CASSAVA newsletter

Viral diseases affecting cassava in the Americas

222670

J.C. Lozano
U. Jayasinghe
B. Pineda

The incidence of viral diseases of cassava in the Americas has been underestimated; current research suggests that there are several viruses affecting the yield potential of the different cultivars grown.

Until 1970 the only viral diseases reported in Latin America were the common mosaic and leaf vein mosaic. Later on, research carried out at CIAT indicated that there were other viral diseases of cassava, such as frog skin and Caribbean mosaic, together with an undetermined number of latent viruses which were not previously recognized. These viruses represent a complex problem of great economic importance for the continent.

Although the effect of each virus or virus complex on production has not yet been investigated, recent studies have shown that if planting material is obtained by meristem culture, yields can be increased more than 3 times (Table 1). When cuttings are taken from healthy or from the highest root yielding mother plants, yields increase two- or threefold in comparison with those obtained from unselected cuttings. If a physical, agronomic, or biotic factor (mostly viruses) affects the quality of the cutting, the clone may not express its full yield genetic potential. ▷

Centro Internacional de Agricultura Tropical

Cassava Newsletter

Volume 7 No. 2, November 1983

Publication of the Communications and Information Support Unit and CIAT's Cassava Program

Contents

Contributors to this issue:

José Carlos Lozano, Ph.D. Pathologist, CIAT's Cassava Program.
Upali Jayasinghe, Ph.D. Postdoctoral Scientist, Virology, CIAT's Cassava Program.
Benjamín Pineda, M.S. Plant Pathology, CIAT's Cassava Program.
Reinhardt Howeler, Ph.D. Soil Scientist, CIAT's Cassava Program.
John K. Lynam, Ph.D. Agricultural Economist, CIAT's Cassava Program.
Anthony Charles Bellotti, Ph.D. Entomologist, CIAT's Cassava Program.
César A. García, Agricultural Engineer, currently in CIAT's Tropical Pastures Program.

Editorial Committee:

James Cock, Coordinator Cassava Program
Lynn Menéndez F., Documentalist and translator
Ana Lucía de Román, Editor Spanish version

Production: CIAT's Graphic Arts

Common mosaic and leaf vein mosaic viruses

The common mosaic virus, first reported in 1983, is caused by a filamentous virus (500-600 nm* in length) that affects other differential host plants besides cassava. Recent investigations suggest the existence of virus strains, all transmitted by mechanical means.

Leaf vein mosaic, reported in 1940, occurs sporadically in some plantations of northeastern Brazil and in the Venezuelan eastern plains. The causal agent has been partially characterized as a polyhedral virus with a restricted host range.

Frog skin disease

This disease was reported for the first time in 1971 in the region of Quilcacé (Cauca, Colombia). Since then, its incidence has been so severe that by 1982 it had caused a reduction of 90% in the area planted to cassava in that region and neighboring areas.

In most clones, only the roots are affected. Diseased plants look apparently vigorous and healthy aboveground, but their roots remain thin and fibrous and there is no starch accumulation. The epidermis has a corky formation with small, longitudinal, deep fissures resulting in lip-shaped lesions (Figure 1).

The disease is transmitted by planting material (cuttings) and whiteflies. The whitefly genus infesting cassava in the Americas has not yet been determined due to the difficulty in obtaining pure colonies. Frog skin disease can also be transmitted by grafting. However, the mechanical transmission to cassava or other species using the sap of diseased plants as inoculum has not been successful.

---

* nm = nanometer (10^{-9}m)

Table 1. **Root yield of native clone "Secundina" related to source of cuttings and their selection.**

Source of plants from which cuttings were obtained	Yield[1] Fresh roots (t/ha)	Starch (t/ha)	Yield reduction[2] (%)
Selected cuttings[3]			
Meristem culture	24.0a	7.9a	0
Traditional cropping systems, without symptoms of mosaic or other major diseases in the region	19.6b	6.2b	18.3
Traditional cropping system regardless of disease symptoms	18.2b	5.8b	24.2
Traditional cropping system with mosaic symptoms	14.7c	4.5c	38.7
Unselected cuttings			
Traditional cropping system	7.3d	2.4d	69.5

1. Values with the same letter were not significantly different according to Duncan's test ($p = 0.05$).
2. Yield reduction with respect to yields obtained with plants from cuttings obtained through meristem culture.
3. Cuttings were selected according to their healthy appearance, length (20 cm), maturity, etc. (See Cassava Newsletter, Series GE-17, 1977.)

