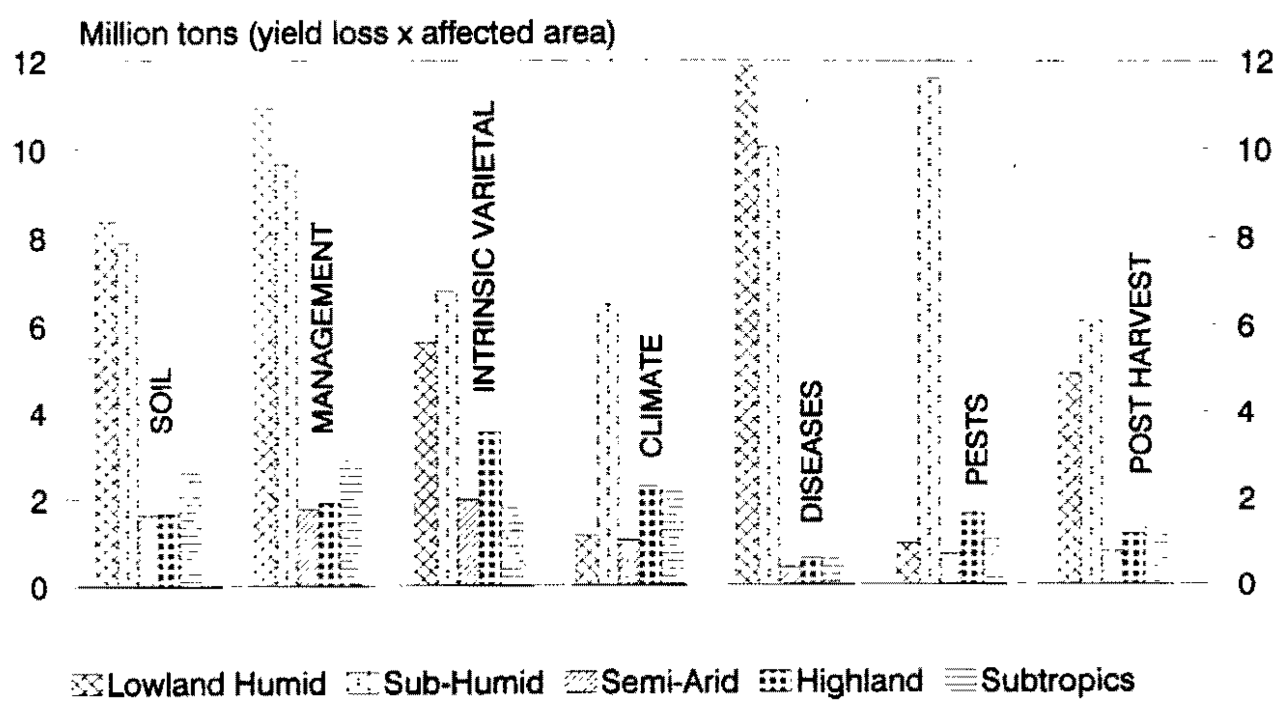


Figure 26. Constraints of cassava in Latin America, by agroecosystem, 1993.



Source: Cassava Economics Data Base, 1994

Figure 27. Constraints of cassava in Asia, by agroecosystem, 1993.



Source: Cassava Economics Data Base, 1994

Figure 28. Constraints of cassava in Africa, by agroecosystem, 1993.

Global Cassava Trends

Reassessing the Crop's Future

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CIAT Cassava Program

October 1996

CIAT
Centro Internacional de Agricultura Tropical
International Center for Tropical Agriculture

Working Document No. 157

The International Center for Tropical Agriculture (CIAT, its Spanish acronym) is dedicated to the alleviation of hunger and poverty in developing countries of the tropics. CIAT applies science to agriculture to increase food production while sustaining the natural resource base.

CIAT is one of 16 international agricultural research centers sponsored by the Consultative Group on International Agricultural Research (CGIAR).

The Center's core budget is financed by 27 donor countries, international and regional development organizations, and private foundations. In 1996, the donor countries include Australia, Belgium, Brazil, Canada, China, Colombia, Denmark, France, Germany, Japan, Mexico, the Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom, and the United States of America. Donor organizations include the European Union (EU), the Ford Foundation, the Inter-American Development Bank (IDB), the International Development Research Centre (IDRC), the International Fund for Agricultural Development (IFAD), the Nippon Foundation, the Rockefeller Foundation, the United Nations Development Programme (UNDP), and the World Bank.

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Contents

Foreword

Opportunities to bring about change in agriculture through technological innovation depend on economic, sociopolitical, and institutional factors within agriculture itself and in the environment with which this sector interacts. A detailed understanding of these factors and of their evolution provides a basis on which to formulate development strategies and set priorities for research. In agriculture this research aims to provide technological innovations that, through more efficient use of natural and human resources, contribute to the overall economic development of a country or region.

International agricultural research institutions, such as CIAT, are in a good position to compile and analyze data, that may not be available to national institutions. The information we generate should help both us and our partners define appropriate research strategies according to the different socioeconomic and institutional conditions in particular regions or countries.

This document is the result of an on-going effort to compile reliable information on global socioeconomic trends in cassava production, processing, and markets and to provide reasonable estimates of the crop's constraints in different environments. We are very grateful to all who have assisted us in this task by providing data and advice.

Information of the sort presented here needs to be reviewed and updated periodically, as circumstances change or new knowledge is generated. For that reason we have published this document in a limited edition to be shared with our principal research partners and collaborators. In the first instance, we hope this publication will be useful in preparing the Global Cassava Development Strategy, an effort spearheaded by the International Fund for Agricultural Development (IFAD). We also hope this information will help in the planning and priority setting of cassava research projects within and among countries.

CIAT is working with the Food and Agriculture Organization of the United Nations (FAO) on a joint publication that will extend the information presented in this document. Any observations you have on the data presented, particularly that related to the quantification of global cassava constraints, will be very useful for improving the accuracy of the information to be published jointly with FAO. We will appreciative any feedback you can provide.

Rupert Best
Leader, CIAT Cassava Program
14 May 1996

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The data presented in this document were compiled and analyzed with the valuable assistance of Norbey Marín and Carlos Chilito. The authors also acknowledge the useful collaboration of Anna Coccia, Christian Chikhani, Guilia Cimino, Maurizio deNigris, and Luigi Di Giorgio of FAO, who supplied data for this study. We are grateful to staff of national cassava programs and the International Institute of Tropical Agriculture (IITA) for providing essential input and feedback for the estimation of cassava sector constraints. Finally, we thank Rupert Best, Mabrouk El-Sharkawy, and Reinhardt Howeler for their comments on initial drafts and Nathan Russell for editing the final version.

seem equally severe in both the lowland humid and subhumid zones. Pests and diseases together account for almost 30% of the cassava constraints in Africa, with management constraints representing 20%. The future yield potential of cassava was estimated at 22.6 t/ha, from a 1993 observed yield base of 9 t/ha.

Interestingly, the yield gap, or difference between the observed 1993 yield and the potential yield, averages about 12 t/ha for each continent. There is thus similar scope worldwide for advances in cassava research and development.

Many scientists, especially biological scientists, are skeptical about methodologies of the sort used in this study to quantify constraints. To produce accurate estimates, they rightly argue, requires robust data, which are sometimes difficult to obtain. Nevertheless, the results and aggregations do lead to lively and extremely useful discussions. Two points to bear in mind are that 1) since constraints (especially biotic constraints) are dynamic, their analysis must also be dynamic, requiring periodic feedback and updating, and 2) the true value of this analysis lies not in its absolute results but in the measure it provides of the relative importance of constraints.

To gauge the validity of the results of the current exercise, we compared them with similar studies in the literature. The only study of similar scope to ours is that published by Sarma and Kunchai (1991), based on a Delphi survey[10] conducted in 1985-1986. However, those authors estimated only potential cassava yields (for the year 2000) by continent. Their estimates were stratified according to two criteria: 1) with/without improved varieties and 2) with/without fertilizer and irrigation.

Sarma and Kunchai estimated the global average yield potential of cassava in farmers' fields at 117.7% with improved varieties on "inferior"[11] soils and 203.6% with improved varieties, "optimal" soils, and irrigation. The present study shows a potential yield ceiling of 126.5%, from a 1993 yield base (see Annex 3). However, this result assumes only that fertilization remains at its "current" levels and that drought is alleviated through new cultural practices and varietal improvement without irrigation.

Arguably, the comparison of these two studies is irrelevant. However, in the absence of a better point of reference, one can conclude that, first, the results of the current exercise are "in the ball park" and, second, that these results are probably rather conservative. Again, the value of the results lies not so much in the absolute numbers as in what it tells us about the relative importance of groups of constraints on different continents and in different agroecosystems.

Future Trends

In the foregoing sections, we have analyzed historic patterns in cassava production and utilization as well as major trends in cassava product markets. This study has also identified and quantified the main constraints of cassava worldwide. In addition, it has touched on current and future advances and impact in cassava research and development. We now turn

[10] The survey was sent to 400 biological and social scientists, considered knowledgeable about cassava, in 57 countries. Of these, 153 responded, and 123 of the responses were usable (Sarma and Kunchai, 1991, pp. 61).

[11] Sarma and Kunchai refer to "inferior" soils as nonimproved cassava soils, while "optimum" soils refer to those improved through fertilization and irrigation.

[12] Sarma and Kunchai adapted a model developed by the International Food Policy Research Institute (IFPRI) to project supply and demand separately for each country, assuming the continuation of past trends in output and per capita income. Annual FAO data for the period 1961-1983 were used to calculate yields in subregions. Semilogarithmic trend growth rates were then computed for area and yield in each subregion. These trends were extrapolated to the year 2000.

