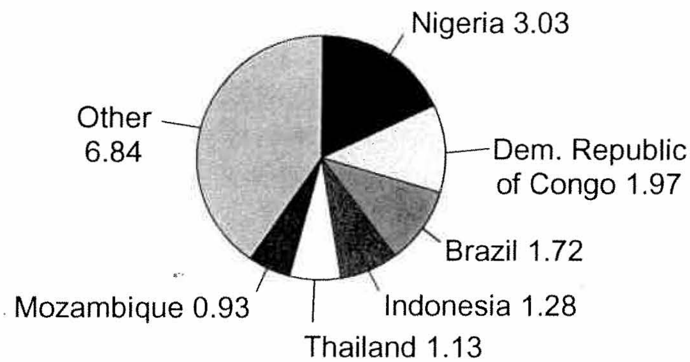
Cassava *Manihot esculenta*

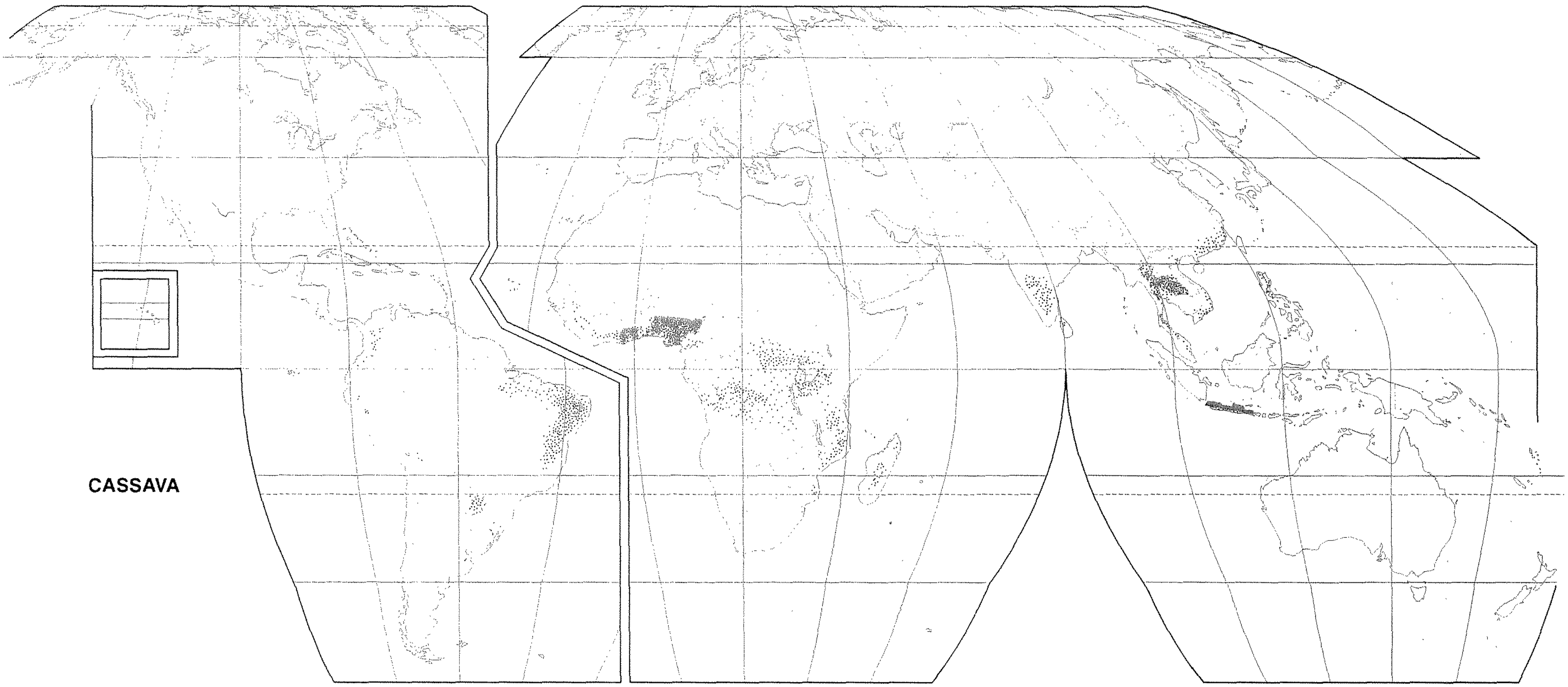
Production	
Area Under Cultivation	16.8 million ha
Global Production	178.6 million MT
Average Productivity	10,611 kg/ha
Producer Price	$69 per MT
Producer Production Value	$12,182 million
International Trade	
Share of World Production	9%
Exports	15.8 million MT
Average Price	$30 per MT
Value	$472 million
Principal Producing Countries/Blocs (by weight)	Nigeria, Brazil, Thailand, Indonesia, Dem. Republic of Congo
Principal Exporting Countries/Blocs	Thailand, Indonesia, Vietnam, Costa Rica, China, Brazil
Principal Importing Countries/Blocs	Netherlands, Spain, China, Belgium, Indonesia, South Korea, Portugal, Japan, Malaysia, Germany
Major Environmental Impacts	Habitat conversion Soil erosion and degradation
Potential to Improve	Fair Cassava is produced on marginal areas with big impacts Most poor producers have few options, few have land titles Polyculture (e.g. multiple food crops grown at the same time) production reduces cassava's impacts