▷

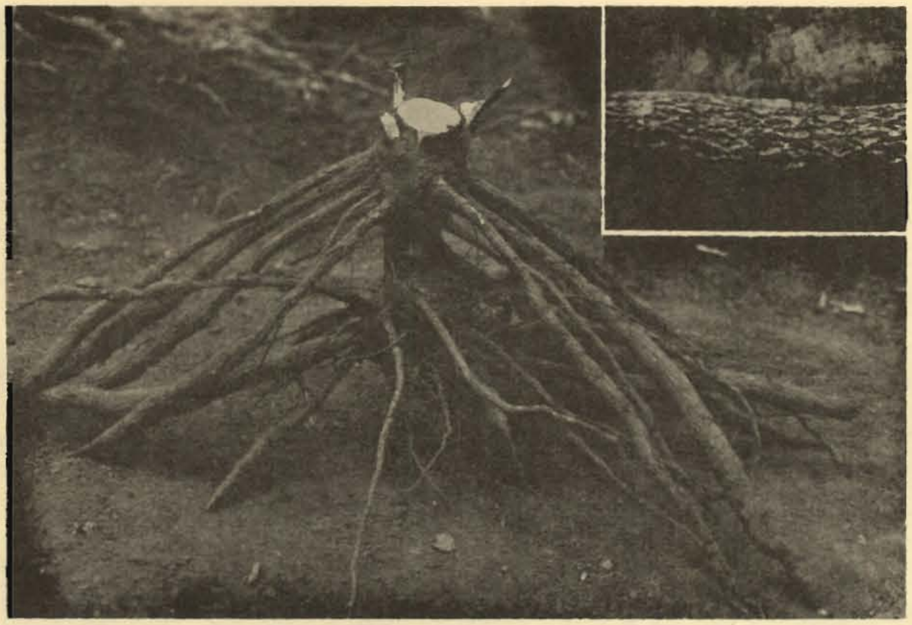

Figure 1. *Root system of a plant infected with frog skin disease. The inset shows disease symptoms on the epidermis.*

Partial purifications of diseased rootlets has shown filamentous virus-like particles. When the healthy clone Secundina was grafted to other diseased clones, a mosaic occurred, which is not present in most other stocks (approximately 400 clones). Likewise, the use of whiteflies in insect-proof cages to inoculate Secundina induced a similar mosaic disease 20 days after inoculation and produced frog skin symptoms on the roots. These symptoms, however, were moderate since the roots temporarily accumulated starch.

Mechanical transmission of a virus to *Nicotiana benthamiana* was achieved using the sap of Secundina plants that showed mosaic symptoms and frog skin disease by whitefly inoculation. Chlorotic, round leaf lesions were initially observed; later, a severe vein necrosis appeared on infected plants. The new leaves were initially mottled, but later they showed a generalized necrosis. This virus was called WF to facilitate its identification. When other differential host plants were inoculated, however, it was found that *N. benthamiana* was affected by other viruses. Among these, a virus (called N-WT for easier identification) was isolated. It produces a greenish mottling and then etching. A serological distinction from the common mosaic virus has not been possible, but their host range differs.

The results are somewhat confusing since there is no information on Potexviruses[1], although some information exists on Carlaviruses[2] and other flexous elongated particles transmitted by whiteflies. To date no other viruses have been separated from this complex related to frog skin disease.

Caribbean mosaic virus

This disease has been observed on the northern coast of Colombia in local clones such as Secundina and Venezolana 1. Its symptoms are similar to those of other mosaics but it causes less leaf distortion and stunting. Symptom expression is directly related to temperature, being mild at temperatures higher than 30ºC and more severe at temperatures between 24-28ºC (Figure 2).

Research carried out at CIAT to identify the causal agent of the Caribbean mosaic, isolated a flexous virus-like particle. It seems to be a Potexvirus, named BPL to facilitate its identification. This virus is serologically related to the cassava common mosaic and the N-WF viruses, but its host range differs and, in Secundina, it induces symptoms different to those originally observed in material affected by Caribbean mosaic. Field experiments suggest the presence of a vector still unknown.

Figure 2. *This plant, initially exposed to low temperature, developed symptoms of the Caribbean mosaic (lower leaves). The plant recovered when maintained at a temperature above 30ºC (upper part of foliage).*

[1] Belonging to the potato X virus

[2] Belonging to the carnation latent virus

▷

Latent viruses

In addition to the aforementioned viruses, there are others present in different cassava cultivars, but these normally do not produce symptoms. Several years ago Kitajima and Costa reported the occurrence of a latent virus with bacilliform particles in cassava.

Another latent virus, found recently at CIAT, affects a high percentage of cassava clones existing in the Americas. In order to detect it Secundina was grafted to the clone being tested. If infected, the leaves that developed in Secundina showed curling and severe mosaic as well as vein necrosis (Figure 3). The symptoms of this mosaic differ from those of the Caribbean mosaic under controlled conditions. Partial purifications showed the presence of low concentrations of polyhedral particles of approximately 30 nm. To date the virus has not been successfully transmitted to any other differential species.

Figure 3. *The presence of a latent virus in the stock (symptomless) was determined when grafted to the healthy clone Secundina. The latter produced severe symptoms.* □

Mycorrhizal inoculation, a cultural practice with potential in cassava cultivation

R. H. Howeler

The ability of cassava to grow well on some low phosphorus soils is due to the association of its roots with vesicular-arbuscular mycorrhiza (VAM), which are soil fungi that live in symbiosis with the plant. (See Cassava Newsletter No. 11, August 1982.)

The dependency of cassava on mycorrhiza to yield in phosphorus-deficient soils has been verified on several occasions. In greenhouse trials with low phosphorus soil (from CIAT-Quilichao) when mycorrhiza were eliminated by soil sterilization, 1600 kg P/ha had to be applied to obtain the same yield that was obtained with mycorrhizal-inoculated plants growing on the same soil without phosphorus fertilization. The critical phosphorus level in soils without mycorrhiza was found to be 190 ppm while in soils with mycorrhiza it was only 15 ppm.

Effectiveness of native mycorrhiza

Under natural field conditions nearly all soils have an indigenous mycorrhizal population and cassava roots become rapidly infected; however, both the quantity and the quality of the native mycorrhizal populations vary, and therefore soils differ greatly in their responsiveness to mycorrhizal inoculation and phosphorus fertilization.

The effectiveness of mycorrhiza differs among the 70-80 species presently identified and described. This effectiveness depends on soil characteristics (pH, organic matter, and phosphorus content), soil humidity and temperature, fertilization practices, and plant species and varieties.

