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CASSAVA IN ASIA

BY

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3. Cassava in Asia

Cassava was probably brought to Asia through the Philippines, where it was introduced during the Spanish regime in the early part of the 17th century. By the turn of the 19th century it had been effectively distributed throughout Southeast Asia. From this point in time development of the crop varied substantially between countries in the region. Colonial administrations developed it as an export crop in Malaysia and Indonesia and as a famine reserve in Kerala, India and on Java. As compared to cassava in Africa and Latin America, cassava in Asia developed as a truly multi-use crop. However, it has always remain a secondary crop to rice in the region.

Future development of the crop requires a definition of how cassava fits into essentially rice economies. The rationales will vary by country but will in general cover the issues of more productive land use, nutrition, farmer incomes, and export earnings. Presently, end-use of cassava varies substantially between countries (Table 3.1)and cassava in each country has evolved to find a particular niche in the agricultural economy. An understanding of the future of cassava in Asia must therefore be done on a country-by-country basis. Moreover, in traditional agricultural export economies, such as Thailand and Malaysia, cassava has developed as essentially an export crop. Therefore, a brief description of the world market for cassava products will precede the sections discussing cassava in each country.

Cassava Export Markets

The world export trade in cassava products had its beginnings with the development of the cassava starch and tapioca pearl industry in the Malayan Peninsula in the 1850's. By the turn of the century Java had overtaken Malaya as the principal cassava exporter, and by the end of the World War II Thailand had assumed, and continues to assume, the role of leading cassava starch exporter. Moreover, since world War II there has been a shift from starch to chips and pellets for animal feeds as the major export market for cassava.

An estimated 16 million tons of starch are produced on a world basis, approximately 8% of which is cassava starch (Jones, 1983) Given this quite substantial production base, only approximately 3% of world production moves in trade, most of which is cassava starch. Moreover, while starch production has been increasing, world trade has been stagnant. The reasons for this lie in technological advance in starch modification, technical change in the maize wet-milling process, and the existence of trade barriers in all major import markets except the USA.

Trends in the world market for cassava starch are reflected in the changing structure of the starch market in Japan (Figure 3.1), the world's largest starch importer. Cassava starch imports face a 25% tariff as well as a quota, which protects domestic potato producers. However, maize as grain enters under much more liberal conditions and particularly since 1976 investment in maize wet-milling capacity has captured most of the starch market. As in most countries, domestic production, quite often from imported grains, is the principal means of meeting increasing domestic demand for starch.

The situation in the USA is reflected in Figure 3.2, which shows that cassava starch is uncompetitive on a price basis with domestically produced maize starch. The reason is high transport costs relative to the value of the starch (Table 3.2). The future of cassava starch trade thus lies in developing markets close to export points and free of trade barriers. Such has been the recent example of Taiwan, which increased imports from 4.2 thousand tons in 1975 to 86.4 thousand tons in 1980. However, a Taiwan $1,500/ton tariff and recent investment in maize starch production capacity will probably eliminate future growth in this market.

In summary, the world market for cassava starch will continue to remain stagnant. Cassava starch will fill shortfalls in domestic starch production and certain speciality markets, such as for baby-foods. This will cause a certain instability in the market. Movement to export of modified starch products may offer some future growth, but at present this market is no more than 100 thousand tons (Jones, 1983) and is dominated by subsidized exports from the EC. Finally, cassava starch producers must compete against maize starch on the demand side and must compete on the supply side for cassava roots whose price is determined by internal EC grain prices, a situation which often squeezes profit margins.

Over the past two decades world trade in cassava underwent a major structural change as trade shifted from starch and tapioca pearl to cassava chips and pellets for animal feed concentrates. The impetus for this change in cassava trade lies in the creation of the Common Agricultural Policy (CAP) in the European Community in 1962. Initially cassava products were brought under the variable levy system that was the key to maintaining high internal grain prices, but in July 1968 during the Kennedy Round the levy on cassava pellets and chips was bound in the GATT at a 6% ad valorem duty. This binding provided the impetus for the development of the Thai cassava industry and since that date cassava has been making up an increasing percentage share of compound feeds in the EC (Table 3.3).

As the margin between domestic and world market prices for grains has widened in the EC (Figure 3.3), cassava exporters have increased their shipments and have been able to reap substantial social profits paid for by European meat consumers. Such a situation would have been politically sustainable were it not that the EC has moved to a net export position in grains. Mounting surpluses must either be stored, exported as food aid, or exported by means of subsidy payments. Growing budgetary expenditures, particularly during the recent economic slowdown, have put pressure on the EC to reduce cassava imports, which are displacing domestically produced barley and soft wheat.

Since there were no politically feasible means of unbinding the cassava duty in the GATT, the EC has sought "voluntary" quota agreements from major exporters. The EC started negotiations with the major exporters in 1981 and by 1982 has signed five-year agreements with

Thailand and Indonesia (Table 3.4). The major thrust of the agreements was to limit the growth in Thai imports and even to reduce import volume over the medium term. The quota would be enforced by a system of export permits administered by the Thai government. The EC has thus shown itself to have enough leverage on cassava exporters to control cassava imports - -though this leverage does not extend to U.S. export of maize gluten feed, wheat bran, and citrus pulp.

The result of these developments is that the world cassava market is now in a stasis. The EC has shown itself committed to protecting the CAP from the financial pressures that cassava imports were inducing. It would seem logical that the EC would continue with this same basic modus operandi beyond the current agreement period. Cassava exporters in the medium-to-long term thus face the task of either cutting back exports through either increased domestic consumption or reduced production levels or making cassava more competitive in the broader world grain market. All these alternatives require lower price levels and the only potential mechanism beyond government subsidies that would buffer farm incomes is cost-reducing production technology. These options will be explored in more detail in the following country studies.

Thailand

Thailand is the classic example of an agricultural economy which is geared to export. The Thai agricultural economy has undergone rapid growth in the post-war period, principally due to rapid expansion in cultivated area, with upland crops expanding relative to rice and with output principally directed toward export markets. Moreover, regional specialization in crop production is a dominant characteristic of the growth process Another principal attribute of the Thai economy is that it has been relatively quick to respond to changing world market conditions and Thailand was thus well positioned to be the first and principal country to respond to the chink created in the EC tariff wall at the Kennedy Round.

Growth in cassava production during the seventies was very rapid, rising from approximately 2 million tons at the beginning of the decade to 17 million tons in the 1980/81 crop year (Table 3.5). This growth was due exclusively to expansion in area planted and was concentrated in the northeast portion of the country, a more marginal agricultural zone where kenaf was previously the principal crop.

The growth in cassava in Thailand was export-led, as can be seen by the export series in Table 3.6. However, a preferential access to the high-priced grain market of the EC was not the only factor responsible for this rapid growth. Other principal factors include the availability of the 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 experienced commercial middlemen already established in the rice and maize export trade; and substantial reinvestment to capture economies of scale in processing and shipping. For example, by 1980 90% of cassava pellets were being shipped in bulkcarriers carrying over 60,000 tons of cargo, with an average cargo size of 87,000 tons. By comparison the average grain cargo size from North America was 41,000 tons (Graan Elevator Maatschappij, 1981).

The EC quota agreement with Thailand would appear to halt any further growth. Moreover, since the last two year's export volume would suggest a current production capacity of 6 million tons of pellets, the quota in 1985 and 1986 would result in a 1.5 million ton surplus. For Thailand the issue is what adjustments are to made in both the short and medium term to adapt to this major change in market conditions. The government has up to this point sought a mechanism for remaining within the quota. The options open to the government will be briefly analyzed, which will be followed by a brief discussion of whether Thailand ought to consider readjusting domestic cassava prices to world grain prices and attempting to open new export markets.

Thailand is currently searching for means to remain within the quota. There are several options but the focus up to this point has been on crop diversification in principal cassava production zones. In the eastern provinces the focus has been on rubber schemes, while in the northeast crops such as kenaf, groundnuts, castor beans and cashew nuts are being considered. Analysis of social profitability for groundnuts and kenaf have shown that cassava continues to be substantially more profitable (T. Lokaphadhana and D. Welsch, 1982) and prospects for castor beans and cashew nuts are only hypothetical at this stage. Diversification in the northeast is a medium term solution but only if more profitable crops can be identified for the region.

Expanding domestic consumption of cassava products is another option. Cassava is not consumed directly as a food source in Thailand, and it is highly improbable that this situation will change. Domestic consumption of cassava starch has been increasing very rapidly in the past decade (Table 3.7); however, domestic consumption had reached only 170 thousand tons by 1980 versus an export volume of about 250 thousand tons.

The other major potential domestic market for cassava products is the animal feed concentrate market, which grew at a 27% annual rate during the last decade (Table 3.8). However, this growth was based on use of broken rice, rice bran, and maize as the principal ingredients, while cassava was used in only minor quantities. Least cost feed formulation models suggest that the high cost of protein sources together with the relatively narrow spread between cassava and maize prices made cassava uncompetitive (Chayaputi, et. al., 1981)[1] Even should price relationships change a 20% inclusion rate implies only around 300,000 tons, a mere dent in the 1.5 million ton surplus. Expanding domestic consumption offers some relief, but is by no means a solution.

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[1] A trade source in Bangkok said that cassava entered in their feed formulation model up to 10% maximum in August 1982.

Another option is to increase exports to non-EC countries, while not attempting to severe the price linkage to the EC market. Cassava pellet prices are sometimes competitive with world grain prices (Figure 3.4), particularly in Asian markets. Thus, South Korea was a significant cassava importer in 1981/82. However, with the decline of world grain prices in 1982, Korea has switched completely to maize. In order to stabilize such exports, the government would have to institute a variable export subsidy scheme to insure that cassava maintained competitiveness in third markets. Budgetary requirements, Thailand's traditional free trade policy, and its negotiations to enter GATT would militate against such a course. Moreover, world grain stocks and low prices will probably make cassava uncompetitive in third markets in the short term.

The above would appear to imply that the Thai cassava sector has no alternative other than the relatively harsh fallback position in which there is a stock build-up, a fall in farm-level cassava prices, and stagnation in the agricultural economy of the northeast. It is the author's opinion that Thailand needs to rethink it medium-to-long term policy for cassava and that the most viable option is to realign domestic prices with world grain prices. In doing this Thailand will need to continue to capture the substantial social profits available by exporting to the EC and will need to maintain sufficient incentives to cassava growers. The first objective can be achieved by a variable export tax on shipments to the EC, which could possibly involve an extension of the export certificate scheme which Thailand has instituted to control shipments to the EC. This will result in an income redistribution from cassava producers to the public treasury but is preferable to this profit being captured by EC feed manufacturers.

The maintenance of farmer incentives, at least at current world grain prices, will require cost-reducing production technology. The focus of such a research strategy would be quite simple: to minimize per unit cost of cassava production on a dry weight basis. Variety and soil fertility maintenance will be the key factors to be addressed. Whether this realignment can be done depends critically on four factors; (1) the potential for cost reduction due to new production technology, taking into account the not neglible cost component that must cover processing and shipping (Figure 3.5); (2) the prospects for world grain and protein meal prices; (3) the price differential with maize and sorghum required to open new markets; and (4) transport costs to third markets relative to major grain exporters. The scope of the present study permits only identification of the issues and not a definite answer to the prospects for realignment[2]

The role of a cassava research program in Thailand is clear: to maintain growth of small farm incomes in the marginal production conditions of the northeast. Success will depend on the yield potential that can be exploited and the world grain market. A basic change in government policy will be absolutely necessary to affect the price

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2 A study is underway to estimate the domestic resource cost and social profitability of cassava at each stage from production to export. The study will then evaluate the sensitivity of these estimates to changes in yields and export prices, leading to a set of yield targets.

realignment and timing of this policy change will be crucial in avoiding disallocations. Although there are many unknows in such a course, there appear to be no other viable alternatives and a totally unsatisfactory fallback position.

Indonesia[3]

Although cereal imports make up only 9% of total cereal disappearance, Indonesia is far and away the world's largest importer of rice and therefore significantly influences the import price that must be paid. In this situation Indonesia has attempted to move toward self-sufficiency in grains and as well uses imports and the government import and stock monopoly (BULOG) to control internal food prices. Rice provides over half the calories in the Indonesian diet and food makes up 74% of average consumer expenditure. Rice prices are therefore a significant means of affecting consumer purchasing power and welfare. Such market intervention to influence rice prices was felt necessary, since an estimated 40% of the population is below the minimum calorie requirement (Knudsen and Scandizzo, 1979).

Agricultural policy in Indonesia is focused on rice but there is a growing consensus that secondary food crops must as well be included in a comprehensive food policy. To this end it is important to define the role of cassava within the agricultural economy of Indonesia, particularly if resources are to be directed to increasing cassava production.

Indonesia is the premier example of a well integrated cassava economy. The multiple uses of cassava are fully reflected in utilization patterns (Table 3.9). Cassava is consumed as food, both in a fresh and dry form, it is exported, and a substantial portion is processed into starch. The market serves to allocate cassava roots to these end uses on the basis of demand conditions and this integration of diverse end markets critically depends on the intermediate product <u>gaplek</u>, essentially a peeled root which has been quartered and dried. In no other country, apart from <u>kokonte</u> in Ghana, is cassava found in this particular form.

Cassava is the most important food crop in Indonesia after rice (Table 3.10) but still makes up no more than 10% of average calorie intake. The importance of cassava in the food economy lies in the distribution of cassava consumption. First, cassava is principally consumed in rural areas. This is a typical pattern for cassava,

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[3] This section relies very heavily on Nelson (1982), Unnevehr (1982), Roche (1982) and Dixon (1982), studies within a project carried out by the Food Research Institute, Stanford University.

particularly where a large portion is consumed in a fresh form. Second, there is substantial regional variation in consumption patterns of both fresh cassava and gaplek. Although per capita consumption levels for cassava are the same for Java as the outer islands, fresh consumption is much more important off-Java. Gaplek consumption is concentrated is the eastern part of Java, where soil and rainfall conditions are more marginal (Figure 3.6), while fresh consumption on Java is relatively more evenly distributed (Figure 3.7).