Source: FAO 2002. All data for 2000.

Cassava

Area in Production (MMha)





CASSAVA

Each dot represents 100,000 MT average annual production

Chapter 20

Cassava

Overview

Cassava is the only food staple cultivated widely throughout the world that is poisonous to consume prior to processing. Cassava was discovered and domesticated by Indians in the Amazon. It was a food staple for lowland Indians long before the arrival of corn. Several varieties were cultivated and there are indigenous villages where dozens of varieties are still planted.

With the arrival of the Europeans, cassava was taken to many different parts of the world. In 1558 cassava was already reported on the margins of the Zaire River. Today it is consumed in many parts of Africa, and Nigeria is the main producer and consumer. Cassava was introduced to Asia during the seventeenth century, and today Thailand is the main exporter of the product.

Cassava is the highest producer of carbohydrates per hectare among staple food crops. According to the Food and Agriculture Organization of the United Nations (2002), it is the fourth most important food crop in developing countries after rice, corn (maize), and wheat. Two parts of the cassava plant are used for human consumption—the starchy roots and the leaves. Though the root is the main crop, in most cassava-growing countries in Africa the leaves are also consumed as a green vegetable, which provides protein and vitamins A and B. In Brazil, the leaves are only used occasionally for special dishes. More often, the leaves are used in dairy cattle rations.

As a food crop, cassava has some inherent characteristics that make it especially attractive to small farmers throughout the world. These characteristics include:

- *Multiplicity of end uses:* Cassava roots are rich in carbohydrates, especially starch, and can be consumed in a number of different ways.
- *Food security:* It is available all the year round, making it preferable to other, more seasonal staples such as grains, peas, and beans. Its roots can remain in the ground for several years after they mature.
- *Sturdy, tolerant, and pest resistant:* Compared to grains, cassava is more tolerant of low soil fertility. In addition it is more resistant to drought, pests, and diseases.

These attributes combined with socio-economic considerations have made cassava a leading crop in poverty alleviation programs. Many poor or landless farmers only have access to marginal land which is well suited to the production of cassava. The rural poor often need food at periods of the year when other crops do not produce and when there is little paid labor in rural areas. Cassava lends itself well to such conditions (Dostie, Randriamamonjy and Rabenasolo 1999). These attributes are also what give cassava its final advantage over many other basic food crops—it is very cheap for poor people to buy.

Producing Countries

In 2000 the total area planted to cassava was 16.8 million hectares and total production was 178.6 million metric tons. Nigeria was the largest producer with 32 million metric tons followed by Brazil (23 million metric tons), Thailand (19 million metric tons), Indonesia (16 million metric tons), and the Democratic Republic of Congo (16 million metric tons); these are the top five producers of cassava in the world (FAO 2002). An overview of cassava production is given in Table 20.1. There are two complicating issues that affect estimates of total cassava production. Most cassava is interplanted with other crops. In addition, most cassava is consumed by the producer or sold in local markets. It is thus very hard to track either the total global area cultivated or the volume produced.