Over the past three years Dr. Ewald Sieverding, head of the Mycorrhizal Project at CIAT, has collected about 300 mycorrhizal strains from different species, some of which had not yet been described and named. Six new species found in Colombia were recently described (Schenck et al) and are named: *Glomus manihotis, Acaulospora morrowii, A. mellea, A. appendicula, A. longula,* and *Entrophospora colombiana.*

Those isolates, identified as effective under greenhouse conditions, with sterilized and nonsterilized soil, are now being tested under natural field conditions.

Inoculation tests

To determine where and under what conditions mycorrhizal inoculation would be beneficial, a group of isolates has been evaluated at several sites.

Field experiments were conducted in CIAT-Quilichao and in Mondomo (Cauca, Colombia) in volcanic ash-influenced soils (Dystropepts), and in Carimagua in a highly weathered acid soil (Oxisol). Table 1 shows that these soils are all very acid and low in phosphorus, but that they vary in their organic matter (OM) content and mycorrhizal population. In the Mondomo area, soils are particularly variable because severe erosion on steep slopes has resulted in a marked decrease in OM content and native VAM populations.

For these trials a soil-root mixture containing spores and other infective structures of a certain VAM isolate was used as inoculum. In most cases 100-500 g of this inoculum were used per plant, but sometimes only small amounts (2-4 g) of infected roots were used. The inoculum was placed directly under the stake at the time of planting so that emerging roots passed through the inoculum and became infected.

Although the trials were mainly conducted on unsterilized soil, some plots were sterilized with methyl bromide to see the effect on yield of eliminating the native mycorrhizal population. It was observed that soil sterilization seriously affected plant growth due to phosphorus deficiency caused by the elimination of native mycorrhiza; however, plants grew well when reinoculated with mycorrhiza (Figure 1).

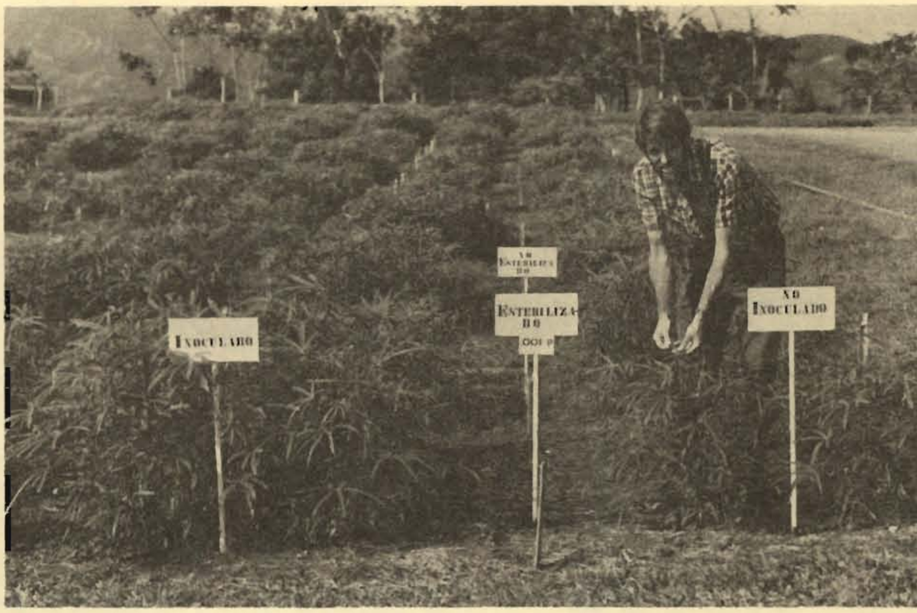

Figure 1. *Mycorrhizal inoculation is essential in sterilized soil; otherwise, plant development is drastically affected by the absence of a mycorrhizal association.*

The negative effect of sterilization lasted only about 5-6 months because roots became reinfected with mycorrhiza as soon as they reached unsterilized soil in neighboring plots or in the subsoil, and the plants recuperated quickly from their initial phosphorus deficiency.

Results in Quilichao. VAM inoculation did not increase yield in nonsterilized soil; however, it did increase yield in sterilized soil (from 31 to 50 t/ha) without phosphorus application. Thus, even though noninoculated plants had recuperated from their initial phosphorus deficiency in sterilized soil, inoculation still increased their yields by 60%.

In another trial at the same site in nonsterilized soil, none of the inoculation treatments (different types and quantities of inoculum) increased yields significantly, whereas soil sterilization decreased yields from 41.3 to 19.6 t/ha due to the initial lack of a mycorrhizal association (Table 2). These results illustrate the marked dependency of cassava on a mycorrhizal association and the high effectiveness of the native VAM population in Quilichao.

Results in Mondomo. The effectiveness of seven selected strains was tested in the Mondomo region (in Cauca) in a trial located on a slope with two replications on noneroded soil and two replications on highly eroded soil. As observed in Table 2, inoculation increased yield from 4.1 to 10.4 t/ha on eroded soil, but there was no significant response on noneroded soil. Therefore, in this area where soils are extremely variable due to varying degrees of erosion, cassava yields as well as the response to VAM inoculation are equally variable, largely depending on the presence or absence of an effective VAM population.