Third, and most importantly, there is substantial variation of cassava consumption by income strata. Particularly, the poorer income groups, principally in the rural areas, substitute cassava and maize for the more expensive but more highly preferred, rice (Figure 3.8). Cheap cassava (Table 3.11) allows the lower income segments of the population to achieve a higher calorie intake with their limited food budget than they would have been able to achieve with just rice. Cassava is a potentially key commodity to focus on in improving nutrition in rural areas and in managing rice imports.

These particular roles for cassava follow from an analysis of demand parameters (Table 3.12). What the income elasticities show is that among the poorer income strata there is a significant increase in cassava consumption, both as fresh and gaplek, with increases in income. Such changes in cassava consumption could come from real increases in income or from changes in the rice price, since expenditure on rice makes up such a large part of the consumer budget. Substantial substitution between caloric staples by the poor would be expected depending on relative prices. In fact, price elasticity estimates suggest substantial responsiveness to price changes on the part of consumers (Table 3.12).

The benefits of cheaper cassava arising from new cassava production technology would be captured essentially by the poor. However, this potential nutritional impact could possibly come at the expense of farmer incomes, since overall growth potential in the cassava food market, as expressed by average income elasticities, is negligible. Thus, too rapid an increase in production could substantially drive down prices unless there are alternative markets. In Indonesia such markets are well developed.

Starch is the largest single form of utilizing cassava in Indonesia. There has been a major starch industry on Java since the turn of the century. Moreover, production has been growing rapidly in the last decade (Table 3.13) and this has been particularly the case in the old transmigration province of Lampung. Starch has been the principal growth market for cassava and unfortunately the reasons behind this growth are not fully understood. Apparently, most of the starch is being incorporated in food products, particularly a wafer-like product called krupuk. One estimate puts food uses of cassava starch at about 80% of total production, with most of this going to krupuk (Nelson, 1982). Krupuk consumption is very responsive to changes in income and with annual per capita consumption levels at around 2 kg. (Unnevehr, 1982), a substantial growth market exists for cassava, to the extent that on Lampung starch is displacing the other major cassava market, gaplek for export.

The gaplek export market, although only a relatively small portion of total cassava disappearance, serves a critical function as a surplus vent and as a price floor. Reflecting this role, cassava exports from Indonesia have been quite variable over the past decade (Table 3.14). Exports in this period in general varied between 100 to 400 thousand tons, except for 1979 when exports soared to over 700 thousand tons, due essentially to a major devaluation and high cassava prices in Europe. In this period exports from Java tended to decline while those from Lampung increased.

The effective operation of the floor under domestic cassava prices, which is set by the export market, depends critically on integration of the various cassava markets. Lauvian Unnevehr (1982) in an analysis of cassava marketing systems on Java provides clear evidence of market integration. In terms of the linkage between fresh root and gaplek prices, variation in fresh root prices explained over 90 percent of the variation in gaplek prices in 7 of 19 markets on Java and over 80 percent of the variation in 18 of the 19 markets.

Not only were gaplek and fresh root prices strongly linked but there was also a strong linkage of gaplek prices between markets across Java, although this linkage was principally due to the operation of the export price floor. Thus, when domestic prices were at export parity the correlation coefficient of gaplek prices in different markets was greater than or equal to 0.90 for 106 of 171 potential pairs. On the other hand, when domestic prices were above export parity only prices in 27 pairs of markets were correlated at the level of 0.90 (Table 3.15). When domestic prices were at export parity, domestic price variation of gaplek was due almost completely to variation in the export price (Unnevehr, 1982) and since there was a generalized price linkage between markets and between roots and gaplek, the operation of an effective price floor was demonstrated. When domestic prices rose above export parity, price variation was much more influenced by regional supply and demand conditions for cassava.

What is remarkable is how often domestic prices have been at the price floor. In the period 1971 to 1979, monthly prices in Surabaya, the major market in eastern Java were at export parity 78% of the time. Production in this period grew at an annual rate of approximately 2.8% at a time when population growth was 2.0% and income growth 5.3%. Normal growth in food demand for cassava (assuming a combined income elasticity of 0.1) and the rapid growth in starch production, should have put some upward pressure on cassava prices. Moreover, never more than 15% of domestic production was exported and the figure was usually less than 10%. Surpluses, thus, were never that large.

However, the other major factor affecting cassava prices is the domestic price of rice and over this period the real price of rice fell substantially (Figure 3.9) due to the impact of improved rice technology and import policy. Thus, an important linkage between rice and cassava prices also exists. During the period of rapid expansion in rice supplies the cassava export market served a critical function of providing an effective price floor and thus maintaining incomes of cassava farmers. As Indonesia has probably exploited most of the yield gain possible from the rice technology, domestic rice prices and rice imports are again likely to become important policy issues. Cassava, because of this price linkage to rice, allows more flexibility in meeting rice price policy objectives. Thus, improving cassava production may be a far less expensive means of maintaining rice prices in the future than rice imports.

The cassava market in Indonesia is unique in comparison to other cassava market systems elsewhere in the tropics. First, the market is well integrated over space, across different end uses, and over time. Second, a domestic growth market currently exists in the starch market. Third, an effective price floor is provided by the gaplek export market. Given such a market structure, the development of an improved cassava technology could simultaneously achieve the dual policy objectives of increasing cassava farmers' incomes and improving nutrition of the rural poor, particularly since the benefits of cheaper cassava are biased almost exclusively toward the low income strata. Often these two goals are contradictory, but given a probable upward pressure on cassava prices in the future, cost-reducing production technology in an Indonesian setting has the potential of impacting on both goals.

Assessment of the demand for new technology requires a consideration of cassava production. In the past decade cassava production in Indonesia has increased at the not insubstantial rate of 2.8% per annum. Production growth was much more rapid on the off-islands than it was on Java, where production increased at less than 2.0% per year. Moreover, whereas most of the grow of cassava on the off-islands was due principally to area expansion, growth of production on Java was due solely to rising yields (Table 3.16). Production possibilities are sufficiently different between Java and the off-islands to make it worthwhile to consider them independently.

Java has some of the highest rural population densities in the world. Median farm size is 0.4 hectares and rarely does farm size exceed two hectares. While relative farm income depends critically on access to land, another major determinant of farm income is access to irrigation. New technologies for upland crops would thus serve to counter the principal income distributional effect of the green revolution, the very skewed distribution of benefits between regions on the basis of irrigation potential.

Cassava is grown throughout Java but is particularly concentrated in the more marginal production areas of Yogyakarta and Madura (Figure 3.10). These are drier areas and ares where soil fertility has substantially degraded. For these reasons average yields tend to be much lower than they are in the more highly productive areas of west Java.

Cassava production systems on Java differ from most other systems in Asia in two regards. First, intercropping is the predominant form of producing cassava (Table 3.17). Second, there is at least some fertilizer applied to cassava (Table 3.18). The two factors are potentially related, particularly where cassava is intercropped with upland rice. Fertilizers applied in Indonesia are principally nitrogen and phosphorous sources and fertilizer prices are substantially subsidized. Nevertheless, rates of fertilizer application to cassava are low when compared to fertilizer application in other crops. Thus, even under the most favorable conditions such as exist on Java, fertilizer use in cassava remains low, generally in contradiction to fertilizer response trials.

Apart from fertilizer use, cassava production systems are very intensive. The intercropping systems can be quite complex (Figure 3.11). The number and type of intercrops will vary depending on rainfall, land type, and market (Roche, 1982). Thus, close to urban markets cassava will be found in monoculture, even ocassionally on irrigated land. Farther, from fresh urban markets but on relatively good soils, cassava will be found in association with upland rice and maize, and ocassionally legumes. As soil fertility declines, first upland rice, then legumes, and finally maize leave the system. On the very eroded hillsides in Yogyakarta only monoculture cassava is found in a long-term bush fallow. Finally, on some irrigated land that depends on flooding cassava will follow rice in a double-cropping system, where timing and early maturity are crucial.

Some of the complexity and intensity of these systems are presented in Table 3.19. Labor use tends to be high, even where substantial animal power is utilized, while cash costs tend to be relatively low. Yields vary substantially, in part due to differences in inputs and production systems, but also in large part due to differences in the inherent productivity of the land system. Finally, cassava in most of these systems is grown principally as a cash crop.

The issue naturally arises as to what is causing the rising yield trend on Java. Roche (1982) attributes it to increasing fertilizer use. Given that what little potassium available is used in perennial crops and that little response has been demonstrated for phosphorous, most of this is apparently due to increased nitrogen use. Since the leaves are often used as a vegetable and are not, therefore, recycled, nitrogen is probably a limiting factor on these volcanic soils. However, yield increases may also be due to shifts in land use patterns or intensification of cassava within the intercropping systems. Whatever the cause, yields at 9.7 tons/ha are still low given the intensive nature of the production systems on Java.

Population densities off Java are about a tenth of what they are on Java. These off-islands form in a real sense the Indonesian frontier. Indonesian development policy has focused heavily on these areas through the transmigration schemes, in which population is moved from Java to these outer islands. Cassava forms an integral part of these schemes, where it serves as a basic food sources in the first few years after land clearing and before irrigation systems are developed. However, it is only in the oldest transmigration area of Lampung that cassava production has increased rapidly, and that is due to the large investment in roads, vehicles, and finally starch processing and gaplek pelletizing capacity.

Soils, as well as land/labor ratios, change dramatically in moving to the outer islands. Phosphorous is the limiting nutrient on these podzolic soils, with soil acidity and aluminium toxicity being associated problems. Nevertheless, on the newly cleared lands cassava yields are relatively high with little use of fertilizer. On the other hand, there are reports of declining yields in the older production areas.

Even though land is relatively abundant rarely are more than 2 hectares cultivated on the off-islands. This is principally because labor requirements of the production systems remain high, labor is in short supply, and there is no animal power for land cultivation. Still, technology development has focused on further land intensification (Table 3.20), along the line of the types of technology required for conditions on Java. However, whereas labor use is more than doubled and input costs are increased four times in these improved systems profits are increased by little more than 90%. Expanding land under cultivation and labor saving technology would seem more profitable alternatives.

In summary, Indonesia offers somewhat the reversal of the needs of a typical cassava producer, in that the marketing system is already in place to absorb substantial increases in cassava production (all the more should rice prices increase). However, partly because of this diversity of end-market utilization, the technology development process will be inherently more complex. First, the production technolgy will face different constraints on Java versus the off-islands. Whereas, off-Java the principal constraint will be labor, with some concern about soil fertility and soil erosion, on Java the constraints will be found in a multiplicity of land systems and cropping systems. Time to maturity will be an important factor in many of these systems and in areas were fresh cassava consumption predominates, quality characteristics will be crucial to adoption. Selection of appropriate testing sites, identification of necessary evaluation parameters, and the choice of the production system for the testing will be a critical component of an effective varietal development program in Indonesia.

India

The principal agricultural policy objective of India in the past couple decades has been the achievement of self-sufficiency in foodgrains. Self-sufficiency, while implying a termination of imports, is in fact a relative concept depending on how demand is specified in relation to production. The government has assumed a dual approach to achievement of this goal, namely promoting increases in grain production and intervening in grain marketing to manage demand. The government operates a public food distribution system at subsidized prices to ensure that a certain minimum level of universal distribution is achieved for food grains. The issue then is how cassava might fit into this policy matrix.

Cassava is very much a regional crop in India, although given the size of India, this could be said of most any crop. Production is concentrated in the south of India in the state of Kerala and the western part of Tamil Nadu. The two states together account for over 95% of total production.

Kerala is one of the most populous rural areas in the tropics. Population densities in some districts exceed 1000 people per square kilometer. About 85% of the population reside in the rural area according to the 1971 census, while a little less than half of the work force are directly involved in agriculture. However, a more accurate reflection of the population pressure is that while average farm size is only 0.49 of a hectare, only one third of the work force in the agricultural sector have access to land. Moreover, over 70% of the population who do own land have less than half a hectare (Table 3.21).

As a consequence of this population pressure, land use is very intensive. Excluding forest reserves and non-agricultural uses, 87% of available land is cultivated. The cropping intensity index in Kerala in 1977/78 was 132 percent, well above the average for India as a whole. However, this figure is more remarkable when it is considered that two-thirds of cultivated area is under permanent tree crops. Thus, for area under annual crops the cropping intensity index is 192 percent; that is almost all the land under annual crops is double cropped. Over time area planted to the higher value tree crops has grown at the expense of annual food crops, a remarkable trend given the size of the average holding and the usual time lag in obtaining a return on investment in trees. A result of these different factors is that Kerala has the lowest per capita foodgrain production of any state in India and is consistently a net importer of grains, principally rice.

Cassava is the most important annual crop in Kerala after rice. Cassava makes up 38% of the net area sown to annual crops. It is worthwhile to consider then why cassava has achieved such importance in such an intensive agricultural system. The answer lies in two factors. First, the non-irrigated upland areas are characterized by lateritic soils which are low in inherent soil fertility, especially phosphorous, and are quite acidic. Cassava in comparison to most other annual crops, is well adapted to such soils, even with relatively minimal amounts of fertilizer. Second, cassava gives very high carbohydrate yields under these conditions. With average yields around 15 t/ha only triple cropping of rice under irrigation gives higher dry weight yields in the state.

Area under cassava in Kerala reached a peak in the 1975/76 crop year and has since been declining quite markedly (Table 3.22) apparently being displaced by continued planting of tree crops, particularly rubber. Yields have probably remained quite constant over the decade. The yield decline evident in the production statistics comes from the institution of a crop-cutting survey in 1975/76 and the revision downward of what were apparently slightly inflated yields. Given that the consistent trend in planting tree crops continues, area under cassava will probably continue to decline. Increases in yields seem a necessity in the state, given that there is a continuing demand for cassava.