Table 20.1 Production and Export of Cassava, 2000

Country	Production (MT)	Total Exported (MT)	Percent Exported
Nigeria	32,010,000		0.0
Brazil	23,335,974	56,666	0.24
Thailand	19,064,000	13,438,310	70.5
Indonesia	16,089,100	444,226	2.76
India	6,800,000	5,232	0.08
Dem. Republic of Congo	15,959,000	545	0.003
China	3,800,933	58,598	1.54
Paraguay	2,719,410		0.0
Madagascar	2,463,360	50	0.002
Vietnam	1,986,300	337,642	17.0
Colombia	1,792,380	938	0.05
Philippines	1,765,710	1,615	0.09
Malaysia	380,000	6,818	1.79
Costa Rica	67,402	146,537	217.4
World	178,567,247	15,755,728	8.82

Source: FAO 2002.

Table 20.1 shows the major cassava producers as well as the major exporters. Thailand is the main exporter globally, exporting some three-quarters of all its production and more than 85 percent of global exports. Other smaller exporters include Indonesia, Vietnam, Costa Rica, China, and Brazil. While there is some year-to-year variation, Thailand is always by far the largest cassava exporter globally (FAO 2002).

Consuming Countries

Nigeria, Brazil, Indonesia, the Democratic Republic of Congo, Ghana, Tanzania, India, Thailand, Mozambique, Uganda, and Angola grow and consume more than 70 percent of all cassava grown each year (FAO 2002).

The main importing countries are the Netherlands, Spain, China, Belgium, Indonesia, South Korea, Portugal, Japan, Malaysia, and Germany (FAO 2002), as shown in Table 20.2. A few alternative markets have developed for cassava such as in the former USSR, but most of the international cassava trade continues to depend heavily on European imports, where it is used for animal feed.

Table 20.2 World Trade in Cassava, 2000

Country	2000 (million MT)
World Exports	**15.8**
Thailand	13.4
Indonesia	0.4
Others	2.0
World Imports	**17.4**
Netherlands	3.4
Spain	3.3
China	2.8
Belgium	1.9
Indonesia	1.0
South Korea	0.7
Portugal	0.7
Japan	0.6
Malaysia	0.4
Germany	0.4
Others	2.2

Source: FAO 2002.

Production Systems

Cassava is a perennial woody shrub that grows from 1 to 3 meters tall. It can grow from 30 degrees north to 30 degrees south of the equator and from sea level to an altitude of 2,000 meters. The ideal temperature for cassava is about 20 degrees Celsius. On good soils with adequate rains, production can reach 30 metric tons per hectare. Tubers can reach .5 meter in length and 10 centimeters in diameter.

Cassava is propagated through cuttings 20 to 30 centimeters long taken from the woody stems. Spacing is usually 1 to 1.5 meters between plants. During the first year beans, corn, tobacco, or other annual crops are grown between the young cassava plants.

Cassava is produced under diverse ecological conditions and production systems. It has the ability to withstand poor environmental conditions such as low rainfall and infertile soil. In Africa, cassava is mostly grown on small farms, usually intercropped with vegetables, plantation crops (such as coconut, oil palm, or coffee), yam, sweet potato, bananas, melon, corn, rice, and peanuts or other legumes. Only a few countries, notably Thailand and Brazil, produce cassava primarily as a single crop over relatively extensive areas of land. Monocropped cassava is rare in the rest of the world. Monocrop cultivation is sometimes associated with food production but more often with the production of animal feed or alcohol.

Land clearing and soil preparation demand high inputs of hand labor due to the vigorous growth of native vegetation in the lowland humid tropics ecosystem. Weed control is the most labor-intensive activity after crop establishment. Preemergence herbicides like fluometuron, diuron and alachlor are currently recommended for weed control in cassava. Paraquat has also been recommended for postemergence application as a complement to hand, machete, or hoe weeding.

The application of fertilizer and pesticides remains limited among small-scale farmers due to the high cost and lack of availability. While the crop grows well with little or no fertilization, it responds well to fertilizer application on infertile soils. For the most part, small farmers use their own labor to remove pests. While there are pests that can affect production to a high degree, the pesticides to address them are not cheap and are rarely used.