[13] The FAO projections were based on the period 1968-1989 and adjusted to take into account current research and development programs and other relevant factors. Demand for food use was projected from expected income and population growth and income elasticities of demand, while trends in feed demand were adjusted in line with current policies. The demand for cassava as food in Africa was also adjusted to reflect urbanization effects.

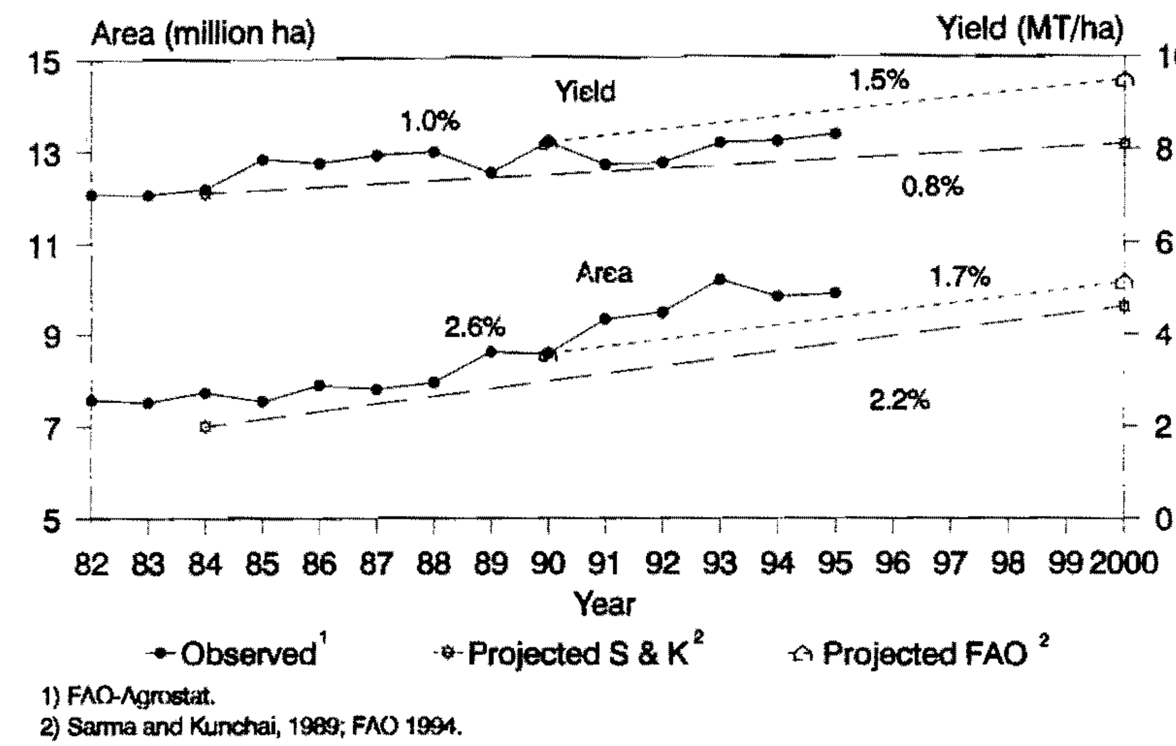

Figure 31. Observed and projected cassava area, yield, and annual growth rates in Latin Africa, 1982-2000.

to a more detailed discussion of future cassava trends. This discussion centers on two sets of projections of cassava production, yield, and area, one by Sarma and Kunchai[12] (1989) and the other by FAO[13] (1994b). The 1982-2000 projections of annual growth rates in cassava yield and area are presented, by continent, in Figures 29, 30, and 31. Each figure includes the 1982-1995 ***observed*** annual growth rates, calculated through simple regression, and Sarma and Kunchai and FAO's ***projected*** annual growth rates.

FAO's figure on yield growth for Latin America (Figure 29) appears to be significantly overestimated at 2.7%. Sarma and Kunchai, on the other hand, seem to slightly underestimate yield growth. One must bear in mind that cassava yields in Brazil have been low since 1991-1992 as a result of the most severe prolonged drought in the history of the country's Northeast. However, at the same time, increased plantings on more fertile lands in southern and central Brazil will boost future average yields. A more realistic estimate of yield growth would be 0.6-0.8%. Estimated projections of area seem to follow the same pattern; both are overestimated by FAO and underestimated by Sarma and Kunchai. Given what we have said about estimates of future yield and strengthening derived demand for roots, especially in southern Brazil, Paraguay, and Colombia, cassava area will at least remain constant or even expand slightly. This would translate into a projected growth rate for area of 0-0.2%.

For Asia (Figure 30), FAO's projected yield increase again seems overly optimistic, while that of Sarma and Kunchai is slightly above the historic trend. The latter is much more in line with current trends and future expectations. The adoption of improved cassava varieties is gaining momentum in India, Thailand, Indonesia, and to a lesser extent in Vietnam and China. Moreover, the demand for roots from the starch industry is partially replacing that from the pellet industry, especially in Thailand. Historic aggregate yields in Asia appear to have been suppressed. On this basis, we assume a future growth rate in yield of 0.5-0.7%. Similar arguments hold with respect to projections of

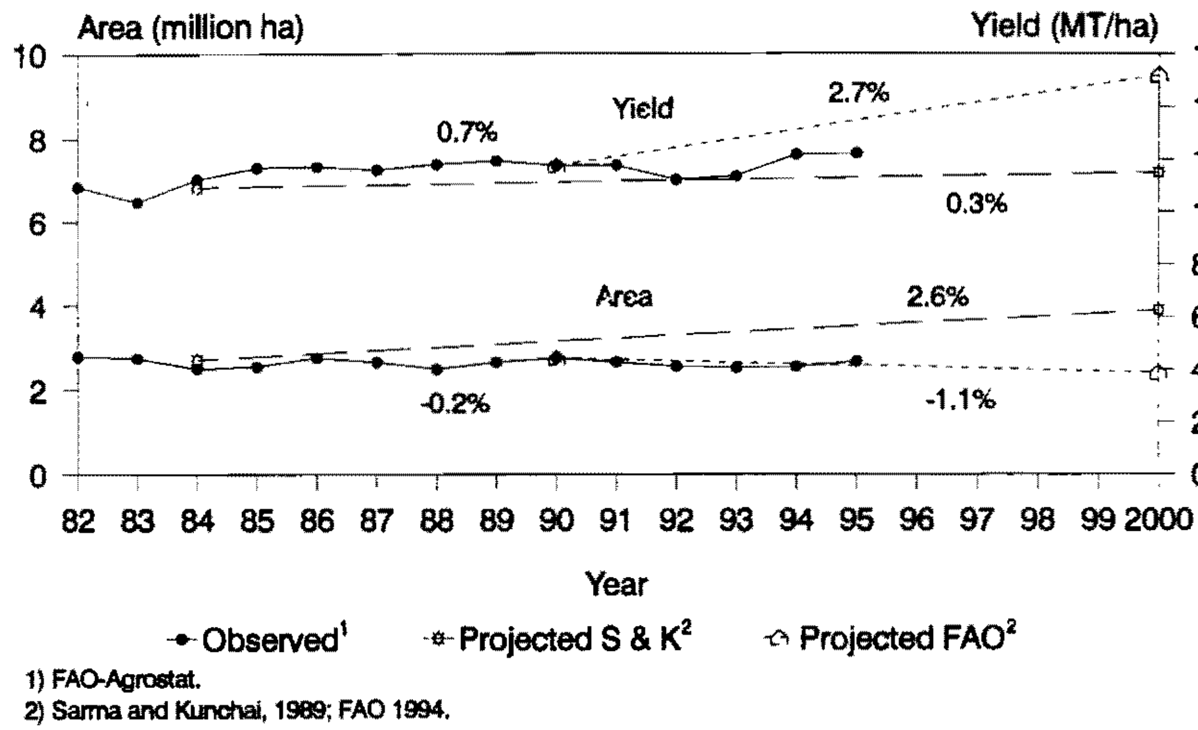

Figure 29. Observed and projected cassava area, yield, and annual growth rates in Latin America, 1982-2000.

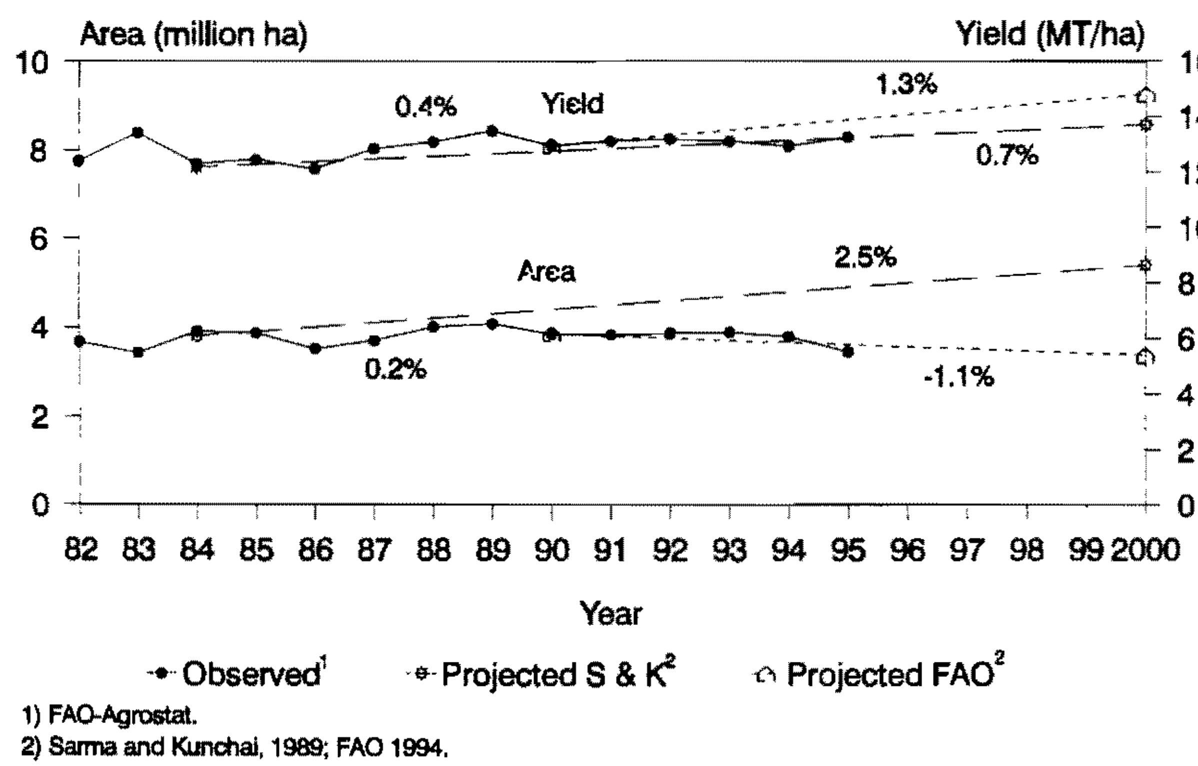

Figure 30. Observed and projected cassava area, yield, and annual growth rates in Asia, 1982-2000.