As might be expected where there is such population pressure on the land, per capita food consumption levels are low. About 70% of average incomes are spent on food, with the principal component being rice (Table 3.23). An average caloric intake of just over 2000 calories per day implies that a substantial percentage of the population are below minimum calorie standards; in the urban areas as much as half the population fall below minimum levels and in the rural areas, 35% (Table 3.24).

As in Indonesia, cassava serves principally to supplement the limited rice intake of the poor. Because there are not other secondary staples, such as maize, per capita consumption levels are high. Unfortunately, there are conflicting estimates of how high consumption levels are (Table 3.25). The author would put annual consumption somewhere between the estimate of the National Sample Survey and P.S. George, that is at around 100 kg/capita. This is a very high average rate for cassava principally consumed in a fresh form.

The role of cassava in food consumption patterns is more clearly seen in relation to the public distribution of rice through the ration shops (Table 3.26). Consumption of rice sold at lower prices (Table 3.27) through ration shops was relatively constant across income strata. But, whereas the higher income strata were able to complement this allotment with rice from open market purchases and at the highest income levels from own production, the lower income strata supplemented the ration rice with very high levels of cassava consumption, most of which was purchased. Nutrition of the poor depended principally on ration rice allotments and cassava purchases.

Given the preference for rice, a principal determinant of the demand for cassava will be ration rice allotments. The first factor to consider is whether ration rice consumption is influenced by demand factors. Two studies (George, 1979 and Kumar, 1979) conclude that ration rice consumption is not influenced by demand factors but purely by supplies available, that is, all that is available would be consumed.

As levy procurement of rice within Kerala dropped to negligible levels, the ration system in Kerala came to rely almost completely on allotments from the Central Pool of the Food Corporation of India (FCI). Moreover, these allotments now account for over half of rice supplies in Kerala (Table 3.28), and whereas such allotments should introduce a certain stability in rice supplies, they are in fact, the major cause of variability in rice availability in the state. The author knows of no study which analyzes the determinants of state allocation of ration rice by the FCI, but obviously there are other criteria than just maintenance of per capita consumption levels over time. It is apparent that cassava will continue to be a principal component of a food strategy in Kerala and thus can be used to provide a certain flexibility in the operation of the ration system in the state.

Since 1975 declining cassava production and, somewhat oddly, declining rice prices are rapidly eliminating cassava's advantage as a relatively cheap calorie source (Table 3.27). In 1979 the ratio of rice to fresh cassava prices was close to the point where cost per calories were equal, that is at a ratio of 3.4. What is inexplicable with the available data is the low rice price in 1978 and 1979. Since food zoning was eliminated in 1977, that is restrictions on interstate trade of food grains, it is possible that there have been flows of rice into Kerala from other states brought by private traders and sold on the open market. With the available data it is not possible to gauge the importance of this trade and its potential effect on cassava demand.

There are no apparent data sets with sufficient disaggregation to allow the estimation of demand parameters for cassava, such as were obtained in Indonesia. However, it is probable that demand for cassava as a food is relatively income inelastic. There is also probably a high cross-price elasticity with rice. Thus, any substantial increase in production due to new technology and/or drop in rice prices would probably entail a major drop in cassava prices. To maintain some stability in cassava supplies with a major increment in cassava yields would require the development of an alternative market.

A somewhat fragmented starch industry currently exists in Kerala. This consists of two large-scale plants, 3 medium-scale, and an estimated 50 small-scale plants. The author estimates starch production in Kerala to be about 54 thousand tons in 1980. The industry probably operates at not more than 50% capacity. This is because the factories have to offer a lower price for cassava roots than the fresh market price in order to remain competitive with the major starch producing zone in Tamil Nadu. Thus, in 1981 a starch factory in Kerala paid 260 rupees/t for roots, while farm level prices in Tamil Nadu were between 280 to 360 rupees/t. By contrast the average farm gate price for the fresh market in Kerala was 400 rupees/t. It is necessary to bring the prices in the starch and fresh food markets closer together in order to maintain an effective price floor; as it is, the starch industry in Kerala is moribund.

The analysis of the cassava starch market leads in turn to a consideration of the cassava industry in Tamil Nadu. Salem District in Tamil Nadu State is the major producing area of cassava starch and tapioca pearl--called sago in India. There are 229 sago factories and 269 starch factories operating in Salem District, with an average daily capacity of 4 tons of starch or pearl. Rail shipments of starch and pearl suggest that production of the two products is about 90 thousand tons (Table 3.29). The starch goes principally to textile mills in the north and the tapioca pearl is shipped principally to Calcutta where it is used as a basic food source. The industry operates at 30 to 40% capacity and the principal factor limiting production is the availability of cassava roots, even though there is almost no consumption of cassava as a food.

Cassava production systems in Tamil Nadu are in many ways unique. This is one of the few areas in the tropics where cassava is grown under irrigation. Average annual rainfall in Salem is 950 mm but with some years receiving only as much as 500 mm. Since irrigation water is provided by wells, the farmer's cropping pattern is planned around the rainfall and available water in the well. When irrigation water is in short supply, farmers turn to water efficient crops and cassava is found to be very efficient in its water use. Thus, irrigated cassava is usually planted after the harvest of the paddy rice crop which is grown in the rainy period. A cassava crop grown under purely rainfed conditions would be planted at the start of the rains. Cassava in such systems is able to take advantage of residual fertility from fertilizer application on prior crops. As a result average yields at close to 30 t/ha are some of the highest farm level yields in the tropics. Results from the crop cutting survey (Table 3.30) found 15% of the plots to yield over 37 t/ha and found a maximum yield of 84 t/ha. This area demonstrates the yield potential of cassava under optimum growing conditions. Because of the difference in yield between Kerala and Tamil Nadu, per unit production costs and therefore farm prices are lower in the latter state.

In summary, cassava serves a major, if somewhat distinct, role in the agricultural economies of Kerala and western Tamil Nadu. In Kerala internal rice production is stagnant and there is an increasing portion of the upland area being planted to higher value tree crops. Food supplies thus rely critically on rice allocations from the central pool and more recently apparent privately-traded inflows from outside the state. However, in maintaining or improving the food intake and nutrition of the low income strata, the options are increases in rice rationing off-take or more plentiful and cheaper cassava. Since an increase in the poor's rice ration allotment implies an increase for everyone, cheaper cassava would target directly on the poor and would not involve subsidies from the public treasury. In Tamil Nadu, on the other hand; the focus is very much on farm incomes.

The issue, then, is how much higher farm level yields can be raised over the relatively high level which farmers already achieve. Such increases will almost certainly depend on higher yielding varieties. In Kerala such a variety would require tolerance to cassava mosaic virus, adaptation to a 4 to 5 month dry season and to low fertility status soils, and high quality characteristics, since most cassava is consumed in a fresh form. In Tamil Nadu there is the rare case of cassava adapted to irrigated conditions. India is one of the few countries where the only frontier to be exploited by cassava is the yield frontier.

Philippines

Cassava has been planted in the Philippines since the 17th century, yet the crop has never achieved a status as a major food source, even on a regional basis. Philippine agriculture combines two principal elements, rice and plantation crops destined for export. Rice production is ubiquitous throughout the islands, with production levels corresponding quite closely with the population distribution. Apart from the plantation crops and maize, other crops are so secondary as to be minor. Cassava in the Philippines, therefore, is an issue of how and whether to develop what appears to be a remarkable yield potential.

Official production statistics show cassava to be a very dynamic crop over the past decade (Table 3.31). However, the author could find no other evidence to corroborate this very rapid growth and furthermore, disaggregated review of the statistics show such startling shifts, such as on Central Mindinao, to call the total figures into question. Based on utilization data, the author estimates current production to be in the neighborhood of 450 thousand tons (Tables 3.1).

Cassava is a minor crop in the Philippine food economy. Annual per capita consumption levels of 3.5 kg. make cassava little more than a vegetable crop (Table 3.32). Rice is universally the principal food staple and in those regions where rice production is not sufficient, maize supplements the shortfall in rice. Consumption of wheat products has also steadily increased in the post-war period and has reached quite significant levels in urban areas. Root crops are generally of minor importance in the diet, with sweet potatoes being more important than cassava.

Nevertheless, low per capita consumption levels and cassava's role as a vegetable crop usually implies a certain elasticity in demand. However, available data suggest that per capita consumption declines with income and that over time cassava consumption has also declined (Table 3.33). There is, thus, little demand for improved cassava technology based on exploitation of the human consumption market. Such demand will have to come from development of alternative markets for cassava.

The principal existing alternative market for cassava in the Philippines is for starch production. The industry is in general organized on a plantation system basis but with substantial purchases from nearby smallholders. The major part of the industry is located on Mindinao, a region which is in many respects a frontier area. Nevertheless, while demand for starch has been increasing rapidly in the last decade, this growing market has been exclusively captured by maize starch production (Figure 3.12). Cassava starch production has remained virtually stagnant and principally supplies the speciality side of the market, that is in confectionery uses and food processing. While cassava starch has not been able to compete with maize starch, even though cassava starch sells at a price discount, it is not clear why this is the case. A principal hypothesis would be that raw material prices of maize wet-milling have been more competitive than cassava raw material prices. Also, the maize starch industry has a transport advantage since it tends to be located around the major market of Manila. Since substantial excess capacity already exists in both the maize and cassava starch industry, basing a cassava development program on the starch market would achieve only limited benefits.

The potential of cassava in the Philippines depends on identifying a growth market for the crop. Plans did exist to exploit cassava as part of a fuel alcohol program, but with the recent weakness in world oil prices the alcogas program was suspended indefinitely. A market which does exist, however, is the rapidly expanding animal feed concentrate market. In the last decade there has been a structural change in poultry, as production has shifted from small-scale units to large, vertically integrated commercial operations. Meat production from these operations has tripled in the last decade (Table 3.34). Such structural change usually spawns rapid growth in the feed concentrate industry and the production of mixed feeds has thus increased at an annual rate of 12.2% over the last decade (Table 3.35). Of total production of the mixed feed industry, 70% goes to poultry while the other 30% is swine feed (Table 3.36). A principal feature of the industry, however, is it locus on Luzon, where 90% of mixed feeds are produced.

Growth in industrial demand for maize has caused a fundamental change in the structure of the maize market (Table 3.37). Although maize production has increased at the very respectable rate of 4.3% per annum over the last decade, increased use of maize for feed and for starch have resulted in a reduction of supplies going to human consumption and a continuing, if not rising, level of imports. Moreover, maize production has stagnated over the past three to four years, raising concerns that imports will have to increase even further. The potential for cassava is thus linked to maize policies and future potential for maize production.

The Philippines is currently pursuing a self-sufficiency program in maize, along the lines of their successful rice program. Maize yields at less than one ton per hectare are low and the heart of the Maisan 99 program is a tropical maize technology, in particular a hybrid maize resistant to downy mildew. If this technology should succeed, then maize will continue to be the dominant feed source in the Philippines. If the maize technology does not succeed in raising yields, then cassava would have a large and growing market.

Development of the animal feed market for cassava will not be easy. First, unlike other cassava producing areas in Asia, agro-climatic conditions in the Philippines are relatively good and the relative yield advantage of cassava over other crops is not as great. Nevertheless, farm level yields are the lowest in Asia at 4 to 5 t/ha. Everywhere that cassava is grown, even though it is grown on the uplands, it must compete with rice for labor, capital, and bullock power. Cassava thus is very extensively produced outside the plantations. The yield increase with new technology will have to be substantial but without major increases in input requirements.

Second, a cheap drying technology will be a critical constraint. It is not clear how and whether this can be solved under Philippine conditions. Possibly, the locus of cassava production could be shifted to the drier areas on Luzon. Third, internal transport costs will play a critical role in determining cassava's ability to compete. Inter-island transport is relatively expensive for a bulky commodity like cassava chips, and with most of the cassava production area in the south and the feed industry on Luzon, transport cost will capture a not unsubstantial portion of the output price. This, however, may be counterbalanced by a recent trend to locate new feed mill capacity in Visayas and Mindinao. Finally, given the Philippines' policy focus on improving the welfare of the rural poor, development of the cassava crop will take place within the smallholder sector rather than within a plantation system. Such a focus would require substantial institutional support to develop production and processing systems and market linkages.

The potential of cassava in the Philippines lies in the animal feed market and developing that potential will depend on the success of the Maisan 99 program. An early prognosis of maize prospects should be in soon. Until then it would be reasonable to assess potential drying systems and potential cassava yields. Certainly, even under these only probabilistic conditions, the achievement of benefits from a cassava research program are dependent on direct policy support at the national level. In this vein a national cassava production and marketing program is currently being developed within the Ministry of Agriculture. The focus of this program is on the animal feed market. Moreover, the program is seen as complementary to the Maisan 99 program as the objective is to move the Philippines to a net export position in maize. Thus, as far as institutional and policy commitment to cassava is concerned, the Philippines is probably the farest advanced of the other countries in the region.

Malaysia

Malaysia ranks as the first major exporter of cassava products in the world and until just recently the cassava industry in Malaysia has remained dependent on export markets. The start of the cassava industry is dated as 1855 when cassava plantations were planted in Malacca for the manufacture of starch and, especially, tapioca pearl. Exports from Malaysia reached their peak at the beginning of the century. Then, due to the rise of rubber in the country and competition from starch exports from Java, the industry stagnated and has remained a relatively minor crop ever since.