There are several constraints for cassava production. In Africa, for example, pests and diseases cause yield losses as high as 50 percent (Ross 2002). One source suggests that improved pest and disease management and better processing methods could increase cassava production in Africa by 150 percent (Ross 2002). The production of cassava is also dependent on the supply of good-quality stem cuttings. The success rate for these cuttings is very low compared to the germination rate of grain crops. In addition, cassava stem cuttings are bulky and highly perishable; they tend to dry up within a few days. Moreover, they are costly to cut, handle, and transport.

There are several varieties of cassava. They tend to fall into two groups—the sweet and the bitter types. The bitter types contain higher concentrations of cyanogenic glucosides than the sweet types. Because cassava is propagated from cuttings, the rate of multiplication of new, improved cassava varieties is slow. This also retards their adoption, so there are relatively few different cultivars. Furthermore, because propagation from a producer's own cuttings is free, many are reluctant to spend money for improved varieties. To the extent that cultivars exist, they tend to be mostly regional. Some of the various cultivars that are commonly grown in countries throughout the world are listed below:

- Brazil: IM-158, IM-168, IM-175, BGM-021, IAC-12–829, IAC-576–70, Aipim, Pioniera, and Gigante
- China: SC 205, and Colombia CM 4031–2
- Colombia: Manihoica P-12, CG 1141–1, CM 3306–4, ICA-Sebucan, ICA-Catumare, and Manihoica P-13

- Cuba: CMC-40, Señorita, CEMSA 5–19, CEMSA 74–6329, and Jaguey Dulce
- Indonesia: Adira 1, and Adira 4
- Nigeria: TMS 30572 and 4(2)1425
- Paraguay: Meza-I
- Philippines: Kalabao, Golden Yellow, Colombia CM 323–52, Lakan 1, Datu 1, and Sultan 1
- Thailand: Rayong 1, Rayong 2, and Rayong 3

As a root crop, cassava requires considerable labor to harvest. Owing to their highly perishable nature, cassava roots require immediate or early transport to the marketplace, and the transportation costs involved are quite high relative to the value of the commodity because of the high water content of the roots. This remains a major constraint in cassava production for markets.

Processing

Processing cassava for food for humans can be partially mechanized, but it still requires considerable labor. This makes it time-consuming given that the relative value of cassava is quite low by comparison to other food crops. In Brazil and other areas the wet, ground cassava meal is dried over a griddle to turn it into a flour that can then be stored. This takes a fair amount of time and firewood. Finally, many cassava varieties contain cyanogenic glucosides, and inadequate processing can lead to toxicity and even cyanide poisoning.

Avoidance of rapid postharvest deterioration and reduction of cyanide levels are traditionally the main reasons for processing cassava into different food products. Roots are processed into a wide variety of granules, pastes, flours etc. The roots of sweet cassava, with only a third the levels of prussic acid compared to bitter cassava, can be consumed freshly boiled or raw. Cassava is used in the production of food and animal feed, and it also has industrial uses. In 1993, 58 percent of the world production was used for food, 25 to 28 percent for animal feed, 2 to 3 percent in industry, and 14 percent was waste (Balogun 2002).

However, the use of cassava for different purposes varies considerably by region. In Africa and Asia only 6 percent of cassava utilization is accounted for by feed, while in Latin America and the Caribbean the animal feed share rises to some 47 percent, reflecting high feed usage in Paraguay and Brazil. In parts of Latin America it is also used commercially for the production of animal feed and starch-based products.

In some areas of the world, cassava is ground and used directly as an animal feed. In other places cassava meal, a residue from the extraction of starch from cassava roots, is included in cattle and pig rations. Starch and pomace (cassava meal) are used extensively for pigs in Southeast Asia where they are regarded as valuable feeds. Cassava is used in concentrations of up to 10 percent in poultry rations to cut the richness of other feed grains. Brazil uses nearly half of its cassava in swine, poultry, and fish farming production systems. According to the FAO (2002), one of the attractive properties of cassava is that it can be added to animal feeds at concentrations of 15 percent and protect the feed from insect losses.