cassava area in Asia. Cassava plantings in Thailand will further decline. Other Asian countries, however, show sufficient potential for demand growth to force further expansion of cassava area. Sarma and Kunchai and FAO's projections seem either too optimistic or too pessimistic. A more realistic scenario would show growth in area stabilizing at a rate of 0%.

For Africa (Figure 31), the FAO's projected rate of growth in yield seems high, while that of Sarma and Kunchai is somewhat conservative. In the past several years, yields in many African countries have been reduced significantly by drought, green mite, and mosaic virus. On the other hand, improved varieties are being adopted to some extent. Future solutions to the two main biotic constraints will hopefully lead to further yield improvement. It therefore seems realistic to project the rate of yield increase at 0.8-1.0% per annum. As mentioned earlier, cassava area on this continent has expanded recently because of expected threats to food security (such as drought and war) and as a result of changes in government policy, which, of course, could change in the future. It may therefore be overly optimistic to assume a continuation of the historic trend. A realistic projection of Africa's rate of area expansion might have an upper bound of 1.7%, with a lower bound of 1.5%.

If we translate the foregoing projections into rates of growth in cassava production, the following picture emerges. For Latin America this rate would be in the range of 0.6-1.0%, for Asia it would be 0.5-0.7%, and for Africa 2.3-2.7%. Aggregating the figures for individual continents, we project that (to the year 2000) global cassava production will grow at an annual rate of 1.6-2.0%. This is somewhat below the observed trend of 2.0% for 1986-1995.

Conclusions

From the information presented here on historic and future trends in the cassava sector and on its current constraints, we draw a number of general conclusions. It seems interesting and useful to formulate these in light of Lynam's conclusions (1987), which were based on an assessment of the 1961-1984 period and which are summarized in the introduction to this document. Revisiting Lynam's conclusions, we find that:

1. The decline in consumption of fresh cassava in Latin America has been reversed, and there is now a modest increase, especially in Colombia. This is expected to continue in light of lower retail prices for cassava relative to the major substitutes. Improved production and market technologies have been and will be an important prerequisite for sustaining this trend. Positive income elasticities of fresh roots for rural and poor urban populations will form the basis for further growth. This is much in line with Lynam's earlier assessment.

2. Processed cassava for human consumption (e.g., farinha in Brazil or gari in Nigeria) will continue contributing importantly to the daily energy intake of rural and lower- to medium-income urban populations. Cassava continues to play an important role in food security, particularly in Africa. Again, positive income elasticities for the above-mentioned income groups will make the demand for processed cassava sustainable following population and income growth. The demand for processed products will suffer less than that for fresh cassava as urbanization increases. However, the quality of processed products will have to be improved to ensure acceptance, especially by urban consumers. Moreover, in Africa improved marketing channels will have a positive impact on urban consumption levels, as cassava products are slowly transformed from a subsistence to a market orientation. The policies of African governments continue to have a significant impact on the cassava sector. There seems to be a trend in Africa toward the substitution of expensive grain imports for domestic cassava products, as Lynam observed earlier in Brazil.

3. Domestic utilization of dried cassava for animal feed has slowly become more important in Latin America. This trend is reflected both in on-farm feeding and in sales of dried cassava to feed industries. Although feed demand is potentially large, the actual level of growth in the utilization of this product will depend on future developments related to imported feed grains and on reductions in root prices made possible by the adoption of improved technology.

   Lynam could not have anticipated the significant impact of GATT policy changes on Asian, and especially Thai, pellet exports. Cassava product and market diversification in Thailand may not fully offset the reduction in export earnings resulting from erosion of pellet market in the EU. Both foreign and domestic policies will remain key factors in the future of this product.

4. Although Lynam foresaw growing demand for cassava starch, especially in Asia, the real strength of this trend in Asia and in Latin America has become apparent only in the last couple of years. In addition to Thailand, the newly opened economies of China and Vietnam, along with Brazil, Colombia, and Venezuela have joined the stampede into native and modified cassava starch processing. To a large extent, this development has taken pressure off the eroding pellet markets, given that the profit margins of cassava starch processing are substantially higher than those of pellet processing. The starch industry is developing on a large scale, based on advanced technology, at the expense of small-scale processing, especially in Asia. Highly elastic domestic and foreign markets will sustain this development, at least for the intermediate future, assuming that farmers increasingly adopt improved technologies to maintain the cost advantage of cassava roots over alternative raw materials for starch (e.g., grains and sugarcane). Less interventionist government policies in countries that import starch may further boost the demand for this product.

5. Our analysis of constraints in the cassava sector underscores the enormous challenges at hand. Across three continents, the average yield gap is roughly 12 t/ha. Most of the limitations are concentrated in the humid and subhumid agroecosystems. Roughly 60% of the global cassava constraints concern soil, water, and plant management, while almost a fifth are related to postharvest issues, such as product quality, processing, and marketing. The latter estimate does not take into account the potential for product and market diversification. A central conclusion of this exercise is that to sustain yield improvements and growth in supply, postharvest issues, especially the improvement of products and broadening of cassava-based markets, must receive increased global attention.

6. Future cassava production will be much in line with historic levels over the last de cade. The largest share of additional cassava supplies will continue to be pro duced in Africa. However, it is predicted that cassava production in Latin America will pick up slightly, while Asia's cassava supplies will grow at the same or a slightly slower rate than in the last decade. Improved yields, rather than area expansion, will be the driving force of this growth in Asia.

The picture of the global cassava sector depicted in this publication confirms the crop's changing role in developing economies. In Asia the crop has essentially completed its evolution from a basic rural staple to a multiuse source of carbohydrates. In Latin america the transition is still under way, while in Africa this development is still in its initial stages. The evidence suggests that, with careful and targeted support, cassava production can serve as a vehicle for economic development in regions where the crop is grown.

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Annex 1: Cassava Production, Area, Yield, Trade, and Annual Growth Rates, by Continent and in Selected Countries

Trends in cassava production, area, and yield, by continent, 1973-1995

Continent	Production (000 MT)			Area (000 ha)			Yield (MT/ha)		
	73-75	83-85	93-95	73-75	83-85	93-95	73-75	83-85	93-95
Africa	43,117	55,262	81,867	7,177	7,873	9,837	6.0	7.0	8.3
Asia	30,167	47,782	48,646	2,925	3,744	3,712	10.3	12.8	13.1
Latin America	31,652	28,670	30,886	2,718	2,585	2,587	11.6	11.1	11.9
World	104,936	131,714	161,399	12,820	14,202	16,136	8.2	9.3	10.0

Note: Columns may not add exactly due to rounding.

SOURCE: FAO, FAOSTAT 1996.

Annual growth rates in cassava production, area, and yield, by continent, 1976-1995

Continent	Production		Area		Yield	
	76-85	86-95	76-85	86-95	76-85	86-95
Africa	2.6	4.1	1.3	2.2	1.3	1.9
Asia	3.0	0.3	1.4	-0.9	1.7	1.2
Latin America	-1.2	0.0	-1.1	-0.3	-0.1	0.2
World	1.8	2.0	0.8	1.0	1.0	1.0

SOURCE: Calculated from FAO, FAOSTAT 1996.