The factors influencing the Malaysian cassava industry in the post-war period have remained virtually the same; competition for land and labor with tree crops, especially oil palm and rubber, and strong competition in world starch markets, although now from Thailand and maize starch. The agricultural sector of Malaysia is export oriented and agricultural policy has served to strengthen that orientation. Policy has focused on developing the substantial underutilized land resources in the peninsula and in exploiting the strong comparative advantage Malaysia has in tree crops. Thus, 85% of cultivated area is under either rubber, oil palm, or cocunut. However, even in this context rice has not lost its cultural importance and the other major element of policy is self-sufficiency in rice production. Cassava is in many ways a relic from the search for comparative advantage in export crops.

The cassava situation within Malaysia has two principal aspects. First, the market for cassava products over the last decade has switched from the export market to supplying the domestic market. Thus, in 1980 net exports accounted for only 5% of total production of cassava products. Domestic demand for these products is expected to grow and will be met by imports, if production trends continue as they have in the past. Second, cassava production has been maintained only because of anomalies in land use policy. Future expansion of the crop will depend on identifying areas where cassava can compete successfully with tree crops.

Domestic disappearance of cassava starch and pearl has increased from 22 thousand tons in 1972 to around 50 thousand tons by the end of the decade (Table 3.38). Moreover, almost all the production of cassava chips goes into domestic consumption. The starch is used principally in the monosodium glutamate, food, and textile industries, while the chips go into the rapidly expanding mixed feed industry (Table 3.39). Cassava forms only a minor ingredient in the feed rations, essentially because supplies are limited. Malaysia imports practically all of its feedgrain requirements, as there is virtually no domestic production. Maize imports amounted to over 400 thousand tons in 1980 (Table 3.40), some of which was used in a maize starch industry. Given the rapid industrialization and growth in incomes in the country, the starch and animal feed market will continue to grow. Moreover, given the vagaries of the world starch market, basing the cassava industry on domestic markets is a very logical evolution.

Since there are quite expansive domestic markets, the real constraint on the cassava industry is lack of sufficient supplies at competitive prices. Area planted to cassava has been stagnant over the past two decades (Tables 3.41). Area has oscillated between 10 and 20 thousand hectares, which compares to a planted area of 15 thousand hectares in 1930 and an area of over 30 thousand hectares in 1902 (Greenstreet and Lambourne, 1933). Since the beginning of the century the locus of production has switched from Malacca State (pre-World War I) to Johare and Kedah States (inter-war period) to Perak State, where the industry is centered today.

Cassava is a smallholder crop in Malaysia, although plantation systems have been tried. Apparently, a substantial part of the cassava is grown by squatters on federal lands. For example, in Perak State in 1976 3,892 ha of cassava were planted legally, while 10,240 ha were planted illegally (Hohnholz, 1980). Because there is not the security of rights in land, these farmers do not invest in tree crops but rather plant annual crops. For this reason a portion of the cassava area is probably not included in the production statistics, since the fresh root equivalent of starch and chip production is usually substantially more than the root production estimate. Much as in India, cassava has not been able to compete with tree crops and the government is seeking to promote cassava production on the very acid, peat soil areas, where tree crops have a lodging problem. Research is currently underway to develop a cassava technology adapted to these peat soil zones.

Land use policy remains the key to cassava's future. Since only 25% of Malaysia's land area is cultivated, there is still room for expansion. Moreover, since Malaysia supplies about 45% of the world's rubber and 50% of the world's palm oil, future expansion in these crops will have to depend on demand projections for these two commodities. On the basis of such projections, policy makers will have decide whether it is socially more profitable to promote further expansion of tree crops or expansion of feed grain substitutes. At the minimum, the issue deserves fuller study.

Conclusions

Whereas in tropical Asia rice policies and, in turn, food policies have common themes --self-sufficiency, a focus on the irrigated sector, and price policy --the role of cassava in the region reflects much more the very broad differences that exist between countries in their overall agricultural sectors. Cassava is obviously not the crop that rice is in the region but there is a particular niche in the agricultural economies of each country in the region. That niche, however, is different for each country and is usually defined by the broader agricultural policy goals which the country is pursuing.

Cassava in tropical Asia fits into a very broad policy matrix, with each country having a uniquely defined set (Table 3.42). This plasticity in cassava to meet different policy objectives arises from the crop's adaptation to a wide variation in agro-climatic conditions and cassava's multiple uses. Further development of the cassava crop in Asia will depend on development of technology appropriate to the intended production zones and appropriate market development. The two taken together define the potential for cassava to meet particular policy goals.

Present cassava markets in tropical Asia are diverse and in general well developed; however, future expansion in production will be absorbed in markets that are currently not well developed (apart from Indonesia) (Table 3.43). In Indonesia and India (Kerala State), where cassava is a major food source and a potential component in a generalized food and nutrition policy, the principal rationale behind development of alternative markets will be to set a price floor under the food market and thereby to provide a certain stability in cassava supplies. In the Philippines, Malaysia, and Thailand development of alternative markets is a means of raising small holder incomes in upland areas, and ocassionally in frontier areas.

In India, Malaysia, and Indonesia (except off-Java where transport infrastructure is constraining) increased cassava production for the development of these alternative markets is constrained by competition for land. On the other hand, in the Philippines and Thailand market development is limited by cost and price considerations, that is cassava is not currently competitive in the principal growth markets. There are thus two rationales for increasing yields, the first where there is a natural market pressure to substitute for land by increasing yields and the second where increased yields arise from perceived improvements in market opportunities. Cassava development is obviously more difficult in the latter case but in either case a demand for new technology can be said to exist.

Requirements for new technology depend on the characteristics of the production systems, agro-climatic conditions, end-market requirements, and input-output price relationships. Within tropical Asia there is substantial variability in each of these factors. How this diversity may affect a regional program for cassava technological development remains to be assessed in detail. Some of the variation in production systems can be seen in terms of labor input, cost structure and yields (Table 3.44). Labor use varies tremendously in Asian cassava systems and whereas in some of the more labor intensive systems the object will be to employ even more labor, in a Malaysian or Thai context or on Sumatra labor is in relatively short supply. Labor supply conditions will influence research on agronomic practices. Moreover, the very substantial diversity in cropping systems introduces different agronomic and varietal --plant type, time to maturity, and vigor-- characteristics.

The effect of the variability in agro-climatic conditions on the requirements for varieties with differences in adaptation are not known. Certainly, temperature variation will not be an issue, apart from southern China. Rainfall is not as variable as, for example, in Latin America, although areas such as the northeast of Thailand, Tamil Nadu and eastern Java may have to be distinguished from other higher, and more stable, rainfall areas. Finally, without a doubt there are substantial differences in soils throughout the regions. At the minimum this will influence agronomic research on soil fertility.

The interaction between varietal characteristics and end-market requirements applies essentially to the fresh food market. Low HCN content, high starch content and low cooking time will be dominant considerations, with fiber and starch quality being potentially important. Varietal quality characteristics for the starch market are not as well reported, but starch content, the non-preference for so-called yellow varieties, and possibly starch quality are apparently important factors. In general, cassava varieties in tropical Asia tend to have a relatively low starch content, a not restrictive problem in the industrial markets but a factor which usually leads to larger price differentials than just that based on starch differences. All in all the problem of root quality principally applies to Indonesia and India.

In summary, as an upland crop in tropical Asia cassava provides a complement to rice on the irrigated areas. There is sufficient flexibility in end market use that cassava can be used in raising incomes in the upland areas and still fit into the diverse agricultural economies that comprise tropical Asia. Maize would be the only crop that could come close to this potential but maize does not have the adaptive range that cassava has in the lowland tropics. A regional cassava technology development program appears more than justified in tropical Asia on the basis of the above analysis. What remains to be shown is the yield potential of the crop in the region and appropriate support for the crop at the policy level.

Table 3.1. Production and Utilization of Cassava in Principal Producing Countries in Asia

Country	Production (000 t)	Export (000 t)	Domestic Utilization: Human Consumption: Fresh	Domestic Utilization: Human Consumption: Dried	Domestic Utilization: Starch (000 t)	Domestic Utilization: Animal Feed (000 t)	Domestic Utilization: Waste (000 t)
Thailand (1977)	13,554	9,451 (73%)	-	-	788 (6%)	16 (0.1%)	2800 (21%)
Indonesia (1976)	12,191	801 (7%)	3035 (25%)	2830 (23%)	3308 (27%)	-	2217 (18%)
India							
Kerala (1977)	4,189	-	1796 (67%)	799 (19%)	246 (6%)	-	348 (8%)
Philippines (1976)	436	-	243 (56%)	13 (3%)	97 (22%)	18 (4%)	65 (15%)
Malaysia	432	66 (15%)	-	-	302 (70%)	43 (10%)	21 (5%)

Note: Figures in brackets are the percentage distribution of production between end uses.

Source: Titapiwatanakun, 1979; Unnevehr, 1982; CIAT estimates

Table 3.2 Ocean Freight Rate for Tapioca Starch from Thailand, December 1980

Destination	Freight Rate (US$/t)	Percent of FOB Bangkok Price 1/
Taiwan	25	10%
Indonesia	25	10%
Japan	30	12%
Western Europe	75 (non-conference)	29%
	110 (conference)	42%
USA	100 (non-conference)	38%
	120 (conference)	46%

1/Bangkok FOB price in December 1980 was $260/t.

SOURCE: Jones, 1983

Table 3.3. European Community: Cassava Use In Compound Feed Production

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Compound feed production (1000 mt)	49,098	52,936	58,562	57,763	58,098	65,454	67,860	71,078	77,920	N.A.
Oilseed cakes and meals (1000 mt)				10,902	12,547	14,318	14,420	15,793	N.A.	N.A.
Grains (1000 mt)				23,994	26,127	28,127	27,926	27,643	N.A.	N.A.
Imports, dried cassava (1000 mt)	1,348	1,542	1,433	2,073	2,222	2,984	2,801	5,977	5,375	4,866
From Thailand			1,281	1,739	1,873	2,786	3,639	5,688	4,529	4,1116
From Indonesia			87	260	314	179	144	219	694	372
From China			0	4	4	7	1	1	51	336
Imports of dried cassava as a percentage of compound feed production	2.7	2.9	2.5	3.5	3.8	4.6	5.6	8.4	6.9	N.A.

SOURCE: Nelson, 1982; Koester, 1982

Table 3.4: "Voluntary" Quota Imposed by EEC on Imports of Cassava.

Country	1982 (000 t)	1983 (000 t)	1984 (000 t)	1985 (000 t)	1986 (000 t)
Thailand	5,600	5,200	5,000	4,500	4,500
Indonesia	500	500	750	800	800
Brazil, China	200	200	350	350	350

Table 3.5: Thailand: Production, Area and Yield of Cassava, 1965-1981

Crop Year	Production Northeast (000 t)	Production Thailand (000 t)	Area Planted Northeast (000 ha)	Area Planted Thailand (000 ha)	Yield Northeast (t/ha)	Yield Thailand (t/ha)
1965/66	167	1,475	12.6	102.0	13.3	14.4
1966/67	126	1,892	11.4	130.3	11.2	14.5
1967/68	158	2,063	12.9	140.9	12.2	14.6
1968/69	109	2,611	9.1	170.6	12.1	15.3
1969/70	256	2,474	16.8	166.8	15.3	14.8
1970/71	342	2,431	20.3	161.5	16.8	15.1
1971/72	485	3,673	33.8	210.2	14.4	17.5
1972/73	1061	4,436	68.5	307.7	15.5	14.4
1973/74	2158	7,770	155.1	517.7	13.9	15.0
1974/75	3555	9,503	246.5	623.8	14.4	15.3
1975/76	4999	11,638	317.9	745.2	15.8	15.6
1976/77	9425	13,554	449.9	888.9	20.9	15.3
1977/78	7306	13,024	553.1	943.5	13.2	13.8
1978/79	6033	12,877	468.9	877.9	12.9	14.7
1979/80	8365	13,864	595.9	1002.3	14.1	13.8
1980/81	9445	17,204	708.5	1318.9	13.3	13.1

SOURCE: Department of Agricultural Extension, Ministry of Agriculture and Cooperatives.

Table 3.6.Thailand: Exports of Cassava Products 1970-1981

Year	Starch (000 t)	Pellets and Chips (000 t)
1970	142.9	1097.0
1971	146.4	970.4
1972	124.5	1111.5
1973	179.9	1530.0
1974	255.0	2029.4
1975	141.7	2104.0
1976	241.2	3316.1
1977	202.5	3669.3
1978	235.0	6040.1
1979	123.4	3880.1
1980	248.5	4838.7
1981	316.7	6033.0

Source: Foreign Trade Statistics of Thailand

Table 3.7: Thailand: Export and Domestic Disappearance of Cassava Starch.

Year	Domestic Utilization Food Uses (000 t)	Industrial Uses (000 t)	Total (000 t)	Export (000 t)
1970	39.3	40.8	80.1	142.9
1971	41.0	49.5	90.5	146.4
1972	44.2	57.4	101.6	124.5
1973	47.5	60.7	108.2	179.9
1974	51.0	64.7	115.7	255.0
1975	54.5	66.1	120.6	141.7
1976	58.1	71.0	128.1	241.2
1977	61.8	80.7	142.0	202.5
1978	65.7	87.4	153.1	235.0
1979	69.5	92.3	161.8	123.4
1980	72.4	95.9	168.3	248.5

Source: Titapiwatanakun, 1982

Table 3.8. Thailand: Production of Commercial Mixed Feeds

Year	Production (000 t)
1967	61.0
1968	64.0
1969	111.0
1970	109.4
1971	199.8
1972	266.5
1973	242.0
1974	284.7
1975	486.5
1976	666.4
1977	792.5
1978	1045.0
1979	1026.0

Source: Economics Department, Ministry of Commerce

Table 3.9. Indonesia: Utilization of Cassava by Form and Market on Java, 1976.