Cassava starch is also derived from the tubers. Cassava is the fourth largest source for starch production after corn, wheat, and potato. The tubers can be processed as a source of commercial starch for use in the food, textile, pharmaceutical, brewing, cosmetic, and paper industries. As a basic foodstuff, the starch may be converted by acid and enzyme hydrolysis to dextrins and glucose syrups. The starch can be used as a thickener in cooking and can be extracted and dried to produce tapioca. Tubers are also used for the production of flour, which in turn is used mainly for making porridge or bread. It is also possible to mix wheat and cassava flour. This blend has excellent baking qualities.

Cassava starch is also used in the production of monosodium glutamate, an important flavor-enhancing agent in some Asian cooking and many processed foods. Various processing methods such as grating, sun drying, and fermenting are used to reduce the cyanide content. Most of the cassava starch industries are located in Asia with the exception of tapioca, which is produced in Brazil.

Cassava meals, flours, and starches are used to produce a wide variety of secondary products including biscuits, chips, and noodles. These are currently being made from cassava flour in Nigeria, Madagascar, Tanzania, and Uganda.

The whole cassava plant (including the root, stems, and leaves) can be chopped and stored in simple pit silos for dry-season feeding at the village level. This tends to be done more often in Asia and Africa than in Latin America.

Finally, cassava also has nonfood and industrial uses. Cassava is used to produce alcohol for human consumption as well as for automobiles in Brazil. There is also experimentation with the starches from different varieties of cassava to make polymers with many different uses. Polymers from cassava starches are being used as filters in a wide range of industrial processes including the refining of sugar.

The different forms of cassava can be processed into many different products. Some of these products include:

- *From fresh and dried roots:* Food, flour, animal feed, alcohol
- *From normal starch*: Glue, plywood, paper, textiles, monosodium glutamate
- *From modified starch*: Sweeteners, prepared foods, medicines, biodegradable products

Substitutes

Most grains, such as corn, wheat, rice, sorghum, etc. and most other roots and tubers such as potatoes act as substitutes for cassava both for human food and for animal feed. Starches from corn, white potato, and sweet potato compete with the cassava starch industry as well. Sugar and corn compete with cassava in the manufacture of alcohol. Cassava products for animal feed are facing increasing competition from grains on international markets. However, the price of cassava makes it relatively competitive with most substitutes. The issue is the caloric value and palatability for human and animal feed uses.

Market Chain

Well-developed market access infrastructure is crucial for cassava marketing. Cassava roots are bulky and, with about 70 percent moisture content, are both unnecessarily heavy and very perishable. Rapid deterioration can begin as soon as 24 hours after harvest. Fresh cassava roots are traditionally marketed without postharvest treatment or protection and therefore have to reach consumers within a short time before deterioration becomes a problem. It is therefore imperative that effective marketing channels be available to avoid postharvest losses. Alternatively, cassava tubers can be dried at the point of production. For the most part they are ground into flour and used dried or rehydrated as necessary at the point of use.

As cassava is mostly produced in rural areas of developing countries, market infrastructure has not been very well developed. Marketing problems are becoming exacerbated as increasing urbanization is placing both distance and time between producers and consumers. Being produced mostly in developing regions with unstable local economies, cassava is often not available in the market with the same regularity and predictability as, for instance, corn. Furthermore, cassava is found in many grades and qualities that are often not comparable and even highly variable internally. Its price, especially in recent years, has fluctuated considerably.

Cassava marketing varies tremendously around the world. In some parts of the world, the cassava market has not evolved much. Typically, farmers transport their farm produce to the market on their heads, on bicycles, or in trucks that happen to pass by. Cassava can be purchased in the ground with traders supplying their own labor to harvest the crop when required. However, the quantities handled by cassava traders are usually low. By contrast, Thailand, the major exporter of cassava in the world, has a very well developed market chain that has enabled the industry to experience a pattern of growth similar to that of other agricultural commodities, especially grains. In Ghana, cassava marketing chains have evolved to cope with the perishability of the root. Rapid marketing is ensured through a wide range of operators including producers, itinerant traders, transporters, intermediaries, market traders, and market chiefs. Operators such as farmers, traders, and consumers are often connected through complex systems of information flow, credit, and transportation.