Annual growth rates for cassava in Africa, 1976-1995

Country	Production (%)		Area (%)		Yield (%)	
	76-85	86-95	76-85	86-95	76-85	86-95
Nigeria	1.7	9.4	1.4	10.1	0.3	-0.7
Zaire	3.2	1.5	2.5	0.1	0.7	1.4
Tanzania	4.3	0.8	4.5	-1.4	-0.2	2.2
Ghana	6.7	8.6	3.4	5.2	3.3	3.5
Mozambique	1.9	0.8	-0.7	6.1	2.7	5.3
Uganda	1.0	0.0	-5.1	-0.1	6.1	0.2
Madagascar	5.0	0.0	5.4	0.0	-0.5	0.0
Angola	1.6	-4.2	0.6	-16.6	1.0	12.4
Cote d'Ivore	2.4	2.5	2.0	4.1	0.4	-1.6
Cameroon	4.0	-1.4	-0.7	-25.7	4.6	24.3
Benin	0.1	6.7	1.2	4.0	-1.2	2.7
Guinea	-3.1	11.1	-2.7	3.5	-0.4	7.6
Kenya	-4.0	5.8	-4.8	6.7	0.8	-0.9
Congo	2.8	-2.2	0.7	-1.4	2.2	-0.9
Central African Rep.	-4.1	1.6	-7.5	1.6	3.3	0.0
Zambia	2.8	13.7	2.3	8.0	0.6	5.7
Burundi	1.2	-1.4	1.7	2.5	-0.5	-3.9
Togo	1.9	1.3	18.0	4.2	-16.1	-2.9
Liberia	-1.3	1.0	-0.1	0.4	-1.2	0.6
Chad	6.9	-4.2	4.6	0.7	2.3	-4.9
Rwanda	3.2	-4.1	4.5	1.2	-1.3	-5.3
Niger	-1.3	1.7	-0.3	1.6	-1.0	0.1
Gabon	1.9	-2.6	0.7	-0.7	1.3	-1.8
Malawi	-3.5	1.4	7.5	1.2	-11.0	0.2
Zimbabwe	5.7	5.8	2.0	6.3	3.7	-0.5
Sierra Leone	2.5	6.0	7.6	0.3	-5.1	5.7
Mali	5.4	-37.7	4.4	-37.8	1.0	0.1
Senegal	-14.1	-0.1	-13.8	5.6	-0.3	-5.7
Equatorial Guinea	1.0	-1.2	2.2	-2.5	-1.2	1.2
Somalia	2.3	-1.5	2.8	-0.3	-0.5	-1.2
Sudan	0.3	-28.8	0.1	-25.4	0.1	-3.5
Africa	2.6	4.1	1.3	2.2	1.3	1.9

SOURCE: Calculated from FAO, FAOSTAT, 1996.

Trends in Africa's cassava production, area, and yield, 1973-1995

Country	Production (000 MT)			Area (000 ha)			Yield (Mt/ha)		
	73-75	83-85	93-95	73-75	83-84	93-95	73-75	83-85	93-95
Nigeria	10,067	11,750	30,770	1,007	1,200	2,889	10.4	9.2	10.6
Zaire	11,345	15,044	18,405	1,648	2,093	2,225	6.8	7.2	8.0
Tanzania	4,477	6,854	6,670	783	673	645	4.8	10.3	10.4
Ghana	1,700	2,956	5,417	245	312	540	7.3	9.0	7.2
Mozambique	2,517	3,183	3,661	517	540	912	5.2	5.8	3.7
Uganda	2,491	2,607	2,615	529	358	346	5.4	7.6	8.5
Madagascar	1,249	2,060	2,303	195	338	336	6.3	6.1	6.8
Angola	1,673	1,950	1,482	480	500	260	3.4	3.9	3.6
Cote d'Ivore	729	1,187	1,554	180	224	309	3.4	5.2	5.1
Cameroon	788	1,309	1,300	492	510	80	1.6	2.6	16.3
Benin	580	658	1,126	90	98	135	6.1	6.7	8.4
Guinea	604	487	916	81	70	113	7.0	7.0	7.6
Kenya	550	568	790	86	71	104	8.1	6.7	8.3
Congo	518	690	631	102	96	96	4.9	7.1	6.9
Central African Rep.	898	672	620	290	181	180	3.2	3.6	3.3
Zambia	166	210	577	53	62	115	3.1	3.4	5.0
Burundi	405	486	533	37	43	61	10.9	11.2	8.9
Togo	417	421	423	21	80	71	19.5	4.2	6.8
Liberia	251	257	383	45	45	50	5.7	5.9	7.5
Chad	145	273	243	46	66	73	3.1	3.9	4.0
Rwanda	373	534	317	30	50	47	12.2	11.5	6.2
Niger	177	174	223	30	22	30	6.0	7.4	7.5
Gabon	173	252	200	34	42	40	5.0	6.0	5.0
Malawi	254	204	205	38	74	75	6.6	4.1	2.5
Zimbabwe	48	77	130	16	19	33	3.0	3.7	3.9
Sierra Leone	82	105	186	17	31	34	4.9	3.2	4.6
Mali	35	73	25	5	8	3	6.8	8.7	9.1
Senegal	120	22	66	33	7	26	4.0	3.1	2.5
Equatorial Guinea	47	54	47	19	25	18	2.6	2.2	2.6
Somalia	28	40	38	3	4	4	10.8	10.7	9.6
Sudan	121	105	8	38	41	5	3.4	2.7	1.7
Africa	43,117	55,262	81,867	7,177	7,873	9,837	6.0	7.0	8.3

Columns may not add exactly due to rounding.

SOURCE: FAO, FAOSTAT 1996.

Trends in Asia's cassava production, area and yield, 1973-1995

Country	Production (000 MT)			Area (000 ha)			Yield (MT/ha)		
	73-75	83-85	93-95	73-75	83-85	93-95	73-75	83-85	93-95
Thailand	6,334	19,412	18,331	460	1,243	1,315	13.8	15.6	13.9
Indonesia	12,254	13,442	15,989	1,449	1,287	1,341	8.5	10.4	11.9
India	6,373	5,630	5,732	373	309	245	17.1	18.2	23.4
China	2,361	3,802	3,470	194	245	230	12.2	15.5	15.1
Vietnam	1,130	2,713	2,370	153	333	274	7.4	8.1	8.7
Philippines	581	1,482	1,848	101	211	212	5.8	7.0	8.7
Malaysia	336	380	435	29	35	42	11.6	10.9	10.4
Sri Lanka	701	661	302	154	55	34	4.6	12.0	8.9
Cambodia	35	95	33	4	13	7	8.8	7.3	4.7
Laos	22	77	68	1	5	5	22.0	15.4	13.6
Myanmar	23	86	67	2	8	7	11.5	10.8	9.6
Brunei Darus	2	1	1	0	0	0	8.8	8.9	12.5
Singapore	2	0	0	0	0	0	10.0	11.0	10.0
East Timor	12	0	0	5	0	0	2.4		
Asia	30,167	47,782	48,646	2,925	3,744	3,712	10.3	12.8	13.1

Columns may not add exactly due to rounding.

SOURCE: FAO, FAOSTAT 1996.

Annual growth rates for cassava in Asia, 1976-1995

Country	Production (%)		Area (%)		Yield (%)	
	76-85	86-95	76-85	86-95	76-85	86-95
Thailand	7.0	-0.6	6.4	-0.7	0.6	0.2
Indonesia	1.0	1.4	-0.8	-0.9	1.8	2.3
India	-1.6	2.1	-2.9	-1.3	1.3	3.3
China	5.3	0.3	2.4	-0.1	2.8	0.4
Vietnam	1.2	-2.1	0.7	-1.9	0.5	-0.2
Philippines	1.8	0.5	3.5	-0.1	-1.8	0.6
Malaysia	1.0	1.6	0.2	1.8	0.8	-0.2
Sri Lanka	0.3	-6.2	-8.6	-5.3	8.9	-1.9
Cambodia	-2.2	-18.6	-1.8	-14.4	-0.5	-3.4
Laos	8.2	-3.0	9.2	-2.6	-1.0	-0.4
Myanmar	20.5	-4.5	17.6	-2.0	2.9	-2.5
Brunei Darus	-11.7	3.1	-12.6	-0.4	0.9	4.5
Singapore	-14.3	-36.5	-14.2	-35.3	-0.1	0.0
Asia	3.0	0.3	1.4	-0.9	1.7	1.2

SOURCE: Calculated from FAO, FAOSTAT 1996.

Trends in Latin America's cassava production, area, and yield, 1973-1995

Country	Production (000 MT)			Area (000 ha)			Yield (MT/ha)		
	73-75	83-85	93-95	73-75	83-85	93-95	73-75	83-85	93-95
Brazil	25,814	22,146	24,117	2,050	1,915	1,876	12.6	11.6	12.9
Paraguay	1,310	2,749	2,602	89	184	178	14.7	14.9	14.6
Colombia	2,048	1,436	1,848	252	160	187	8.1	9.0	9.9
Bolivia	267	279	338	20	30	37	13.4	9.3	9.1
Peru	443	462	484	37	33	46	12.0	14.0	10.5
Haiti	225	267	330	53	65	82	4.2	4.1	4.0
Venezuela	294	322	297	37	41	36	7.9	7.9	8.3
Cuba	238	337	277	57	77	68	4.2	4.4	4.1
Argentina	258	135	153	21	15	15	12.3	9.0	10.2
Dominican Rep.	193	111	105	38	19	18	5.1	5.8	5.8
Ecuador	377	221	77	40	22	19	9.4	10.0	4.1
Costa Rica	11	19	68	2	5	4	5.5	3.8	17.0
Nicaragua	21	66	52	5	6	5	4.2	11.0	10.4
El Salvador	16	27	45	1	2	2	16.0	13.5	22.5
Panama	40	34	31	5	5	6	8.0	6.8	5.2
Honduras	12	7	20	3	0	2	4.0	17.9	10.0
Jamaica	16	18	20	2	2	1	8.0	9.0	20.0
Guatemala	7	9	15	3	3	5	2.3	3.0	3.0
Suriname	2	3	4	0	0	0	6.2	6.5	14.4
Barbados	1	1	1	0	0	0	26.2	24.0	27.5
Mexico	54	19	1	3	1	0	18.0	19.0	9.3
Trinidad & Tobago	5	2	1	0	0	0	12.3	11.4	1.1
Latin America	31,652	28,670	30,886	2,718	2,585	2,587	11.6	11.1	11.9

Columns may not add exactly due to rounding.

SOURCE: FAO, FAOSTAT 1996.