Results in the Llanos Orientales. In this region of Colombia, inoculation of cassava with VAM produced ▷

Table 1. **Soil characteristics and mycorrhizal infectivity at experimental sites.**

Site	Texture	pH	MO (%)	P (ppm)	Al (meq/100 g)	Ca (meq/100 g)	Mg (meq/100 g)	K (meq/100 g)	Infectivity* (no./100 g)
Quilichao	Clay loam	4.3	7.1	1.8	2.8	1.80	0.70	0.18	2506
Mondomo	Clay loam	4.1	4.8	1.6	5.1	0.45	0.12	0.11	-
Carimagua-Yopare	Clay loam	4.3	2.3	1.6	2.4	0.22	0.07	0.07	171
Carimagua-Alegría	Sandy clay loam	4.6	2.4	0.9	1.4	0.09	0.05	0.04	72

* Mycorrhizal infectivity = number of infectable propagules/100 g dry soil.

more promising results. In a trial in Carimagua-Yopare with sterilized soil, yields were increased 199% with inoculation and without applied phosphorus, and 164% when 100 kg P were applied per hectare as rock phosphate. As was observed in Quilichao, noninoculated plants grown in sterilized soil were extremely small and phosphorus deficient, but later recuperated when their roots reached unsterilized borders and subsoil.

Although highest yields were obtained in Carimagua with inoculated plants grown in sterilized soil, inoculation also increased yields in nonsterilized soil, 21% without applied phosphorus and 37% with 100 kg P/ha. The greater response to inoculation in the presence of applied phosphorus indicates that these soils are so low in phosphorus that some phosphorus fertilization is required to stimulate the effectiveness of the introduced mycorrhizal species, *Glomus manihotis.*

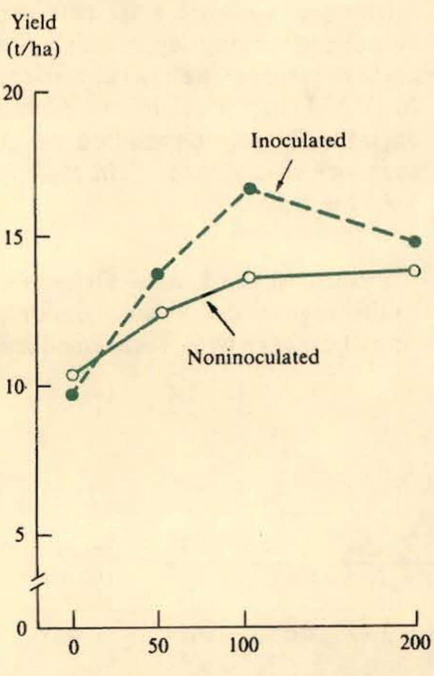

Figure 2. *Effect of mycorrhizal inoculation and various levels of P application ($\bar{X}$ five P sources) on root yield of cassava cv. M Ven 77, in Carimagua-Yopare, 1981.*

Table 2. **Effect of soil sterilization and mycorrhizal inoculation on root yield of cassava grown in locations with high and low native VA-mycorrhizal populations.**

Sites	Yield according to treatment (t/ha)			
	Sterilized soil		Unsterilized soil	
	Noninoculated	Inoculated*	Noninoculated	Inoculated*
With high VAM population				
Quilichao	19.6	-	41.3	42.7
Mondomo noneroded	-	-	26.1	27.3
With low VAM population				
Mondomo eroded	-	-	4.1	10.4
Carimagua-Yopare	7.7	20.2	11.7	16.0
Carimagua-Alegría	-	-	12.3	17.0

* Species used: *Glomus manihotis* in Quilichao and Carimagua-Yopare, and *Glomus caledonicum* in Mondomo and Carimagua-Alegría.

The influence of phosphorus on mycorrhizal effectiveness was illustrated in another trial where five sources of this element were applied at four levels ranging from 0 to 200 kg P/ha. Figure 2 shows there was no response to inoculation without the application of phosphorus, while the response increased at levels of 50 and 100 kg P/ha and decreased again at the level of 200 kg. These results correspond with data from greenhouse trials, in which greatest responses are generally observed at intermediate levels of application.

Although there were no significant differences among sources, the greatest response was obtained with triple superphosphate. Inoculation increased yield 51% at a level of 100 kg P/ha, applied in this form.

In another trial in Carimagua-Alegría on a highly infertile sandy soil, seven mycorrhizal strains were tested with the application of either 50 or 100 kg P/ha. At both levels of application, inoculation with all strains increased yields, although not always significantly. The best response was obtained with strain C 4-2 of *Glomus caledonicum,* collected in Mondomo, which increased yields 38%.

When to inoculate

According to the results obtained, VAM inoculation under natural field conditions rarely produces responses as marked as those observed under greenhouse conditions, especially when using sterilized soil. This is because cassava becomes naturally infected by native mycorrhizal fungi present in most soils.

Only in case the native VAM population is artificially eliminated by sterilization, or is naturally low or inefficient (highly infertile soil or highly eroded slopes), there is a potential to increase yield by inoculation. On the other hand, the highly significant yield increases obtained in field-grown cassava inoculated with VAM indicate that this practice might become especially important in cassava and other highly mycorrhizal-dependent crops when these are grown on extremely infertile or highly eroded soils with low or inefficient native VAM populations.

To be effective, the introduced strains must be highly efficient under a range of soil and climatic conditions, must tolerate levels of liming and fertilization that produce economic yields, and must compete effectively with native microorganisms. Thus, much work still has to be done on strain selection, the determination of soil and climatic factors that influence their efficiency, and inoculum production and methods of application. □

Cassava in Asia. A look at the present and at the future

222671

John K. Lynam

Cassava was probably first introduced into Asia through the Philippines, where it was brought by the Spanish from Mexico in the early part of the 17th century. By the end of the 19th century cassava had been effectively distributed throughout Southeast Asia. Today Thailand and Indonesia are by far the largest producers of cassava in the region, followed by India (Table 1); Thailand is the world's dominant cassava exporter.