Also, there are some hopeful signs for niche marketing. Cassava flour produced in Cruzeiro do Sul, in the extreme westernmost part of the state of Acre in the Brazilian Amazon, is sold as far away as the city of Belém at the mouth of the Amazon River for a premium price. In fact, the river towns all along the Amazon carry, at minimum 20 and sometimes 50 different varieties of cassava flour distinguished by their texture (e.g. fine to course or even or uneven), color (e.g. white, gray, yellow or gold), additives (e.g.

coconut, peach palm flour, etc.), or origin. Prices range accordingly and can vary by more than 300 percent.

Market Trends

The combination of high marketing costs for cassava and market interventions such as subsidized cereal prices often leads to high relative cassava prices. This can reduce urban demand because of the significant cross-price elasticities between cassava and major grains. This is when production or marketing subsidies lower the price of grains which tends to dampen the price of cassava.

FAO projections to 2005 point toward sustained growth in cassava production. This is likely to be dominated by a rise in productivity but little change in area planted. This will depend, however, on whether the dissemination of the new technologies among farmers gains momentum and these technologies become more popular. World cassava production is projected to maintain an annual growth rate of 2 percent. The rate of expansion is anticipated to be in the range of 3 percent in Africa, while it is likely to be a more modest 1 percent in Latin America and the Caribbean and in Asia. The utilization of cassava, on the other hand, is projected to remain small relative to output and to involve only a few countries. Total utilization is projected to grow at 2.2 percent annually, with food consumption representing about 59 percent of the total.

About 15 percent of global production in 1993 was exported to Europe and Japan, mainly for industrial purposes and to mix with vegetable meals as animal feed. These uses are expected to continue to grow gradually (UNCTAD 1994). Changes in European agricultural subsidies and import policies could greatly affect this crop.

Cassava has a high potential as a basic food crop during periods of civil and economic stress or when markets are otherwise disrupted. It requires very few inputs, and it has a long storage life in the ground and out if properly processed. It will, in all likelihood, long be a basic food crop in areas where it is currently known, particularly for the rural and urban poor. However, as people's incomes increase, they tend to eat far less cassava. Therefore, cassava markets will expand only if it is used increasingly in animal rations or if new industrial applications for the product are discovered.

Environmental Impacts of Production

Though cassava, particularly the sweeter varieties, is subject to pests, few producers who grow it can afford chemical pesticides. Partly for this reason, the main environmental problems from its production are habitat conversion and soil erosion.

Habitat Conversion and Soil Erosion

In most parts of the world the environmental impacts of cassava production are related to who grows it and where it is grown. Cassava tends to be a poor peoples' food that is most often grown by poor people. As a consequence it is most often grown on lower value, more marginal lands. In short, these are often lands that people have claimed because others do not want them. However, such lands often have a high biodiversity value.

Cassava's requirements are few and as a consequence it is frequently cultivated where few other cultivated crops could survive much less yield food for the producer or for sale. The cassava plant does not produce enough vegetation to cover the soil well. Even if other crops are interplanted, the early crops tend to be harvested within a few months or the first year at the latest. For both these reasons, the production of cassava can result in considerable soil erosion during the entire life of the plant. Because little else grows on such soils, the erosion often continues well after the cassava is harvested.

Better Management Practices

For most producers, cassava is an ancillary crop, i.e. it is not often the main crop being produced but rather a sequence crop that is grown in association with others. Consequently, it allows producers the possibility of gaining a little more production of either food or marketable crop from an area that would otherwise be allowed to return to fallow. As a result, the most effective conservation strategies are those that are aimed at the primary agricultural crops that are causing the environmental problems that need to be addressed. Even so, there are at least two strategies that can be pursued with regard to cassava.

Reduce Habitat Conversion

The most effective way to reduce the habitat conversion associated with both cassava production in marginal areas and with slash and burn cultivation (where agricultural plots are cleared from forests or secondary growth and planted to food crops and then abandoned for a period of time to allow the soil to rejuvenate) is to increase the fallow cycle time for poor farmers and to plant leguminous trees or other plants that will more actively rejuvenate the soils. When land is relatively abundant compared to overall population in many parts of the world, the fallow cycle for shifting cultivation is often 10 to 15 years or even more. In many parts of the world where more people now depend on less land for agriculture, the fallow cycle may be as little as 3 to 7 years. Such rapid reuse of often relatively marginal areas does not give them sufficient time to rebuild fertility. Over time, shorter fallow cycles deteriorate soil productivity.