Annual growth rates for cassava in Latin America, 1976-1995

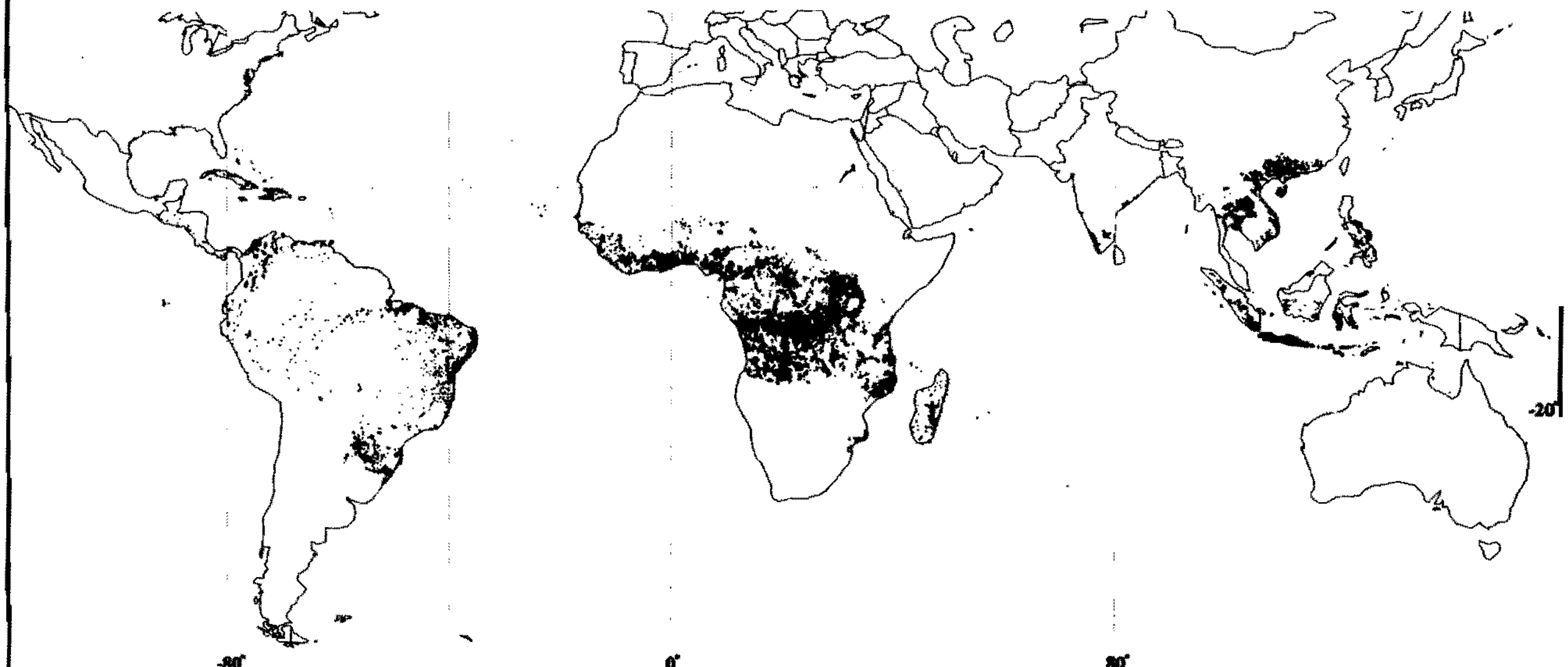
Country	Production (%)		Area (%)		Yield (%)	
	76-85	86-95	76-85	86-95	76-85	86-95
Brazil	-1.8	0.2	-1.5	-0.3	-0.3	0.5
Paraguay	6.9	-4.0	7.0	-2.8	-0.2	-1.2
Colombia	-4.3	4.7	-4.9	2.6	0.6	2.1
Bolivia	1.0	-3.3	5.7	-1.6	-4.6	-1.7
Peru	1.2	2.9	-0.9	3.2	2.1	-0.3
Haiti	1.0	1.9	1.7	2.2	-0.8	-0.3
Venezuela	0.8	-1.0	-0.2	-1.4	0.9	0.4
Cuba	2.3	-1.1	2.3	-0.4	0.0	-0.6
Argentina	-4.8	0.2	-4.6	1.2	-0.3	-1.1
Dominican Rep.	-6.7	-0.7	-9.7	-2.3	3.0	1.6
Ecuador	-1.5	-7.0	-3.8	-1.4	2.3	-5.6
Costa Rica	4.0	13.0	9.0	-7.9	-5.0	20.9
Nicaragua	14.7	-3.6	1.8	-3.3	12.9	-0.3
El Salvador	9.5	7.1	4.7	3.0	4.7	4.1
Panama	-2.1	-1.6	0.9	2.2	-3.1	-3.8
Honduras	-3.2	8.2	-28.4	17.0	25.2	-8.8
Jamaica	-5.1	3.2	-7.4	0.1	2.4	3.1
Guatemala	2.6	7.1	0.8	6.9	1.8	0.2
Suriname	3.7	1.0	3.5	-4.9	0.2	6.0
Barbados	0.7	-9.4	1.3	-11.2	-0.6	1.7
Mexico	-26.0	-0.9	-22.1	-3.9	-3.9	3.0
Trinidad & Tobago	-17.5	7.9	-16.2	7.7	-1.3	0.3
Latin America	-1.2	0.0	-1.1	-0.3	-0.1	0.2

SOURCE: Calculated from FAO, FAOSTAT 1996.

Trends in cassava trade, 1983-1995

	Average for 1983-1985 (000 MT)	Average for 1992-1994 (000 MT)	Annual growth rate (%) 1985-1994
World exports	6,982	9,283	1.2
Developing Countries	6,982	9,283	1.2
Latin America	18	50	11.06
Africa		50	
Asia	6,963	9,183	1.15
China	107	313	6.51
Indonesia	423	1,077	8.17
Thailand	6,433	7,727	0.18
Vietnam		30	
World imports	7,000	9,257	0.6
Developing countries	733	2,133	11.66
Latin America	18	63	-24.85
Africa		43	
Asia	663	2,030	12.06
China	303	763	11.89
South Korea	195	633	12.22
Developed countries	6,267	7,123	-1.39
North America	63	120	1.21
Europe	5,747	6,420	-1.31
CEE	5,530	6,397	-0.67
URSS and Eastern Europe	217	20	-45.13
Other developed countries	383	563	0.23
Israel	90	70	6.89
Japan	323	477	0.17

SOURCE: FAO, Situación y Perspectiva de los Productos Básicos (various years).



Annex 2: Map of World Cassava Distribution

each dot represents 1000 ha.

Miller Projection

CIAT

April 1995

Annex 3: Cassava sector constraints results by agro-ecological region and continent

Cassava sector constraints for the Lowland Humid Tropics, by continent

AGROECOLOGICAL ZONE	LOWLAND HUMID TROPICS											
CONTINENT	LATIN AMERICA				ASIA				AFRICA			
CASSAVA AREA	417 HA (000)				690 HA (000)				3033 HA (000)			
AVERAGE YIELD	11 8 T/HA				13 3 T/HA				8 7 T/HA			
ESTIMATED POTENTIAL YIELD	23.9 T/HA				26.0 T/HA				24 0 T/HA			
CALCULATED POTENTIAL YIELD	24 7 T/HA				24 1 T/HA				21 5 T/HA			
TOTAL POTEN YIELD GAINS (MT)	5396 MT (000)				7459 MT (000)				38842 MT (000)			
CONSTRAINTS	YLD GAIN AFF AREA	% AREA AFFEC	TOTAL % YLD GAIN	TONS YLD GAIN (000)	YLD GAIN AFF AREA	% AREA AFFEC	TOTAL % YLD GAIN	TONS YLD GAIN (000)	YLD GAIN AFF AREA	% AREA AFFEC	TOTAL % YLD GAIN	TONS YLD GAIN (000)
SOIL			35	1702			28	2615			32	8352
LOW SOIL FERTILITY	33	73	24	1185	30	70	21	1927	33	80	26	6966
SOIL EROSION	15	70	11	517	15	50	8	688	15	35	5	1385
SALINITY			0	0			0	0			0	0
SURFACE TEMP			0	0			0	0			0	0
MANAGEMENT			34	1651			18	1689			41	10924
SUB-OPT LAND PREP	5	40	2	98			0	0	6	50	4	1055
POOR PLANTING MATERIAL QUALITY	23	72	17	815	15	36	5	496	27	70	19	4987
INADEQUATE SPACING	10	50	5	246	10	50	5	459	5	50	3	660
WEEDS	20	50	10	492	20	40	8	734	20	80	16	4222
INTRINSIC VARIETAL TRAITS			20	984			27	2478			21	5607
LOW YIELD-POTENTIAL VARIETIES	25	80	20	984	30	90	27	2478	25	85	21	5607
CLIMATE			3	138			2	184			4	1135
DROUGHT	3	10	0	15	10	20	2	184	3	10	0	79
WATER LOGGING	50	5	3	123			0	0	40	10	4	1055
LOW WINTER TEMP PLNT DATE			0	0			0	0			0	0
DISEASES			15	742			3	255			45	11874
ROOT ROT	26	28	7	358	10	11	1	101	20	15	3	792
BACTERIAL BLIGHT	3	18	1	27	5	24	1	110	20	60	12	3166
SUPERELONGATION	5	7	0	17			0	0			0	0
ANTHRACNOSE	5	18	1	44	2	24	0	44	10	50	5	1319
ACMV			0	0			0	0	25	100	25	6597
FROGSKIN	20	30	6	295			0	0			0	0
CCMV			0	0			0	0			0	0
OTHER VIRUS/MYCOPLASMA			0	0			0	0			0	0
VEIN MOSAIC			0	0			0	0			0	0
BROWN STREAK			0	0			0	0			0	0
LEAF/STEM PATHOGENS	5	100	5	246								
PESTS			4	180			3	239			4	950
SPIDER MITE			0	0	10	20	2	184	10	10	1	264
MEALYBUG	3	10	0	15			0	0	6	10	1	158
BURROWING BUG			0	0			0	0			0	0
BURROWING BUG/MEALYBUG			0	0			0	0			0	0
THRIPS	2	10	0	10			0	0			0	0
HORNWORM	11	5	1	27			0	0			0	0
ANTS			0	0			0	0			0	0
WHITEFLY	1	10	0	5			0	0	0	100	0	0
LACEBUG			0	0			0	0			0	0
TERMITES			0	0			0	0			0	0
SHOOT FLIES			0	0			0	0			0	0
MAMMALIAN PESTS	5	50	3	123	5	10	1	48	5	40	2	528
SCALE INSECTS			0	0			0	0			0	0
TIPACOLA PLAGIATA			0	0	10	1	0	9			0	0
WHITE GRUBS			0	0			0	0			0	0
TOTAL YIELD INCREASE (%)			110	5396			81	7459			147	38842
POST HARVEST			31	1525			32	2891			19	4882
QUALITY	35	60	21	1033	25	90	23	2065	25	50	13	3298
PROCESSING	15	40	6	295	15	20	3	275	15	30	5	1187
PRODUCT/MKT	20	20	4	197	20	30	6	551	10	15	2	396
TOTAL POST HARVEST INCREASE (%)			31	1525			32	2891			19	4882
TOTAL CASSAVA SECTOR (%)			141	6922			113	10350			186	43723