Unlike cassava in Africa and Latin America, cassava in Asia developed as a truly multi-use crop, with marked differences in consumption patterns between countries. While several countries export cassava, only Thailand produces cassava principally for export. In Indonesia and Kerala State in India, cassava is a major food item in diets, although in Indonesia it is consumed in both a fresh and dried form while in India consumption is principally fresh. In Malaysia and Tamil Nadu State in India, cassava is principally used in the form of starch, and in the Philippines cassava remains a relatively minor crop, being consumed both as a food item and as starch.

The particular position of cassava in the agricultural economy of Asian countries has been achieved with virtually no government intervention, and it is the result of differences in market patterns and in land use.

Indonesia

Cassava vies closely with maize as the most important upland crop in Indonesia, and is the second most important food crop after rice. Although cassava makes up no more than 10% of average calorie intake, it is a major calorie source for low-income groups, principally in rural areas. During the past decade, production increased at a rate of 2.8% per annum; however, for Java, growth of production was only 2.0% and was due solely to yield increases. On the off-islands growth was mainly due to area expansion.

The potential for cassava in Indonesian food markets is limited since consumers prefer rice. However, since cassava roots are cheaper per calorie than any other staple and are consumed principally by the poor, cassava can form a critical component of a food and nutrition strategy. On the other hand, the diversity and integrated nature of cassava markets in Indonesia provide a firm basis for growth in utilization. Fresh roots can be consumed on-farm, sold to the fresh market or starch processors, or peeled and dried as gaplek. Gaplek, in turn, can be stored and eaten on-farm, sold for human consumption or flour production, or exported to Europe as animal feed.

The principal domestic growth market for cassava is as a source of starch. Most of the starch is being ▷

Table 1. **Production and end-use of cassava in principal producing countries in Asia.**

Country[1]	Production	Export	Domestic utilization[2] (000 t)				
	(000 t)	(000 t)	Human consumption		Starch	Animal Feed	Waste
			Fresh	Dried			
Thailand	13,554	9,996 (74)	-	-	745 (6)	16 (0.1)	2797 (21)
Indonesia	12,191	801 (7)	3035 (25)	2830 (23)	3308 (27)	-	2217 (18)
India	5,688	22 (0.4)	2610 (46)	619 (11)	1784 (30)	-	653 (12)
Kerala	4,189[3]	22 (0.6)	2437 (60)	619 (15)	499 (12)	-	503 (12)
Tamil Nadu	1,310[4]	-	126 (9)	-	1162 (82)	-	131 (9)
Philippines	436	-	243 (56)	13 (3)	97 (22)	18 (4)	65 (15)
Malaysia	432	66 (15)	-	-	302 (70)	43 (10)	21 (5)

1. Data corresponding to 1976 for Indonesia and the Philippines and to 1977 for Thailand and India (Kerala and Tamil Nadu).
2. Figures in parentheses (in the columns) indicate the percentage distribution of production among end-uses.
3. Includes 109,000 t exported to Tamil Nadu.
4. Excludes 109,000 t imported from Kerala.

incorporated in food products, particularly a wafer-like product called krupuk. Recently cassava has been used to produce high fructose sweeteners to replace sugar imports.

The average yields of less than 9.7 t/ha are probably well below their potential. The possibility of increasing yields on the very small-farm, upland areas of Java and of expanding cassava area on the underutilized land resources of the off-islands, together with the capacity of domestic markets to absorb increased production, allow Indonesia to increase incomes and productivity of upland areas through improved cassava technology.

India

Cassava in India is exclusively produced in the states of Kerala and Tamil Nadu, each with very different production systems and utilization patterns.

Kerala. It is one of the most populous rural areas in the tropics with an average farm size of 0.4 ha and with only one third of the work force in the agricultural sector having access to land. Cassava, sown on the lateritic soils of the upland areas, is the most important annual crop in Kerala after rice and accounts for 38% of the net area sown to annual crops. Area under cassava, however, has been declining quite markedly since 1976 when it reached a peak, due principally to displacement by tree crops, particularly coconuts and rubber (Figure 1).

As in Indonesia, cassava in Kerala serves as a basic calorie source principally to supplement the limited rice intake of the poor. Rice is distributed through public ration shops at lower prices. Whereas higher income strata supplement ration rice allotments with rice purchased on the open market, the lower income strata turn to cassava. Cassava consumption, principally in a fresh form, is therefore high, approximately 100 kg/capita, since there are no other secondary staples such as maize. For the poorest rural consumers, cassava can make up to half of total calorie consumption.

Cassava is an obvious component of a food strategy in Kerala, but declining production has been rapidly eliminating cassava's advantage as a cheap calorie source.

Tamil Nadu. Cassava in Tamil Nadu is mainly used in the starch and tapioca pearl industry, which is concentrated in Salem District. There are around 600 small-to-medium scale factories, producing about 300,000 tons per year. The industry, however, operates at only 50% capacity, principally limited by the availability of cassava roots.

Tamil Nadu is one of the few regions in the tropics where cassava is grown under irrigation. The farmers' cropping system is planned around the limited rainfall and available irrigation water (wells). When irrigation water is limited, farmers turn to water-efficient crops such as cassava. As a result of irrigation and residual fertility from fertilizer applications on prior crops, average yields close to 30 t/ha are obtained. The limiting factor in India is land and the issue is how much higher farm level yields can be raised over the relatively high level which farmers already achieve.

Thailand

Thailand is currently the largest cassava producing country in the region, with production rising from approximately 2 million tons at the beginning of the seventies to 17 million tons in the 1980/81 crop year.