Product and Market	Marketed	Own Consumption	Total
Domestic			
Fresh roots	710	1,190	1900
Urban	100	10	110
Rural	610	1,180	1790
Gaplek	900	860	1760
Gaplek flour	80	-	80
Starch	2020	-	2020
Export			
Gaplek	1776	-	1776

Source: Unnevehr, 1982

Table 3.10. Indonesia: Per Capita Consumption of the Principal Carbohydrate Staples, 1976

Region/Commodity	Total (kg)	Rural (kg)	Urban (kg)
Indonesia			
Rice	111.2	110.5	114.3
Corn	9.9	11.9	0.7
Fresh Cassava	26.2	29.9	9.5
Gaplek	6.4	7.9	0.2
Total Cassava	45.4	53.6	10.1
Java			
Rice	103.3	102.4	107.3
Corn	11.5	14.0	0.5
Fresh Cassava	21.6	24.9	6.7
Gaplek	8.0	9.7	0.1
Total Cassava	45.6	54.0	7.0
Off-Java			
Rice	124.8	124.4	126.6
Corn	7.0	8.3	1.1
Fresh Cassava	34.2	36.5	14.4
Gaplek	3.8	4.6	0.3
Total Cassava	45.6	50.3	15.0

SOURCE: Dixon, 1982

Table 3.11. Indonesia: Per capita Calorie and Protein Intake in Indonesia and Fresh Cassava and Gaplek Consumption in Rural Java by Income Strata, 1976

Monthly Per Capita Expenditures	Indonesia			Rural Java	
	Population Share (%)	Daily Calorie Intake (K cal/capita)	Daily Protein Intake (gr/capita)	Daily Fresh Cassava Intake (gr/capita)	Daily Gaplek Intake (gr/capita)
Less than Rp 2,000	15,3	1,381	22.2	44.4	39.1
Rp 2,000-2,999	23.8	1,870	32.3	59.1	30.7
Rp 3,000-3.999	19.5	2,034	40.2	75.3	24.9
Rp 4.000-4.999	13.6	2,084	47.0	94.9	17.6
Rp 5,000-5,999	8.8	2,288	52.7	94.6	11.1
Rp 6,000-7,999	9.4	2,533	60.9	91.4	8.6
Rp 8,000-9,999	4.2	2,794	69.7	91.4	4.3
Rp10,000-14,999	3.8	3,066	79.1	87.4	6.1
More than Rp 15,000	1.6	3,204	93.3	72.4	1.0
Average		2,064	43.3	67.7	26.9

Source: Dixon, 1979; Dixon, 1982.

Table 3.12. Indonesia: Expenditure Elasticities by Income Group and Price Elasticities, Java, 1976.

	Expenditure Elasticity				Price Elasticity
Commodity	Low Income Stratum 1/	Medium Income Stratum	High Income Stratum	Average	Average
Rice					
Urban	0.329	0.107	- 0.121	0.1940	- 0.48
Rural	0.831	0.485	0.133	0.5660	- 0.84
Fresh Cassava					
Urban	0.094	- 0.275	- 0.654	- 0.131	-
Rural	0.849	0.117	- 0.627	0.276	- 0.81
Gaplek					
Urban	-	-	-	-	-
Rural	0.833	- 1.018	- 2.900	- 0.616	- 1.86

1/ Population shares were: for rural areas on Java: low, 54.6%; medium, 37.1%; high, 8.4%
for urban areas on Java: low, 50.9%; medium, 40.2%; high, 8.5%

SOURCE: Dixon, 1982.

Table 3.13. Indonesia: Starch Production by Province, 1974 and 1979.

Province	Starch 1974 (mt)	Starch 1979 (mt)	Fresh Root Equivalent 1974 (mt)	Fresh Root Equivalent 1979 (mt)
West Java	188,220	239,220	941,100	1,196,100
Central Java	126,020	149,180	630,100	745,900
East Java	33,300	57,780	166,500	288,900
Java total	347,540	446,180	1,737,700	2,230,900
Lampung	27,750	150,750	138,750	753,750
North Sumatra	15,900	24,100	379,500	120,500
Riau	30,900	30,900	154,500	154,500
Other provinces	9,600	9,600	48,000	48,000
Total Indonesia	431,690	661,530	2,158,450	3,307,650

Source: Nelson, 1982

Table 3.14. Indonesia: Exports of Cassava Chips and Pellets

Year	Total (000 t)	Java (000 t)	Lampung (000 t)
1970	332.3	261.6	73.5
1971	457.5	361.6	86.3
1972	342.4	241.1	99.6
1973	74.8	42.2	35.8
1974	392.5	189.0	198.5
1975	302.5	87.3	203.3
1976	148.6	9.5	149.7
1977	183.2	37.5	141.8
1978	307.8	98.2	193.5
1979	709.6	494.6	170.0
1980	386.1	219.7	160.6

Note: EC export quota 1983 - 500,000 t
1984 - 750,000 t

SOURCE: Nelson, 1982

Table 3.15. Gaplek Price Correlations Among 19 Producing Area Markets.

Correlation Greater than or Equal to	Number of Markets Correlated When Prices Were: Above Export Price Floor	At Export Price Floor
0.80	102	149
0.85	63	137
0.90	27	106
0.95	2	32
Total Possible Pairs	171	171

SOURCE: Unnevehr, 1982.

Table 3.16. Indonesia: Production, Area, and Yield of Cassava, 1970-1980

Year	Production (000 mt)			Area (000 ha)			Yield (t/ha)		
	Java	Lampung	Indonesia	Java	Lampung	Indonesia	Java	Lampung	Indonesia
1970	8,003	311	10,478	1,094	34	1,398	7.3	9.1	7.5
1971	8,075	388	10,690	1,101	36	1,406	7.3	10.8	7.6
1972	7,078	465	10,385	1,133	44	1,468	7.0	10.6	7.1
1973	8,103	734	11,186	1,056	65	1,429	7.7	11.3	7.8
1974	9,649	604	13,031	1,158	53	1,509	8.3	11.4	8.6
1975	9,309	655	12,546	1,065	61	1,410	8.7	10.7	8.9
1976	8,846	695	12,191	1,004	61	1,353	8.8	11.4	9.0
1977	9,085	786	12,488	995	71	1,364	9.1	11.1	9.2
1978	9,485	808	12,902	1,006	74	1,384	9.4	10.9	9.3
1979	9,900	838	13,330	1,020	76	1,418	9.7	11.0	9.4
1980	9,607	984	13,726	997	84	1,412	9.7	11.1	9.7

SOURCE: Nelson, 1982

Table 3.17. Farms Containing Intercropped Seasonal Crops as Percentages of all Farms on which these Specific Seasonal Crops were harvested, by Type of Crop and Size of Farm, 1973

Farm Size	Percentages of Farms Harvesting Intercropped				
	Cassava	Upland Rice	Corn	Soybeans	Peanuts
0.1-0.3 ha	52.9%	57.7%	51.1%	32.6%	42.5%
0.3-0.5 ha	53.3%	61.5%	51.5%	36.4%	47.3%
0.5-0.75 ha	54.8%	64.6%	52.7%	40.9%	53.7%
0.75-1.0 ha	55.6%	67.7%	53.5%	42.9%	55.8%
1.0-2.0 ha	56.6%	69.2%	44.2%	43.5%	57.5%
2.0+ ha	54.4%	66.3%	52.4%	41.3%	53.4%
ALL FARMS	54.2%	63.1%	54.4%	38.0%	50.5%

SOURCE: Roche, 1982.

Table 3.18. Estimated Average Application Rates of Chemical Fertilizer on Cassava, Corn, and Upland Rice, Java and Madura, 1970-80.

Year	Cassava (kg/ha)	Corn (kg/ha)	Upland Rice (kg/ha)	Average All Crops (kg/ha)
1970/71	6.2	30.3	14.2	-
1971/72	7.8	38.0	65.1	-
1972/73	8.1	45.1	46.5	178.9
1973/74	6.6	34.6	40.4	-
1974/75	8.8	49.8	45.9	-
1975/76	12.6	53.6	58.0	-
1976/77	18.2	58.1	66.8	-
1977/78	17.4	69.7	83.0	-
1978/79	21.7	71.2	82.3	-

SOURCE: Roche, 1982.

Table 3.19. Indonesia: Comparison of Inputs and Outputs in Various Cropping Systems in Java.

	Cassava in Pure Stand	Intercropped Cassava, Upland Rice, Maize and Legumes	Intercropped Cassava, Maize, and Legumes
Location	Kediri	Garut	Gunung Kidul
Land type	Level lowland	Terraced Hillside	Eroded Terraced Hillside
Labor Use (man days/ha)	238	389	378
% Hired Labor	81	42	5
Bullock Power (team days/ha)	38	0	0
Fertilizer (kg/ha)			
Urea	186	77	1
TSP	0	45	0
Manure	5560	1530	170
Non-labor Cash Costs (000 Rupees)	43.1	20.8	3.5
Yields (t/ha)			
Cassava	18.3	8.32	2.27
Upland Rice		0.78	-
Maize		0.46	0.27
Legume		0.17	0.27
Profit (000 Rupees)	177.6	98.80	31.30
% Marketed			
Cassava	96	89	36
Rice	32	28	-
Maize	82	41	16

Source: Roche, 1982.

Table 3.20.Indonesia: Comparison of Current Farmers' Practices and Recommended Cropping System in Lampung, 1977-78.

	Current Practices: Intercropped Cassava, Maize and Upland Rice	Recommended Practice
Labor Use (man-days/ha)	278.00	672.00
Fertilizer (kg/ha)		
Urea	90.00	460.00
TSP	225.00	470.00
KCL	0	150.00
Lime	0	200.00
Non-Labor Cash Costs	Rp 39.50	Rp 161.70
Yields (t/ha)		
Cassava	10.91	19.89
Rice	2.43	3.69
Maize	0.63	2.55
Peanut	-	0.97
Rice Bean	-	0.28
Profit	Rp 380.80	733.30

Source: Roche, 1982

Table 3.21. India: Percentage Distribution of Farms by Size in Kerala, 1970-71.

Size of Holding (ha)	Distribution of Holding (%)
Below 0.04	18.7
0.04 - 0.25	37.2
0.25 - 0.50	15.6
0.50 - 1.00	13.3
1.00 - 2.00	9.7
2.00 - 3.00	3.2
3.00 - 4.00	1.4
More than 4.00	0.9
Total	100.0

SOURCE: Statistics for Planning 1980, Government of Kerala, 1980.

Table 3.22. India: Trends in Area, Production and Yield, Country-wise and in the Major Producing States, 1970-1981.

Crop Year	India Area (000 ha)	India Production (000 t)	India Yield (t/ha)	Kerala Area (000 ha)	Kerala Production (000 t)	Kerala Yield (t/ha)	Tamil Nadu Area (000 ha)	Tamil Nadu Production (000 t)	Tamil Nadu Yield (t/ha)
1970-71	353.0	5216.0	14.9	294.0	4617.0	15.7	47.0	567.0	12.1
1971-72	353.7	6025.9	17.0	303.3	5429.3	17.9	42.6	545.0	12.8
1972-73	363.2	6317.4	17.5	304.8	5629.4	18.7	50.0	629.5	12.6
1973-74	368.2	6420.9	17.1	306.4	5659.5	18.5	51.7	681.6	13.2
1974-75	387.6	6325.9	16.3	317.9	5625.1	17.7	52.7	564.9	10.7
1975-76	392.0	6638.3	16.9	326.9	5390.2	16.5	50.1	1115.8	22.3
1976-77	385.8	6375.0	16.5	323.3	5125.5	15.9	48.0	1128.2	23.5
1977-78	358.3	5688.3	15.9	289.7	4188.6	14.5	52.8	1310.3	24.8
1978-79	361.4	6052.6	16.7	273.5	4044.1	13.9	54.0	1682.0	31.2
1979-80	365.3	5952.2	16.3	290.3	4223.6	14.5	58.1	1591.4	27.4
1980-81	334.5	5817.4	17.4	273.5	4058.2	14.8	52.2	1539.7	29.5

SOURCE: "Bulletin on Commercial Crop Statistics" and "Agricultural Situation in India", Ministry of Agriculture.

Table 3.23. India: Percentage Distribution of Consumer Expenditure, Kerala, 1969-70.

Item	Rural	Urban
Cereals	31.0	26.3
Cereal Substitutes	5.0	2.8
Grams and Pulses	1.2	1.5
Vegetable Oil	3.2	3.4
Milk and Dairy Products	4.0	5.2
Meat, Fish, Eggs	5.5	5.8
Other Food Items	22.7	23.3
Total Food	72.6	68.3
Fuels and Lights	6.0	6.2
Clothing	2.8	4.2
Rent	0.2	1.9
Other non-food	18.4	19.4
Total non-food	27.0	31.7
Total	100.0	100.0

SOURCE: Statistics for Planning 1980, Government of Kerala, 1980.

Table 3.24 India: Caloric Consumption by Income Strata in Kerala, 1971-72

Per Capita Monthly Expenditure (Rupees)	Rural		Urban	
	% Distribution of Households	Per Capita Calorie Consumption	% Distribution of Households	Per Capita Calorie Consumption
0-15	3.1	893	3.3	953
15-21	5.9	1229	7.6	1079
21-24	4.6	1716	5.7	1575
24-28	8.5	1466	6.9	1490
28-34	13.0	1900	12.1	1787
34-43	9.5	2320	14.5	1989
43-55	15.6	2603	14.2	2289
55-75	18.6	2900	10.9	2700
75-100	9.2	3614	7.3	3060
More than 100	12.3	4293	17.6	3907
Average	100.0	2023	100.0	2103

Source: Statistics for Planning 1980, Government of Kerala.