Cassava sector constraints for the Lowland Sub-humid Tropics, by continent

AGROECOLOGICAL ZONE	LOWLAND SUB-HUMID TROPICS											
CONTINENT	LATIN AMERICA				ASIA				AFRICA			
CASSAVA AREA	918 HA (000)				1604 HA				3390 HA			
AVERAGE YIELD	10.0 T/HA				12.0 T/HA				10.0 T/HA			
ESTIMATED POTENTIAL YIELD	20.0 T/HA				25.0 T/HA				21.0 T/HA			
CALCULATED POTENTIAL YIELD	22.9 T/HA				22.9 T/HA				25.5 T/HA			
TOTAL POTENTIAL YIELD GAINS (MT)	11855 MT (000)				17452 MT (000)				52423 MT (000)			
CONSTRAINTS	YLD GAIN IN AFF AREA	% AREA AFFEC	TOTAL % YLD GAIN	TONS YLD GAIN (000)	YLD GAIN IN AFF AREA	% AREA AFFEC	TOTAL % YLD GAIN	TONS YLD GAIN (000)	YLD GAIN IN AFF AREA	% AREA AFFEC	TOTAL % YLD GAIN	TONS YLD GAIN (000)
SOIL			28	2571			31	5871			23	7882
LOW SOIL FERTILITY	30	60	18	1652	25	66	17	3176	25	81	20	6865
SOIL EROSION	20	50	10	918	20	70	14	2695	10	25	3	848
SALINITY	1	1	0	1			0	0	10	5	1	170
SURFACE TEMP			0	0			0	0			0	0
MANAGEMENT			36	3305			23	4350			29	9662
SUB-OPT LAND PREP	10	40	4	367	10	50	5	962	10	60	6	2034
POOR PLANTING MATERIAL QUALIT	25	72	18	1652	15	44	7	1270	20	50	10	3390
INADEQUATE SPACING	10	50	5	459	10	50	5	962	10	50	5	1695
WEEDS	15	60	9	826	15	40	6	1155	15	50	8	2543
INTRINSIC VARIETAL TRAITS			20	1836			23	4331			20	6780
LOW YIELD-POTENTIAL VARIETIES	25	80	20	1836	25	90	23	4331	25	80	20	6780
CLIMATE			10	936			10	1906			19	6475
DROUGHT	17	60	10	936	18	55	10	1906	23	70	16	5458
WATER LOGGING			0	0			0	0	20	15	3	1017
LOW WINTER TEMP PLNT DATE			0	0			0	0			0	0
DISEASES			16	1430			2	346			30	10031
ROOT ROT	33	25	8	757	4	6	0	46	9	11	1	336
BACTERIAL BLIGHT	9	17	2	140	6	15	1	173	20	50	10	3390
SUPERELONGATION	10	7	1	64			0	0			0	0
ANTHRACNOSE	14	30	4	386	3	6	0	35	5	20	1	339
ACMV			0	0	6	8	0	92	22	80	18	5966
FROGSKIN	5	4	0	18			0	0			0	0
CCMV			0	0			0	0			0	0
OTHER VIRUS/MYCOPLASMA	3	10	0	28			0	0			0	0
VEIN MOSAIC	5	8	0	37			0	0			0	0
BROWN STREAK			0	0			0	0			0	0
LEAF/STEM PATHOGENS	3	100	3	275	3	100	3	577	3	100	3	1017
PESTS			19	1776			3	649			34	11594
SPIDER MITE	15	60	9	826	6	30	2	462	30	80	24	8136
MEALYBUG	5	20	1	92	3	1	0	6	10	60	6	2034
BURROWING BUG	15	5	1	69			0	0			0	0
BURROWING BUG/MEALYBUG			0	0			0	0			0	0
THRIPS	5	15	1	69			0	0			0	0
HORNWORM	15	15	2	207			0	0			0	0
ANTS			0	0			0	0			0	0
WHITEFLY	5	60	3	275	3	3	0	17			0	0
LACEBUG	5	50	3	230			0	0			0	0
TERMITES	7	5	0	9	2	5	0	19	5	20	1	339
SHOOT FLIES			0	0			0	0			0	0
MAMMALIAN PESTS			0	0			0	0	5	55	3	932
SCALE INSECTS			0	0	5	15	1	144	3	15	0	153
TIPACOLA PLAGIATA			0	0			0	0			0	0
WHITE GRUBS			0	0			0	0			0	0
TOTAL POTENTIAL INCREASE (%)			129	11855			91	17452			155	52423
POST HARVEST			19	1767			17	3176			18	6102
QUALITY	35	40	14	1285	15	60	9	1732	25	50	13	4238
PROCESSING	15	15	2	207	15	30	5	866	15	30	5	1526
PRODUCT/MKT	20	15	3	275	20	15	3	577	10	10	1	339
TOTAL POST HARVEST INCREASE (%)			19	1767			17	3176			18	6102
TOTAL CASSAVA SECTOR (%)			148	13622			107	20628			173	58525

Cassava sector constraints for the Semi-arid Tropics, by continent

AGROECOLOGICAL ZONE	SEMI-ARID TROPICS											
CONTINENT	LATIN AMERICA				ASIA				AFRICA			
CASSAVA AREA	222 HA (000)				1029 HA				714 HA			
AVERAGE YIELD	7 0 T/HA				13 0 T/HA				8 0 T/HA			
ESTIMATED POTENTIAL YIELD	15 0 T/HA				20 0 T/HA				15 0 T/HA			
CALCULATED POTENTIAL YIELD	19 4 T/HA				26.6 T/HA				18 5 T/HA			
TOTAL POTENTIAL YIELD GAINS (MT)	2760 MT (000)				13956 MT (000)				7493 MT (000)			
CONSTRAINTS	YLD GAIN IN AFF AREA	% AREA AFFEC	TOTAL % YLD GAIN	TONS YLD GAIN (000)	YLD GAIN IN AFF AREA	% AREA AFFEC	TOTAL % YLD GAIN	TONS YLD GAIN (000)	YLD GAIN IN AFF AREA	% AREA AFFEC.	TOTAL % YLD GAIN	TONS YLD GAIN (000)
SOIL			35	549			43	5752			38	1628
LOW SOIL FERTILITY	19	70	13	207	40	70	28	3746	20	90	18	771
SOIL EROSION	20	50	10	155	10	50	5	669	10	50	5	214
SALINITY			0	0			0	0			0	0
SURFACE TEMP	15	80	12	186	10	100	10	1338	15	100	15	643
MANAGEMENT			53	816			19	2542			41	1756
SUB-OPT LAND PREP	5	40	2	31	5	30	2	201	5	70	4	150
POOR PLANTING MATERIAL QUALIT	40	100	40	622	19	50	10	1271	30	100	30	1285
INADEQUATE SPACING	5	50	3	39	5	40	2	268	5	60	3	129
WEEDS	20	40	8	124	20	30	6	803	15	30	5	193
INTRINSIC VARIETAL TRAITS			34	528			23	3010			46	1971
LOW YIELD-POTENTIAL VARIETIES	40	85	34	528	26	90	23	3010	46	100	46	1971
CLIMATE			20	311			15	2007			24	1028
DROUGHT	20	100	20	311	15	100	15	2007	24	100	24	1028
WATER LOGGING			0	0			0	0			0	0
LOW WINTER TEMP PLNT DATE			0	0			0	0			0	0
DISEASES			9	134			1	161			10	407
ROOT ROT	16	27	4	67			0	0			0	0
BACTERIAL BLIGHT	5	10	1	8	5	20	1	134	8	50	4	171
SUPERELONGATION			0	0			0	0			0	0
ANTHRACNOSE	4	20	1	12	1	20	0	27	1	10	0	4
ACMV			0	0			0	0	9	60	5	231
FROGSKIN			0	0			0	0			0	0
CCMV			0	0			0	0			0	0
OTHER VIRUS/MYCOPLASMA			0	0			0	0			0	0
VEIN MOSAIC	10	30	3	47			0	0			0	0
BROWN STREAK			0	0			0	0			0	0
LEAF/STEM PATHOGENS	2	100	2	31	2	100	2	268	2	100	2	86
PESTS			27	423			4	486			16	703
SPIDER MITE	23	80	18	286	5	55	3	368	10	30	3	129
MEALYBUG	8	20	1	16	3	1	0	4	20	47	9	403
BURROWING BUG			0	0			0	0			0	0
BURROWING BUG/MEALYBUG			0	0			0	0			0	0
THRIPS	4	16	1	10			0	0			0	0
HORNWORM	15	5	1	12			0	0			0	0
ANTS	2	20	0	6			0	0			0	0
WHITEFLY	5	50	3	39	5	5	0	33			0	0
LACEBUG	7	50	4	54			0	0			0	0
TERMITES			0	0	2	5	0	13	10	30	3	129
SHOOT FLIES			0	0			0	0			0	0
MAMMALIAN PESTS			0	0			0	0			0	0
SCALE INSECTS			0	0	5	10	1	67	5	20	1	43
TIPACOLA PLAGIATA			0	0			0	0			0	0
WHITE GRUBS			0	0			0	0			0	0
TOTAL POTENTIAL INCREASE (%)			178	2760			104	13956			175	7493
POST HARVEST			36	559			19	2475			18	771
QUALITY	30	75	23	350	25	50	13	1672	25	50	13	536
PROCESSING	15	50	8	117	15	20	3	401	15	30	5	193
PRODUCT/MKT	20	30	6	93	20	15	3	401	10	10	1	43
TOTAL POST HARVEST INCREASE (%)			36	559			19	2475			18	771
TOTAL CASSAVA SECTOR (%)			214	3319			123	16431			193	8264