This growth in cassava production was export led, since exports were stimulated by the binding in the GATT of the duty on cassava going into the European Economic Community (EEC) at a 6% *ad valorem* duty rather than the variable levy which applies to competing feed grain imports. However, other factors were also responsible for this rapid growth such as the availability of marginal, underutilized land resources in the northeast, the massive investment in a road network through the region (arising out of the Vietnam War), the availability of commercial middlemen already established in the rice and maize

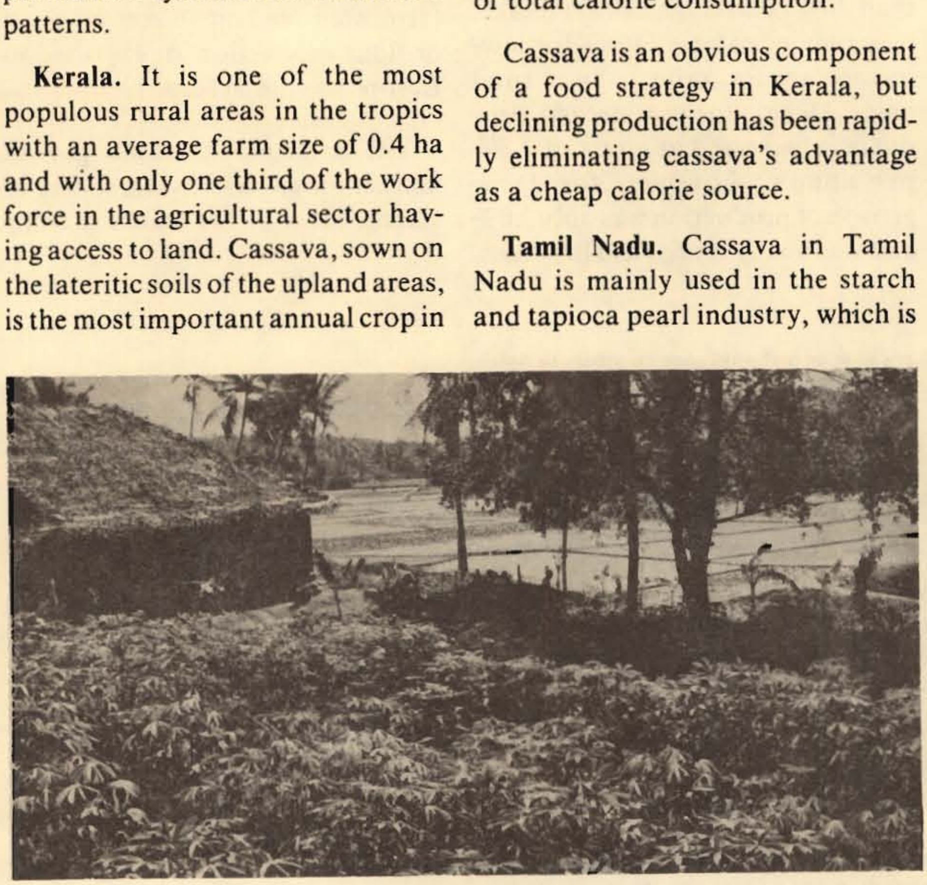

Figure 1. *Intensive land use typical of Kerala. Rice (in the background) occupies the lowlands, while cassava and tree crops are grown on upper lands.*

export trade, and substantial reinvestment to capture economies of scale in processing and shipping.

The EEC, however, has continued to increase its internal grain production and cassava imports are now competing with domestically produced barley and soft wheat in the animal feed industry. Mounting surpluses have been exported by means of subsidy payments, which have contributed to growing budgetary expenditures. Under these circumstances, the EEC has sought "voluntary" quota agreements from major cassava exporters. The five-year quota agreement signed with Thailand in September 1982 fixed the quota for 1983 and 1984 at 5 million tons, dropping to 4.5 million tons by 1986. The EEC quota agreement with Thailand would appear not only to halt any further growth prospects but to result in a substantial surplus, 1.5 million tons in 1986, if the current production capacity is viewed to be 6 million tons. Thailand is currently searching for means to remain within the quota through crop diversification in principal cassava production zones, expanding domestic consumption, and increasing exports to non-EEC countries.

Probably the most viable option for the medium-to-long term is to realign domestic prices with world grain prices in order to compete in the larger world grain market. The only mechanism that would buffer farm incomes from the effects of lower prices is to increase farm-level productivity. This is feasible through improved production technology taking into account the scope offered by average yield levels of 13 t/ha.

Possibilities for cassava in Asia

The Green Revolution that swept the continent in the late-sixties and the seventies was limited to the irrigated areas. The next major challenge is to raise crop productivity and farmer incomes in the upland areas. Apart from tree crops, cassava has the most potential for developing these areas of tropical Asia.

This potential lies not only with cassava's high productivity, but because of its multi-use characteristics, it is particularly adaptable to changing market conditions. In addition to its important role as a low-cost carbohydrate food source in rural Asia, there are possibilities of growth in the rapidly expanding feed concentrate industry and in the production of starch and sweeteners, the latter for net sugar importers such as Indonesia or Sri Lanka.

Due to the flexibility in its uses, cassava has a potential role in all of the different agricultural economies that exist in tropical Asia. This role can be defined to encompass many different development objectives, summarized in Table 2. Cassava will continue to develop in Asia without government intervention, but an increased investment in research on the crop would increase cassava's potential much more quickly.