Cassava can be harvested for up to 3 years after planting; it is a crop that extends the productive life of agricultural land into the fallow cycle. Cassava, like fruit trees and other perennials, provides a crop on agricultural lands long after annual crops have been harvested. Such plants not only extend the productive life of otherwise abandoned agricultural plots during their fallow cycle, they attract insects and animals which are important sources of protein for the rural poor (Clay 1988). For farmers that plant cassava, the strategy should be to increase soil productivity during fallow periods through planting strategies that increase biomass and nutrient production during both production periods as well as fallows.

Reduce Soil Erosion

Intercropping of cassava has great potential to decrease soil loss substantially. For example, intercropping tree crops with cassava has the benefit of reducing runoff and soil loss. However, aggressive, fast-growing tree crops such as eucalyptus effectively utilize available nutrients and moisture at the expense of companion crops. Chemical assays of plant parts indicate that cassava utilizes more soil nutrients when planted alone, and considerably less when grown with fast-growing trees. As a consequence, other tree crops might be examined, particularly leguminous trees (such as leucaena) that hold the soil as well as fix nitrogen, provide fodder and fuelwood, and perhaps even attract game. If cassava were intercropped with such tree crops, the fertility of the soil could be maintained without deterioration. Other studies have shown that runoff and soil loss were effectively reduced when cassava was grown on staggered soil mounds along with eucalyptus or leucaena, due to better canopy coverage of the soil surface.

Standard soil conservation techniques can also help. Contour ridges alone, or in combination with live barriers and no-till farming, have provided effective erosion control under experimental conditions in Latin American and Asia (Panfilo Tabora, personal communication). Mulching or other effective ground covers could also reduce erosion and conserve water in the soil.

Outlook

In the 1960s and 1970s it was assumed that the benefits of green revolution technology would "trickle down" to the rural poor. People would increasingly be able to "eat up" the food chain, substituting more nutritious crops for less nutritious ones. To some extent this happened. But the benefits of green revolution crops did not spread evenly around the world or even within a single country. It became clear that many poor were so disengaged from the market economy that they could not benefit from crops that required purchased inputs. Instead of eating up the food chain, many of the poorest people in both rural and urban areas began to eat down it.

Cassava and others tubers have became the most important food staples for poor and economically marginalized people around the world. There are several reasons for this that are not likely to go away any time soon. Cassava is very productive and consequently very cheap to buy. It grows almost anywhere. This is increasingly important for subsistence farmers and shifting cultivators who find themselves not only farming smaller plots but more marginal ones as well. Cassava is also important because it produces more calories on less land (ten times as much as corn) without inputs than almost any other crop. This frees land for other crops (particularly horticulture and tree crops) that can be sold or eaten or both. Finally, cassava can be left in the ground until it is needed without spoiling. The main drawback with cassava, however, is its poor overall nutritional value when it is the only or even the main food in the diet.

As commodity prices continue to decline, as small farmers are further marginalized, and as there is more rural labor than is necessary for increasingly mechanized agriculture, cassava will be the most important crop between the rural poor and starvation. However, if prices decline cassava is likely to become more attractive for other industrial uses such as alcohol for internal combustion engines, feed supplements for animals in intensive feedlots, and starch-based polymers with an increasing range of applications. While it is doubtful that any of these uses will markedly increase the overall demand for cassava, given the downturn in the global economy it is unlikely that cassava consumption will decline any time soon.

Resources

Web Resources

www.cassava.org
www.globalcassavastrategy.net/
agrifor.ac.uk/browse/cabi/detail/36d9852639934e3e5b210510e881d1e4.html
fadr.msu.ru/rodale/agsieve/txt/vol2/7/art2.html
www.fao.org/english/newsroom/news/2002/10541-en.html
www.cgiar.org/areas/cassava.htm

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