Table 3.25. India: Alternative Estimates of Per Capita Consumption of Cassava in Kerala

Source	Year	Estimate (kg/capita/year)
National Sample Survey	1973-74	85.0
Tapioca Commission	1971	59.6
P.S. George	1977	114.7
S.K. Kumar	1974	171.9
Food Balance	1974	276.2

Source: Government of Kerala, 1980; Government of Kerala, 1972; George, 1979; Kumar, 1979; Government of Kerala, 1977.

Table 3.26. India: Consumption of Rice and Cassava by Income Strata and by Source of Supply, Rural Kerala, 1977 (kg/household/week)

Annual Household Income (Rupees)	Rice				Cassava		
	Total Consumption (kg)	Ration (kg)	Own Production (kg)	Open Market (kg)	Total Consumption (kg)	Own Production (kg)	Open Market (kg)
Less than 600	8.40	5.65	-	2.75	12.90	0.40	12.50
601-1200	9.43	6.39	-	3.04	11.31	2.96	8.35
1201-2400	13.47	7.70	1.77	4.00	15.46	4.13	11.33
2401-3600	13.89	6.67	1.11	6.11	12.66	4.33	8.33
3601-4800	12.00	4.90	2.00	5.10	6.70	4.50	2.20
More than 4800	13.42	5.14	5.71	2.57	3.29	3.29	-

SOURCE: George, 1979.

Table 3.27. India: Retail Prices of Rice and Cassava in Kerala, 1970-1979

Year	Rice (Rupee/kg)	Cassava (Rupee/kg)	Rice/Cassava	Open Market/ Ration Rice
1970	2.68	0.52	5.2	1.5
1971	2.54	0.52	4.9	1.4
1972	2.80	0.51	5.5	1.6
1973	3.24	0.54	6.0	1.8
1974	3.69	0.54	6.8	2.6
1975	3.53	0.54	6.5	2.7
1976	2.91	0.60	4.9	N.A.
1977	2.36	0.50	4.7	N.A.
1978	2.13	0.48	4.4	N.A.
1979	2.07	0.54	3.8	N.A.

Source: Government of Kerala, 1980; George, 1979

Table 3.28. India: Total Rice Supplies in Kerala, 1971-79
(Milled Rice Basis)

Crop Year	Rice Production (000 t)	Ration Card Take-off (000 t)	Total Supplies (000 t)*
1970/71	857	788	1645
1971/72	892	864	1756
1972/73	908	824	1732
1973/74	830	774	1604
1974/75	814	659	1473
1975/76	879	674	1553
1976/77	828	1222	2050
1977/78	854	1138	1992
1978/79	848	654	1502

SOURCE: George, 1979; Government of Kerala, 1980.

Table 3.29. India: Production of Tapioca Pearl and Starch in Salem District, Tamil Nadu

Year	Tapioca Pearl (t)	Starch (t)	Total (t)
1970	52,589	39,553	92,142
1971	55,171	28,987	84,158
1972	41,133	41,488	82,621
1973	22,249	41,102	63,351
1974	18,871	42,822	61,693
1975	44,774	45,827	90,601
1976	36,394	30,656	67,050
1977	55,702	35,081	90,783

Note: Production figures represent quantity moved from Salem market as railway shipments.

SOURCE: Uthamalingam, 1980.

Table 3.30. India: Yield Distribution from Crop Cutting Survey, Tamil Nadu, 1979-80 (287 farms)

Yield Strata (t/ha)	Percentage Distribution
0- 7.5	13
7.5-15.0	14
15.0-22.5	16
22.5-30.0	25
30.0-37.5	16
37.5-45.0	8
45.0-52.5	5
52.5-60.0	2
60.0-75.0	1
75.0-90.0	0.3

Average Yield = 24.5 t/ha
Standard Deviation = 14.1 t/ha
Maximum Yield = 84.2 t/ha
Irrigated Yield = 27.4
Unirrigated Yield = 15.6

SOURCE: Unplublished results of crop cutting survey, Tamil Nadu.

Table 3.31 Philippines: Area, Production and Yields of Cassava in the Country and Central Mindinao.

Crop Year	Philippines Area (000 ha)	Philippines Production (000 t)	Philippines Yield (t/ha)	Central Mindinao Area (000 ha)	Central Mindinao Production (000 t)	Central Mindinao Yield (t/ha)
1970	82.6	442	5.35	-	-	-
1971	81.8	427	5.22	-	-	-
1972	82.7	440	5.32	9.9	56	5.66
1973	87.4	445	5.09	3.9	19	4.89
1974	96.7	480	4.96	3.6	31	8.59
1975	119.3	685	5.74	5.0	14	2.81
1976	144.7	1154	7.98	14.6	374	25.65
1977	179.3	1711	9.54	26.6	733	27.50
1978	181.8	1782	9.80	29.1	763	26.25
1979	192.4	2254	11.72	29.6	1127	38.07
1980	204.2	2277	11.15	29.4	1125	38.29
1981	211.4	2255	10.66	29.2	1118	39.30

Source: Bureau of Agricultural Economics.

Table 3.32. Philippines: Annual, Per Capita Food Consumption Patterns by Region, 1977-1980.

Region	Rice (kg/capita)	Maize (kg/capita)	Wheat (kg/capita)	Cassava (kg/capita)	Sweet Potatoes (kg/capita)
Ilocos	139.8	1.3	7.7	1.6	6.2
Cagayan Valley	101.2	20.4	6.9	1.8	5.7
Central Luzon	120.1	1.6	8.8	0.2	2.0
Metro Manila	103.4	1.6	17.3	0.4	2.0
S. Luzon	118.0	1.3	10.8	1.6	2.6
Bicol	114.0	3.0	7.5	4.9	15.6
W. Visayas	120.7	7.5	6.0	6.0	4.3
C. Visayas	45.6	83.2	7.1	7.6	6.7
E. Visayas	104.7	19.9	7.4	5.4	15.9
W. Mindinao	82.0	25.0	6.2	5.1	8.5
N. Mindinao	77.5	54.9	6.9	2.9	6.4
E. Mindinao	101.4	28.7	7.0	1.8	7.1
C. Mindinao	113.4	12.7	8.0	9.5	7.4
Philippines	105.8	17.7	8.5	3.5	6.5

Source: Aviguetero, et.al., 1981.

Table 3.33. Philippines: Cassava Consumption by Income Strata over time, 1973-1979.

Year	Income Strata				
	Less than 400 (kg/capita)	400-799 (kg/capita)	800-1499 (kg/capita)	More than 1500 (kg/capita)	Average (kg/capita)
1973	6.5	4.4	4.3	3.2	4.9
1974	8.9	6.1	6.7	6.7	6.9
1975	8.2	4.9	6.5	3.6	5.2
1976	8.5	5.0	5.7	4.0	5.6
1977	-	-	-	-	5.2
1978	-	-	-	-	3.6
1979	-	-	-	-	3.1

SOURCE: Special Studies Division, Ministry of Agriculture.

Table 3.34 Philippines: Poultry Stock and Slaughter in Commercial Operations

Year	Poultry Stock (000 head)	Slaughter (000 head)
1970	46,448	34,576
1971	52,526	42,221
1972	52,555	42,276
1973	44,373	32,777
1974	60,609	48,728
1975	69,851	60,928
1976	77,877	64,768
1977	90,315	71,622
1978	103,528	87,813
1979	117,964	101,353
1980	125,362	110,480

Source: Bondad, et.al., 1981.

Table 3.35. Philippines: Production of Mixed Feed, 1968-1979

Year	Total Production (mt)
1968	263,744
1969	357,881
1970	314,415
1971	285,143
1972	312,341
1973	387,680
1974	421,266
1975	654,665
1976	625,345
1977	756,877
1978	873,499
1979	935,900
Annual Growth Rate	12.2%

Source: Lincangeo-López, 1979

Table 3.36. Philippines: Volume of mixed feed production by type and region, 1978

Type of feed	Location			
	Philippines	Luzon	Visayas	Mindinao
Poultry				
Production (000 t)	598.4	556.7	41.7	neg
% of total by region	100.0	93.0	7.0	-
% of total by feed type	69.0	70.0	75.0	-
Hog				
Production (000 t)	262.5	225.1	13.7	22.6
% of total by region	100.0	86.0	5.0	9.0
% of total by feed type	30.0	28.0	25.0	100.0
Other				
Production (000 t)	12.6	12.3	0.3	-
% of total by region	100.0	98.0	2.0	-
% of total by feed type	1.0	2.0	-	-
Total				
Production (000 t)	873.5	795.1	55.7	22.6
% of total by region	100.0	91.0	6.0	3.0

Source: Lincageo-López, 1979.

Table 3.37 Philippines: Supply and Utilization of Maize, 1970-1980.

Crop Year	Production (000 t)	Imports (000 t)	Utilization: Food Consumption (000 t)	Feed (000 t)	Starch (000 t)	Seed (000 t)
1970	2005	31	1248	669	52	39
1971	2013	193	1250	750	73	40
1972	1831	90	1259	680	89	38
1973	2289	94	1337	750	92	45
1974	2568	159	1712	850	96	50
1975	2767	54	1835	900	103	53
1976	2843	160	1669	1150	112	54
1977	2855	134	1647	1230	119	52
1978	3167	56	1600	1338	122	54
1979	3176	94	1657	1580	136	56
1980	3170	351	1604	1699	146	55

SOURCE: Bondad, et.al., 1981.

Table 3.38: Malaysia: Production and Trade of Cassava Products, 1972-80.

Year	Production (mt)	Imports (mt)	Exports (mt)	Net Supplies (mt)
Starch and Pearl				
1972	46,872	366	24,982	22,256
1973	50,134	1,593	26,116	25,611
1974	50,091	1,592	18,289	33,394
1975	52,738	289	20,979	32,048
1976	68,085	16	27,499	40,602
1977	62,400	72	10,831	51,641
1978	57,588	34	4,124	53,498
1979	59,481	22	15,098	47,405
1980	49,828	3,331	6,495	46,664
Chips				
1972	7,145	6	126	7,025
1973	7,371	231	800	6,802
1974	5,765	3,807	156	9,416
1975	22,629	1,269	152	23,746
1976	16,842	140	283	16,699
1977	16,786	8	320	16,474
1978	17,050	3,232	44	20,238
1979	16,606	59	18	16,647
1980	8,972	-	5	8,967

Source: Monthly Statistical Bulletin, various years

Table 3.39: Malaysia: Production of Feed Concentrates, 1972-80.

Year	Poultry (m.t.)	Pig Feeds (m.t.)	Total Mixed Feeds (m.t.)
1972	99,548	118,841	218,389
1973	117,148	103,056	220,204
1974	189,102	113,156	302,258
1975	191,900	123,740	315,640
1976	242,311	148,478	389,789
1977	272,311	113,851	386,162
1978	314,713	130,135	444,848
1979	334,588	122,731	457,319
1980	419,783	128,823	548,606

Source: Monthly Statistical Bulletin, various years.

Table 3.40: Malaysia: Imports of Maize, 1970-80

Year	Imports (000 t)
1970	212,151
1971	216,052
1972	214,462
1973	230,191
1974	243,851
1975	275,799
1976	269,581
1977	288,751
1978	310,386
1979	436,233
1980	430,712

SOURCE: FAO, 1982

Table 3.41: Malaysia: Area Planted and Root Production of Cassava, 1960-1980.

Year	Area Planted (ha.)	Production (m.t.)
1960	12,235	n.a.
1961	15,728	n.a.
1962	18,873	n.a.
1963	22,231	n.a.
1964	18,438	n.a.
1965	16,344	n.a.
1966	14,669	n.a.
1967	18,138	n.a.
1968	17,036	n.a.
1969	17,532	n.a.
1970	17,667	207,200
1971	14,857	161,768
1972	13,151	279,400
1973	11,820	238,720
1974	11,553	254,326
1975	15,112	281,710
1976	20,908	241,840
1977	20,502	357,345
1978	17,815	197,425
1979	16,635	225,057
1980	12,512	254,309

Source: Annual Report, Extension Branch, Ministry of Agriculture, Kuala Lumpur, Peninsular Malaysia.

Table 3.42. Contribution of Improved Cassava Technology in Meeting Agricultural Policy Goals in Selected Asia Countries.