Table 2. **Role of cassava in agricultural policies proposed by selected Asian countries.**

Agricultural policy objectives	Contribution according to country				
	Indonesia	India	Thailand	Philippines	Malaysia
Food and nutrition policies					
a. Flexibility in rice policies[1]	X	X			
b. Nutrition of the poor	X (gaplek)	X (fresh)			
Farm income and land use					
a. Higher small-farm income in upland areas	X	X	X	X	
b. Exploitation of frontier areas	X (except Java)		X (in the NE)	X (in Mindanao)	X (peat soils)
Balance of payments					
a. Increased export earnings			X		
b. Import substitution	X (sugar)			X (feed grains)	X (feed grains)

1. In Indonesia there exists a price policy on rice and in India rice sales are subsidized.

Philippines

Cassava is a minor crop in the Philippine agricultural economy, where annual per capita consumption is only 3.5 kg. Its principal alternative market is for starch production, but this has remained virtually stagnant in the last decade while the increasing demand for starch has been captured by maize starch. The industry is, in general, organized on a plantation system basis but with substantial purchases from smallholders. The major part of the industry is located on Mindanao.

The potential of cassava in the Philippines depends on the identification of a growth market for the crop, possibly within the animal feed concentrate market. This industry is rapidly expanding (an annual rate of 12.2% in the seventies), but to date growth has been based on increased production and imports of maize.

(Continued on page 11)

The subterranean chinch bug, a new pest of cassava

222672

Anthony C. Bellotti
César A. García G.

In recent years a subterranean chinch bug, identified as *Cyrtomenus bergi* Froeschner, has caused considerable damage to cassava roots in several areas of Colombia. Affected roots are commercially unacceptable, especially when they are for human consumption; in some areas cassava processors also reject severely damaged roots, considering them unacceptable for industrial use (Figure 1).

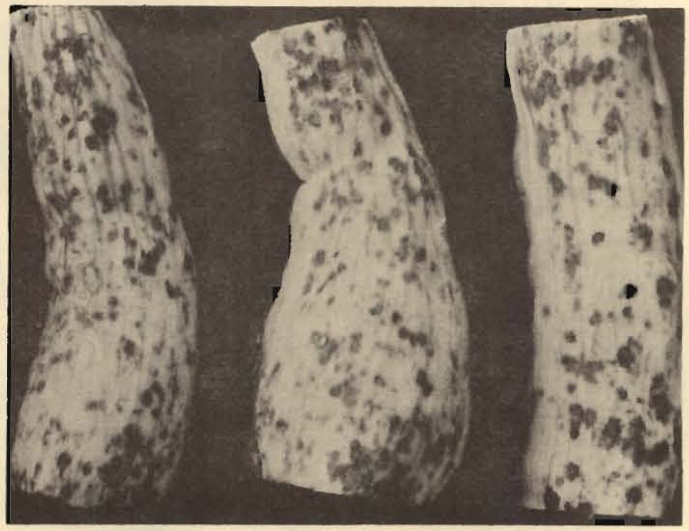

Figure 1. *Damage caused by the subterranean chinch bug on the roots.*

Given the type of damage it causes and its ability to survive in the soil for long periods (Table 1), *C. bergi* has the potential to become a serious cassava pest.

Life stages and habits of the insect

Egg. The eggs are cream colored, hyaline, and oval shaped with a smooth bright surface. The incubation period averages 13.6 days.

Nymph. Nymphs have a white to cream colored abdomen with a dark brown thorax and head. They initiate feeding immediately after emergence and pass through five instars, with a total duration of 111.2 days.

Adult. Adult *C. bergi* can fly and are probably disseminated from one area to another through flight. Recently emerged adults are cream colored but after a few hours they acquire their characteristic dark brown to black color. Their legs, just like those of nymphs, are short with numerous spines that facilitate the insects' movement through the soil (Figure 2). Adult longevity averages 293.4 days.

When disturbed, the insect becomes immobile, appearing dead, which makes them difficult to find in the soil. At harvest, specimens are found adhered to the roots by their injected stylet.

The longevity of *C. bergi* (averaging more than 400 days for the nymphal and adult stages combined) and the fact that the insect can complete its entire life cycle feeding only on cassava roots, as observed in laboratory studies, indicate that the cassava plant can be attacked by this pest during its entire growth cycle.

Maize, onion, sorghum, and groundnut are a few of the host plants of *C. bergi.*

Damage characteristics

Feeding is initiated when the insect (nymphs and adults) injects its strong thin stylet through the epidermis ▷

Table 1. **Dimensions and duration of the different life stages of *Cyrtomenus bergi* Froeschner, fed on roots of cassava variety CMC 40 under laboratory conditions (22°C and 65% RH).**

Life stage	Observations (No.)	Average dimensions (mm)		Duration (days)		Standard deviation
		Length	Width	Range	Average	
Egg	89	1.35	0.92	11-18	13.60	1.79
Nymph						
1st instar	85	1.70	1.18	12-18	13.76	1.31
2nd instar	86	2.76	1.64	15-22	17.80	1.83
3rd instar	75	3.45	2.13	19-26	21.09	1.73
4th instar	98	4.60	2.92	19-30	24.95	2.20
5th instar	103	6.15	3.88	26-38	33.55	2.61
Total				91-134	111.15	
Adult						
Female		7.30	4.44	184-372	293.4	
Male		7.00	4.06			

and root peel into the parenchyma, causing small brown to black spots on the surface. Several soil microorganisms belonging to the genera *Aspergillus, Diplodia, Fusarium, Genicularia, Phytophthora,* and *Pythium* enter into the wounded area and cause a "small pox" effect on the white fleshy root.

Laboratory studies show that damage symptoms appear within 24 hours after the insect initiates feeding. The affected area initially has a cream color which progresses to a clear yellow to dark brown surrounded by a black halo. At first these lesions are small, with an average depth of 5 mm, but they progressively enlarge and after five days may cover 45.5 mm^2 of the root surface.