Cassava sector constraints for the Highland Tropics, by continent

AGROECOLOGICAL ZONE	HIGHLAND TROPICS											
CONTINENT	LATIN AMERICA				ASIA				AFRICA			
CASSAVA AREA.	417 HA (000)				0 HA				892 HA			
AVERAGE YIELD	10.0 T/HA				T/HA				8.0 T/HA			
ESTIMATED POTENTIAL YIELD.	20 0 T/HA				T/HA				18.0 T/HA			
CALCULATED POTENTIAL YIELD	22 1 T/HA				T/HA				21.0 T/HA			
TOTAL POTENTIAL YIELD GAINS (MT)	5045 MT (000)				0 MT (000)				11607 MT (000)			
CONSTRAINTS	YLD GAIN IN AFF AREA	% AREA AFFEC.	TOTAL % YLD GAIN	TONS YLD GAIN (000)	YLD GAIN IN AFF AREA	% AREA AFFEC	TOTAL % YLD GAIN	TONS YLD GAIN (000)	YLD GAIN IN AFF AREA	% AREA AFFEC	TOTAL % YLD GAIN	TONS YLD GAIN (000)
SOIL			34	1397			0	0			23	1641
LOW SOIL FERTILITY	37	50	19	771			0	0	20	75	15	1070
SOIL EROSION	25	60	15	626			0	0	20	40	8	571
SALINITY			0	0			0	0			0	0
SURFACE TEMP			0	0			0	0			0	0
MANAGEMENT			24	1008			0	0			27	1895
SUB-OPT LAND PREP	15	25	4	156			0	0	15	25	4	268
POOR PLANTING MATERIAL QUALIT	14	53	7	309			0	0	16	60	13	913
INADEQUATE SPACING	10	50	5	209			0	0	10	50	5	357
WEEDS	10	80	8	334			0	0	10	50	5	357
INTRINSIC VARIETAL TRAITS			40	1668			0	0			50	3532
LOW YIELD-POTENTIAL VARIETIES	50	80	40	1668			0	0	55	90	50	3532
CLIMATE			3	125			0	0			32	2284
DROUGHT	10	30	3	125			0	0	40	80	32	2284
WATER LOGGING			0	0			0	0			0	0
LOW WINTER TEMP PLNT DATE			0	0			0	0			0	0
DISEASES			14	603			0	0			9	614
ROOT ROT	12	17	2	85			0	0	8	15	1	86
BACTERIAL BLIGHT	12	20	2	100			0	0	10	50	5	357
SUPERELONGATION	2	5	0	4			0	0			0	0
ANTHRACNOSE	8	35	3	117			0	0	1	20	0	14
ACMV			0	0			0	0	10	20	2	143
FROGSKIN	25	10	3	104			0	0			0	0
CCMV			0	0			0	0			0	0
OTHER VIRUS/MYCOPLASMA	13	7	1	38			0	0			0	0
VEIN MOSAIC	10	7	1	29			0	0			0	0
BROWN STREAK			0	0			0	0	2	10	0	14
CONCENTRIC RING LEAF SPOT	10	30	3	125							0	0
PESTS			6	244			0	0			23	1641
SPIDER MITE	2	25	1	21			0	0	20	80	16	1142
MEALYBUG			0	0			0	0	10	50	5	357
BURROWING BUG	12	15	2	75			0	0			0	0
BURROWING BUG/MEALYBUG			0	0			0	0			0	0
THRIPS	3	27	1	34			0	0			0	0
HORNWORM	15	5	1	31			0	0			0	0
ANTS			0	0			0	0			0	0
WHITEFLY	2	40	1	33			0	0			0	0
LACEBUG	3	20	1	25			0	0			0	0
TERMITES			0	0			0	0	10	20	2	143
SHOOT FLIES			0	0			0	0			0	0
MAMMALIAN PESTS			0	0			0	0			0	0
SCALE INSECTS			0	0			0	0			0	0
TIPACOLA PLAGIATA			0	0			0	0			0	0
WHITE GRUBS	12	5	1	25			0	0			0	0
TOTAL POTENTIAL INCREASE (%)			121	5045			0	0			163	11607
POST HARVEST			16	646			0	0			17	1177
QUALITY	15	70	11	438			0	0	25	50	13	892
PROCESSING	10	20	2	83			0	0	15	20	3	214
PRODUCT/MKT	20	15	3	125			0	0	10	10	1	71
TOTAL POST HARVEST INCREASE (%)			16	646			0	0			17	1177
TOTAL CASSAVA SECTOR (%)			136	5691			0	0			179	12784

Cassava sector constraints for the Subtropics, by continent

AGROECOLOGICAL ZONE	SUBTROPICS											
CONTINENT	LATIN AMERICA				ASIA				AFRICA			
CASSAVA AREA	607 HA (000)				598 HA				892 HA			
AVERAGE YIELD	14.0 T/HA				11.0 T/HA				10.0 T/HA			
ESTIMATED POTENTIAL YIELD:	24.0 T/HA				20.0 T/HA				22.0 T/HA			
CALCULATED POTENTIAL YIELD	26.4 T/HA				23.4 T/HA				22.3 T/HA			
TOTAL POTENTIAL YIELD GAINS (MT)	10037 MT (000)				7434 MT (000)				11004 MT (000)			
CONSTRAINTS	YLD GAIN IN AFF AREA	% AREA AFFEC	TOTAL % YLD GAIN	TONS YLD GAIN (000)	YLD GAIN IN AFF AREA	% AREA AFFEC	TOTAL % YLD GAIN	TONS YLD GAIN (000)	YLD GAIN IN AFF AREA	% AREA AFFEC.	TOTAL % YLD GAIN	TONS YLD GAIN (000)
SOIL			22	2486			43	2829			29	2587
LOW SOIL FERTILITY	20	60	12	1356	40	70	28	1842	30	80	24	2141
SOIL EROSION	20	50	10	1130	25	60	15	987	10	50	5	446
SALINITY			0	0			0	0			0	0
SURFACE TEMP			0	0			0	0			0	0
MANAGEMENT			20	2305			26	1710			32	2872
SUB-OPT LAND PREP	10	25	3	282	5	30	2	99	5	30	2	134
POOR PLANTING MATERIAL QUALIT	16	40	6	723	20	70	14	921	23	90	21	1846
INADEQUATE SPACING	5	50	3	282	5	50	3	164	5	50	3	223
WEEDS	15	60	9	1017	20	40	8	526	15	50	8	669
INTRINSIC VARIETAL TRAITS			9	1017			24	1566			20	1784
LOW YIELD-POTENTIAL VARIETIES	15	60	9	1017	28	85	24	1566	25	80	20	1784
CLIMATE			7	781			16	1058			24	2141
DROUGHT	10	20	2	226	16	38	6	400	30	80	24	2141
WATER LOGGING			0	0			0	0			0	0
LOW WINTER TEMP PLNT DATE	10	50	5	565	20	50	10	658			0	0
DISEASES			21	2347			3	186			7	599
ROOT ROT	11	33	4	410	2	3	0	4	2	3	0	5
BACTERIAL BLIGHT	17	72	12	1383	9	23	2	136	10	50	5	446
SUPERELONGATION	5	5	0	28			0	0			0	0
ANTHRACNOSE	8	50	4	407	2	20	0	28	2	40	1	71
ACMV			0	0			0	0	5	15	1	87
FROGSKIN			0	0			0	0			0	0
CCMV	10	10	1	113			0	0			0	0
OTHER VIRUS/MYCOPLASMA	5	1	0	6			0	0	2	5	0	9
VEIN MOSAIC			0	0			0	0			0	0
BROWN STREAK			0	0			0	0			0	0
LEAF/STEM PATHOGENS	3	100	3	339	3	100	3	197	3	100	3	268
PESTS			10	1093			2	105			11	1021
SPIDER MITE	2	20	0	45	3	50	2	99	15	43	6	575
MEALYBUG	5	20	1	113	1	10	0	7	10	50	5	446
BURROWING BUG			0	0			0	0			0	0
BURROWING BUG/MEALYBUG	5	40	2	226			0	0			0	0
THRIPS	1	2	0	2			0	0			0	0
HORNWORM	15	20	3	339			0	0			0	0
ANTS			0	0			0	0			0	0
WHITEFLY	5	20	1	113			0	0			0	0
LACEBUG	3	15	0	51			0	0			0	0
TERMITES			0	0			0	0			0	0
SHOOT FLIES	3	60	2	203			0	0			0	0
MAMMALIAN PESTS			0	0			0	0			0	0
SCALE INSECTS			0	0			0	0			0	0
TIPACOLA PLAGIATA			0	0			0	0			0	0
WHITE GRUBS			0	0			0	0			0	0
TOTAL POTENTIAL INCREASE (%)			89	10037			113	7434			123	11004
POST HARVEST			16	1808			21	1361			17	1472
QUALITY	15	80	12	1356	35	40	14	921	25	50	13	1115
PROCESSING	10	10	1	113	20	20	4	263	15	20	3	268
PRODUCT/MKT	20	15	3	339	20	15	3	197	10	10	1	89
TOTAL POST HARVEST INCREASE (%)			16	1808			21	1361			17	1472
TOTAL CASSAVA SECTOR (%)			105	11845			134	8815			140	12476