Agricultural Policy Objectives	Indonesia	India	Thailand	Philippines	Malaysia
Food and Nutrition Policy:					
Reduced Cost or Increased Flexibility in Rice Policies	Rice Pricing Policy	Rice Subsidies	-	-	-
Improved Nutrition of the Poor	Gaplek	Fresh	-	-	-
Farm Income and Land Use:					
Higher Small-Farm Income in Upland Areas	Positive	Positive	Positive	Positive	-
Exploitation of Frontier Areas	Off-Java	-	Northeast	Mindinao	Peat Soils
Balance of Payments					
Increased Export Earnings	-	-	Positive	-	-
Import Substitution	Sugar	-	-	Feed grains	Feed grains

Table 3.43 Status of Cassava Markets in Selected Asian Countries

Country	Principal Current Market	Mayor Potential Growth Market
Indonesia	Food (Fresh and Dried)	Starch
India	Food (Fresh)	Starch
Thailand	Animal Feed-Export (EC)	Animal Feed-Export(non-EC)
Philippines	Food (Fresh)	Animal Feed-Domestic
Malaysia	Starch	Animal Feed-Domestic

Table 3.44. Labor Use and Cost Structure in Cassava Production Systems 1/

Country Location Period	Indonesia Gunung Kidul 1979/80	Indonesia Kediri 1979/80	Thailand Cholburi 1977/78	Thailand Nakornrajsima 1977/78	India Salem 1978/79	Philippines Central Visayas 1976/77	Malaysia Perak 1977/78
Labor Input (m.d./ha)	345.8	237.2	74.8	67.2	138.5	65.0	62.2
Land Costs (US$/ha)	0	234.4	28.9	74.8	121.3	46.4 2/	17.3
Variable Costs (US$/ha)							
Labor	94.2	227.7	76.2	64.0	90.9	48.8	116.4
Land Preparation	0	52.2	59.2	33.5	13.4	5.1	38.9
Fertilizer	0	21.3	16.6	0	59.8	2.5	25.9
Pesticides	0	0	2.7	0	0	0	12.1 3/
Seed	2.6	0	16.6	1.9	0	0	3.5
Total	96.8	301.2	171.3	99.4	164.1	56.4	196.8
Yield	2.6	17.5	10.9	13.7	10.7	5.5	27.2
Variable Costs (US$/ton)	37.2	17.2	15.7	7.3	15.3	10.3	7.2

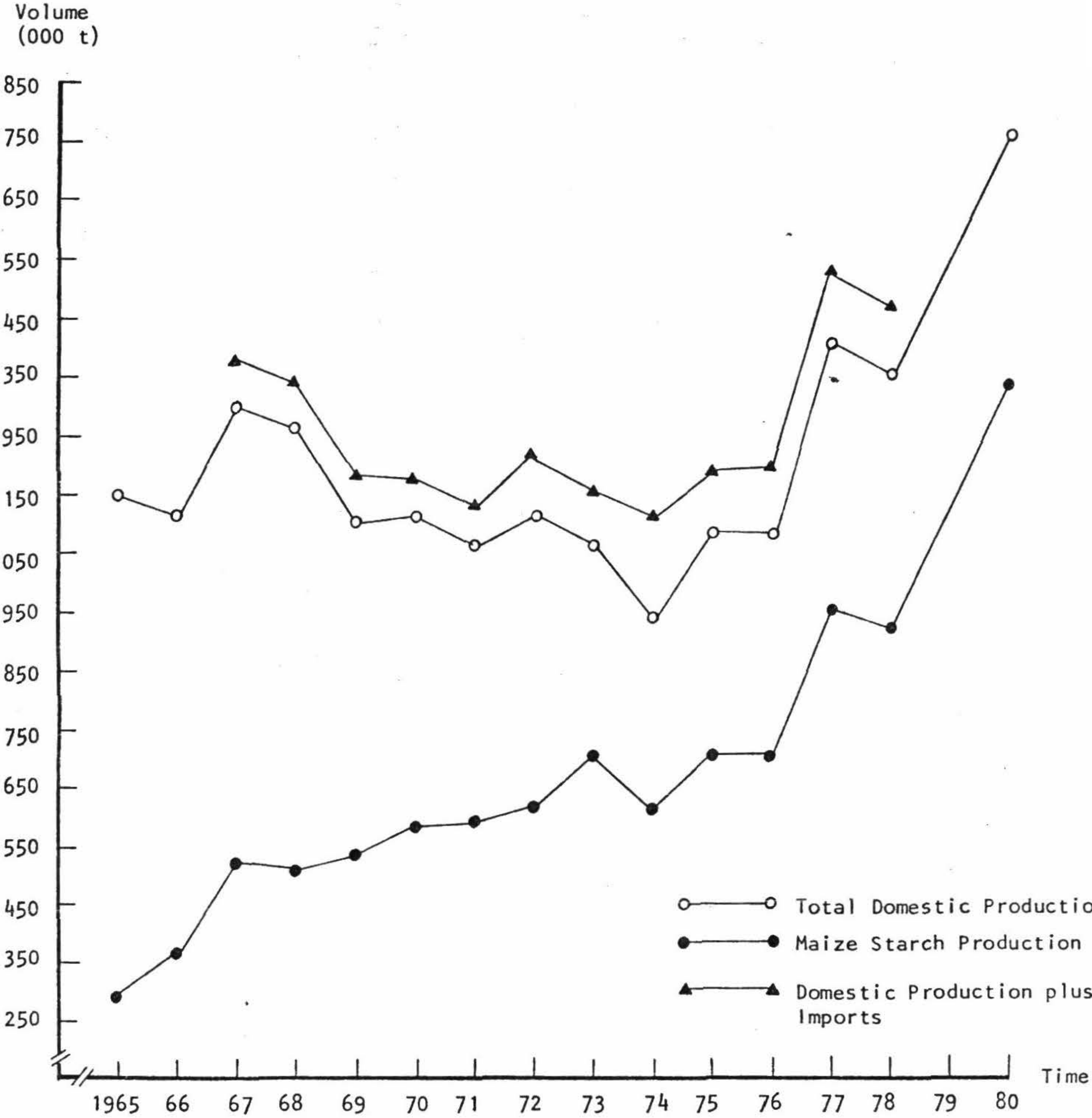
1/ Domestic currency converted to US dollars at existing exchange rate.

2/ Share tenancy - 33% of gross value.

3/ Herbicides

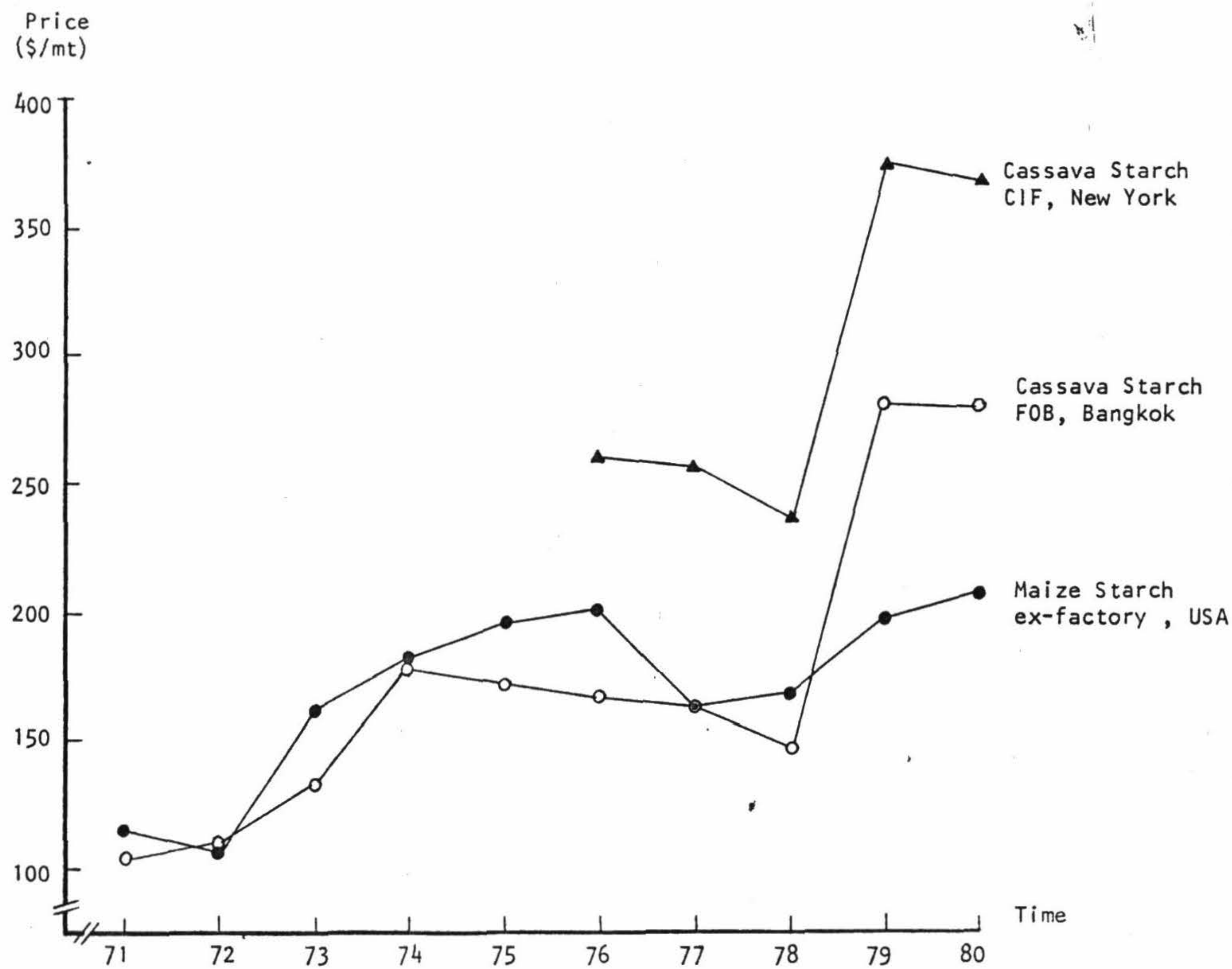
SOURCE: Roche, 1982; Tinprapha, 1979; Uthamalingam, 1981; Mejia, et.al., 1979; Tunku Tahya, 1979

Figure 3.1. Japan: Production, Imports, and Total Supply of Starch, 1965-80.



SOURCE: Titapiwatanakun, 1980; Jones, 1983

Figure 3.2. Price Trends for Starch in Different Markets, 1971-1980.



SOURCE: Jones, 1983; FAO, Monthly Bulletin of Statistics.

Figure 3.3. European Community: Price Structure for Major Feed ingredients, 1971-81.

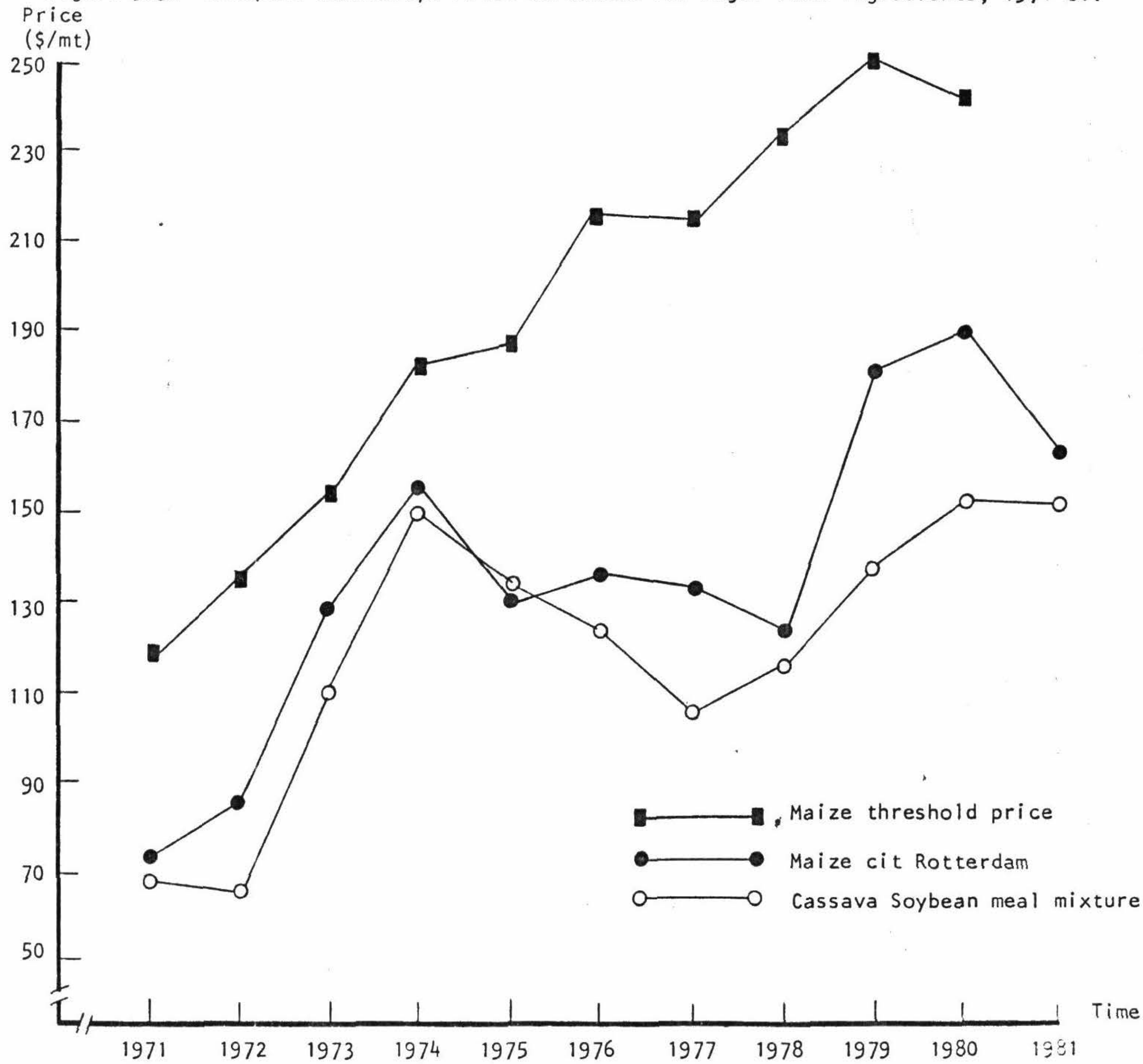
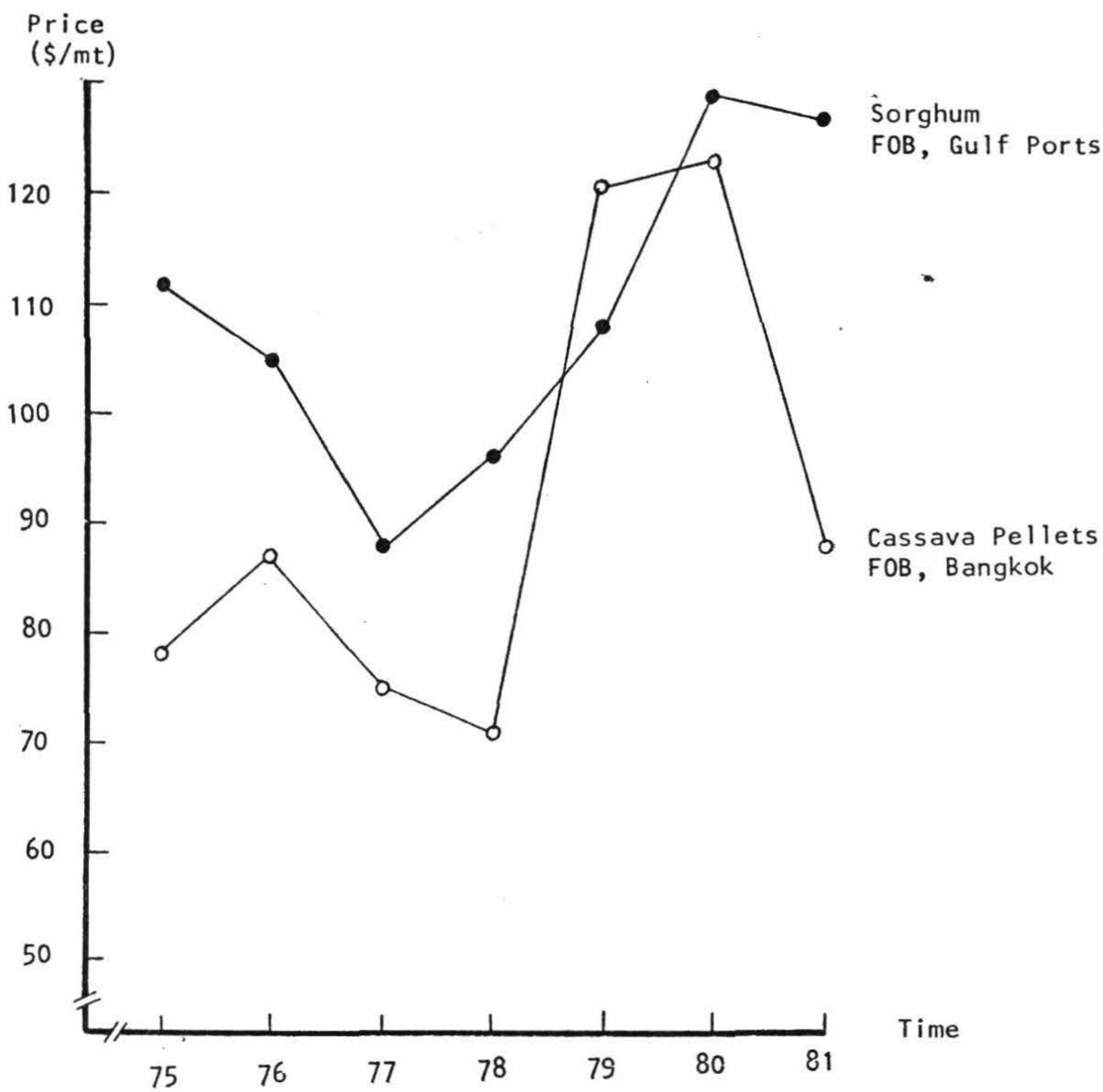