Observations on feeding preferences

Preliminary comparative trials have been conducted with cassava, maize, and crotalaria to determine the feeding preferences of the pest. No differences were observed between maize and cassava; however, nymphs preferred to feed on cassava over crotalaria. Therefore crop rotation, using alternate hosts not preferred by *C. bergi,* offers a feasible measure of controlling this pest.

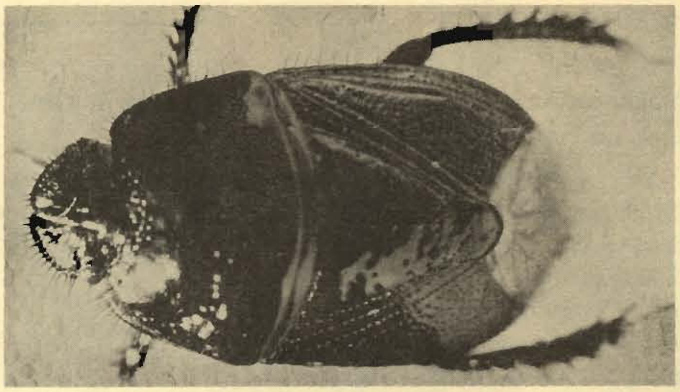

Figure 2. *Adult subterranean chinch bug (***Cyrtomenus bergi** *Froeschner).*

Laboratory studies were also carried out to determine if a feeding preference exists for high or low HCN cassava varieties. Colonies of 50 nymphs and adults were placed on plastic trays containing varieties CMC 40 (low HCN content) and M Col 1684 (high HCN content). Observations made every three days showed a strong feeding preference for low HCN roots since approximately 80% of the nymphs and adults were constantly found feeding on CMC 40. When not given a choice, however, the insect will feed on high HCN roots, causing considerable damage. The effect of HCN on the life cycle and longevity of the insect is still unknown.

Cassava in Asia...

Cassava, however, has potential to compete in this market if yields, currently the lowest in Asia (4-5 t/ha), can be increased and a cheap drying technology developed.

Malaysia

The analysis of the cassava situation within Malaysia highlights the switch over the last decade from supplying export markets to producing for domestic market. Malaysia was the first major exporter of cassava products in the world as the result of the establishment of a starch and tapioca pearl industry in Malacca in 1855. In 1980 net exports accounted for only 5% of total production of cassava products, while domestic consumption of cassava starch and pearl increased from 22,000 tons in 1972 to around 50,000 tons. Domestic demand is expected to grow but if cassava production remains stagnant, as it has in the past decade, this demand will have to be met by imports.

Another outstanding aspect of cassava in Malaysia is its production on federal lands. Tree crops (rubber, oil palm, coconut), which have a comparative advantage, occupy 85% of the cultivated area, much of which is in plantation systems. Cassava, in turn, is a smallholder crop, and in many cases is grown by squatters on federal lands. In the major cassava-producing state of Perak, in 1976, 3892 ha of cassava were planted legally while 10,240 ha were planted illegally. Therefore cassava production has been maintained only because of anomalies in land use policy; except for the insecurity of growing crops on federal lands, cassava would have been displaced by tree crops.

Land use policy remains the key to cassava's future. Only 25% of Malaysia's land area is cultivated, and policy makers will have to decide whether it is socially more profitable to promote further expansion of tree crops or expansion of feed grain substitutes. The expansion of rubber and oil palm crops, which represent 45 and 50%, respectively, of the world's production, will depend on export demand projections for these two commodities. Currently the government is seeking to promote cassava production on the very acid, peat soil areas, where tree crops have a lodging problem.

A publication for plant breeders: Elite Cassava Germplasm from CIAT

This pamphlet provides guidelines for those interested in obtaining elite cassava clones from CIAT for direct release as new national varieties following appropriate local evaluation or for use as cross parents in a breeding program. Clones are listed along with their general adaptation to different ecological conditions, yield and quality characters, potential use, major morphological traits, and resistance to major diseases, pests, and soil problems.

Clones are available as in vitro cultures, and requests should be made using the procedures given in the publication.

This pamphlet may be requested free of charge from CIAT's Cassava Program or Publications Distribution Office, Apartado 6713, Cali, Colombia.

Change in name

The Tropical Products Institute (TPI) has changed its name to Tropical Development and Research Institute (TDRI). Its address continues to be:

56-62 Gray's Inn Road
London WC1 X8LU
England

A new executive board was elected during the annual meeting of the Thai Tapioca Trade Association. The 15 newly elected board members will serve a two year term from March 1983 to March 1985. More information can be requested addressing:

Somboon Vatanasombut
Secretary General
The Thai Tapioca Trade Association
120 North Sathorn Road,
Bangrak, Bangkok 5, Thailand

The Chitedze Agricultural Research Station in Lilongwe, Malawi, is carrying out trials to determine the effects of detopping growing cassava shoots on disease symptom expression. In screening trials for tolerance to cassava African mosaic, several susceptible varieties are being used as infector rows, designed in such a way that the screened varieties are bordered on each end with a susceptible infector variety. The level of tolerance is to be determined by measuring the amount of cassava African mosaic occurring at different distances from the infector variety and by calculating the rate of increase in terms of distance. Suggestions and advice would be appreciated. Please address:

Patricia Ngwira
Plant Pathologist
Chitedze Agricultural Research Station
P.O. Box 158
Lilongwe, Malawi

CIAT
Apartado aéreo 6713
Cali, Colombia