Cassava sector constraints on a global basis

CASSAVA AREA:	15623	HA (000)			
AVERAGE YIELD:	10.2	T/HA			
ESTIMATED POTENTIAL YIELD:	21.8	T/HA			
CALCULATED POTENTIAL YIELD:	23.2	T/HA			
TOTAL POTENTIAL YIELD GAINS (MT):	202763	MT (000)			

CONSTRAINTS	YLD GAIN IN AFF. AREA	% AREA AFFEC.	TOTAL % YLD GAIN	TONS YLD GAIN (000)
SOIL			29.9	47860
LOW SOIL FERTILITY	28.4	74.1	21.0	33675
SOIL EROSION	16.7	44.3	7.4	11848
SALINITY	9.3	1.1	0.1	170
SURFACE TEMP	11.0	12.3	1.4	2167
MANAGEMENT			29.0	46484
SUB-OPT LAND PREP.	8.4	43.3	3.6	5838
POOR PLANTING MATERIAL QUALITY	20.7	61.8	12.8	20501
INADEQUATE SPACING	7.7	49.8	3.8	6151
WEEDS	16.3	53.5	8.7	13994
INTRINSIC VARIETAL TRAITS			23.2	37091
LOW YIELD-POTENTIAL VARIETIES	27.6	83.8	23.2	37091
CLIMATE			12.8	20516
DROUGHT	20.4	52.5	10.7	17098
WATER LOGGING	25.7	5.3	1.4	2195
LOW WINTER TEMP. PLNT DATE	17.0	4.5	0.8	1223
DISEASES			18.5	29708
ROOT ROT	15.5	12.3	1.9	3047
BACTERIAL BLIGHT	14.8	41.2	6.1	9742
SUPERELONGATION	7.2	1.0	0.1	114
ANTHRACNOSE	6.3	28.2	1.8	2846
ACMV	19.3	42.3	8.2	13097
FROGSKIN	20.0	1.3	0.3	418
CCMV	13.7	0.5	0.1	113
OTHER VIRUS/MYCOPLASMA	4.5	1.1	0.0	80
VEIN MOSAIC	6.5	1.1	0.1	113
BROWN STREAK	1.6	0.6	0.0	14
LEAF/STEM PATHOGENS	3.1	68.6	2.1	3429
PESTS			13.2	21102
SPIDER MITE	18.0	43.6	7.8	12536
MEALYBUG	8.7	26.1	2.3	3649
BURROWING BUG	12.9	0.7	0.1	144
BURROWING BUG/MEALYBUG	6.6	2.1	0.1	226
THRIPS	3.5	2.2	0.1	125
HORNWORM	17.1	2.3	0.4	615
ANTS	1.4	0.3	0.0	6
WHITEFLY	1.2	26.7	0.3	516
LACEBUG	4.5	5.0	0.2	360
TERMITES	5.1	8.0	0.4	652
SHOOT FLIES	4.1	3.1	0.1	203
MAMMALIAN PESTS	4.7	21.5	1.0	1629
SCALE INSECTS	4.0	6.4	0.3	407
TIPACOLA PLAGIATA	13.0	0.0	0.0	9
WHITE GRUBS	11.7	0.1	0.0	25
TOTAL POTENTIAL INCREASE (%):			126.5	202763
POST HARVEST			19.1	30633
QUALITY	24.0	54.5	13.1	20930
PROCESSING	14.6	25.7	3.8	6008
PRODUCT/MKT	16.3	14.1	2.3	3694
TOTAL POST HARVEST INCREASE (%)			19.1	30633
TOTAL CASSAVA SECTOR (%)			145.7	233395

Cassava sector constraints by continent

CONTINENT	LATIN AMERICA	ASIA	AFRICA
CASSAVA AREA	2781 HA (000)	3921 HA	8921 HA
AVERAGE YIELD	11 2 T/HA	12.3 T/HA	9 0 T/HA
ESTIMATED POTENTIAL YIELD	21 3 T/HA	23 1 T/HA	21 3 T/HA
CALCULATED POTENTIAL YIELD	23.8 T/HA	24 1 T/HA	22.8 T/HA
TOTAL POTENTIAL YIELD GAINS (MT)	35094 MT (000)	46301 MT (000)	121368 MT (000)

CONSTRAINTS	LATIN AMERICA YLD GAIN IN AFF AREA	% AREA AFFEC	TOTAL % YLD GAIN	TONS YLD GAIN (000)	ASIA YLD GAIN IN AFF AREA	% AREA AFFEC	TOTAL % YLD GAIN	TONS YLD GAIN (000)	AFRICA YLD GAIN IN AFF AREA	% AREA AFFEC	TOTAL % YLD GAIN	TONS YLD GAIN (000)
SOIL			28	8704			35	17067			27	22089
LOW SOIL FERTILITY	27	61	17	5172	32	68	22	10690	27	81	22	17813
SOIL EROSION	20	54	11	3345	17	60	10	5039	12	34	4	3464
SALINITY	1	0	0	1	0	0	0	0	11	2	0	170
SURFACE TEMP	9	6	1	186	11	28	3	1338	10	8	1	843
MANAGEMENT			29	9085			21	10291			34	27109
SUB-OPT LAND PREP	9	33	3	936	6	33	3	1262	9	51	5	3641
POOR PLANTING MATERIAL QUALIT	21	62	13	4121	17	48	8	3958	23	68	15	12422
INADEQUATE SPACING	8	50	4	1235	8	47	4	1853	7	51	4	3063
WEEDS	15	60	9	2793	18	37	7	3218	17	59	10	7983
INTRINSIC VARIETAL TRAITS			19	6033			24	11384			24	19674
LOW YIELD-POTENTIAL VARIETIES	26	75	19	6033	26	89	24	11384	29	84	24	19674
CLIMATE			7	2301			11	5153			16	13062
DROUGHT	13	40	5	1613	16	58	9	4496	25	54	14	10990
WATER LOGGING	53	1	0	123	0	0	0	0	28	9	3	2072
LOW WINTER TEMP PLNT DATE	13	15	2	565	0	8	1	658	0	0	0	0
DISEASES			16	5255			2	929			29	23524
ROOT ROT	20	27	5	1678	6	5	0	161	14	11	2	1218
BACTERIAL BLIGHT	16	33	5	1656	8	19	1	553	17	53	9	7531
SUPERELONGATION	7	6	0	114	0	0	0	0	0	0	0	0
ANTHRACNOSE	8	37	3	966	2	15	0	132	7	31	2	1748
ACMV	0	0	0	0	6	3	0	92	22	73	16	13004
FROGSKIN	18	7	1	416	0	0	0	0	0	0	0	0
CCMV	13	3	0	113	0	0	0	0	0	0	0	0
OTHER VIRUS/MYCOPLASMA	5	5	0	71	0	0	0	0	2	0	0	9
VEIN MOSAIC	8	6	0	113	0	0	0	0	0	0	0	0
BROWN STREAK	0	0	0	0	0	0	0	0	2	1	0	14
LEAF/STEM PATHOGENS	0	90	3	1017	0	62	2	1042	3	56	2	1370
PESTS			12	3715			3	1478			20	15909
SPIDER MITE	11	36	4	1178	6	38	2	1112	26	48	13	10245
MEALYBUG	5	16	1	235	2	2	0	18	11	40	4	3398
BURROWING BUG	12	4	0	144	0	0	0	0	0	0	0	0
BURROWING BUG/MEALYBUG	6	12	1	226	0	0	0	0	0	0	0	0
THRIPS	3	12	0	125	0	0	0	0	0	0	0	0
HORNWORM	16	13	2	615	0	0	0	0	0	0	0	0
ANTS	1	2	0	6	0	0	0	0	0	0	0	0
WHITEFLY	4	37	1	466	4	3	0	51	0	34	0	0
LACEBUG	4	28	1	360	0	0	0	0	0	0	0	0
TERMITES	2	2	0	9	2	3	0	33	6	12	1	610
SHOOT FLIES	4	17	1	203	0	0	0	0	0	0	0	0
MAMMALIAN PESTS	5	7	0	123	5	2	0	46	5	34	2	1460
SCALE INSECTS	0	0	0	0	5	9	0	211	3	7	0	195
TIPACOLA PLAGIATA	0	0	0	0	11	0	0	9	0	0	0	0
WHITE GRUBS	11	1	0	25	0	0	0	0	0	0	0	0
TOTAL POTENTIAL INCREASE (%).			112	35094			96	46301			151	121368
POST HARVEST			20	6308			21	9923			18	14404
QUALITY	23	62	14	4462	22	60	13	6390	25	50	13	10078
PROCESSING	13	21	3	815	15	24	4	1806	15	28	4	3387
PRODUCT/MKT	20	17	3	1030	20	18	4	1727	10	12	1	938
TOTAL POST HARVEST INCREASE (%			20	6308			21	9923			18	14404
TOTAL CASSAVA SECTOR (%)			133	41400			116	56224			168	135772