Figure 3.4. Trends in Cassava Pellet and Sorghum Export Prices, 1875-1981



Source: FAO, Monthly Bulletin of Statistics

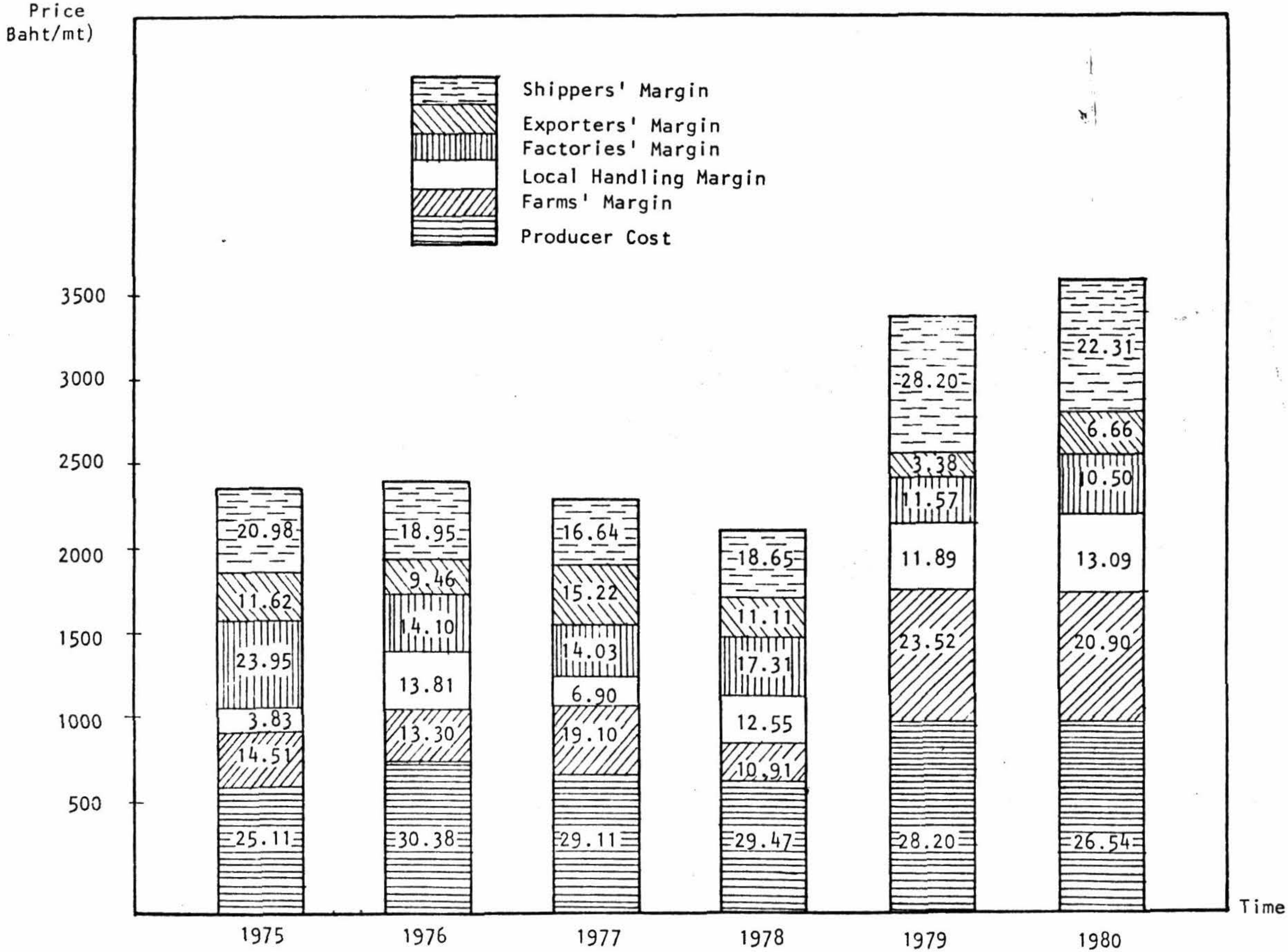
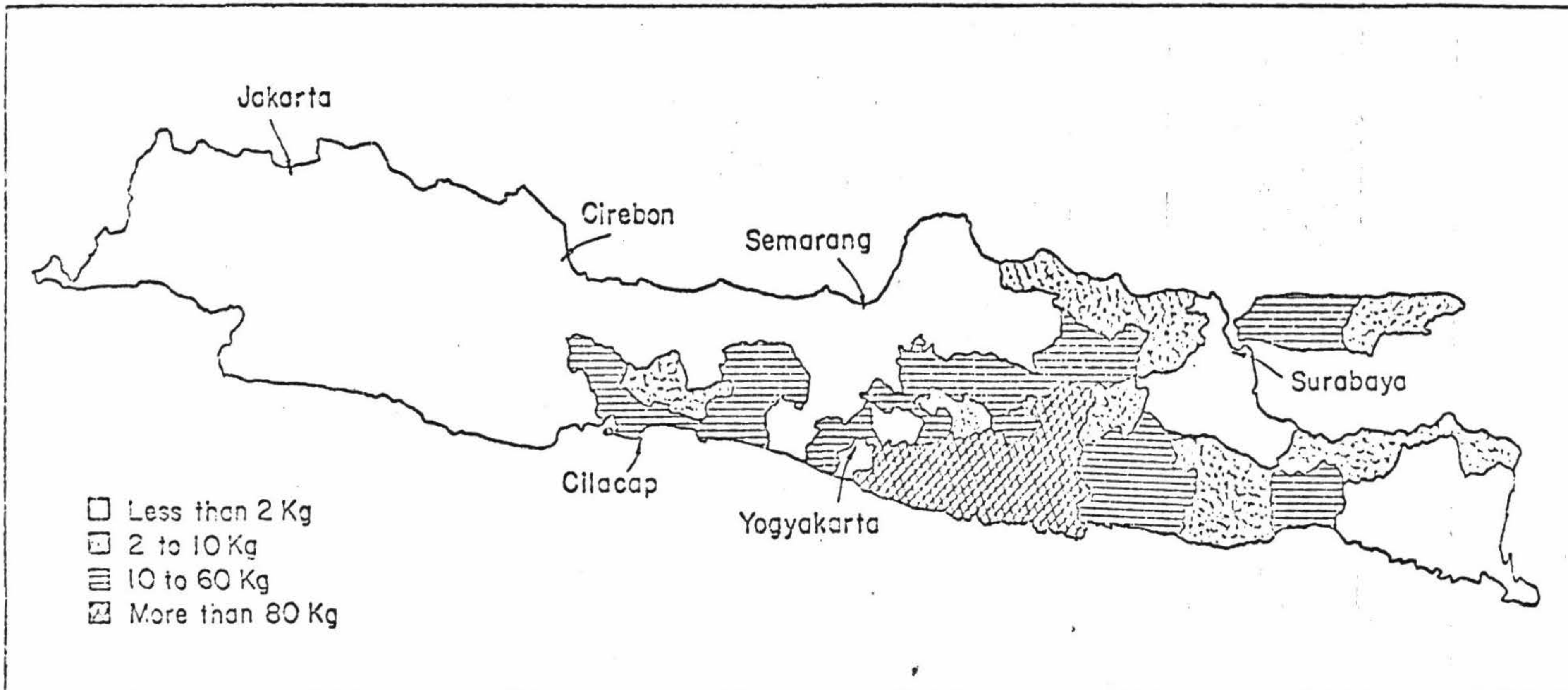


Figure 3.5. Thailand: Marketing Margin of Pellets for Export: 1975-1980.

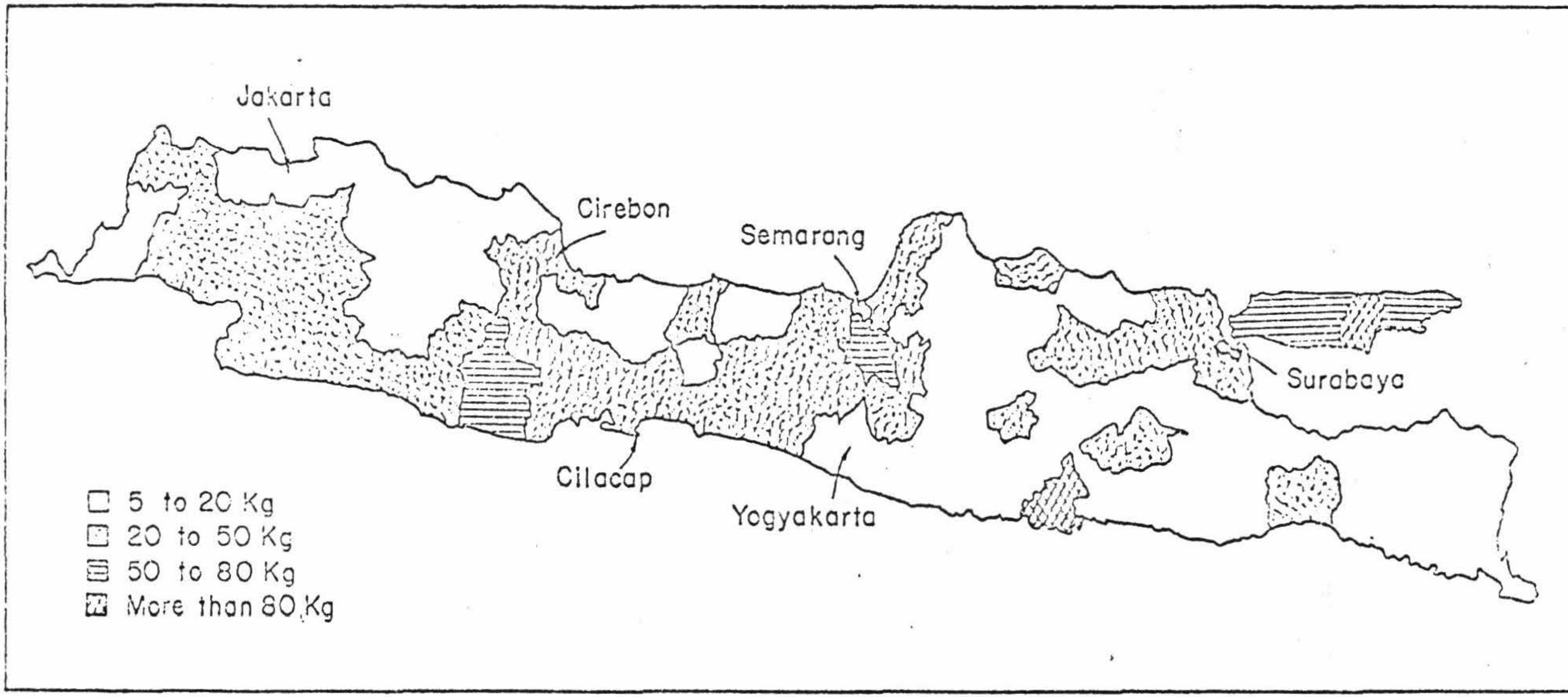
SOURCE: Titapiwatanakun, 1982.

Figure 3.6. Map of Per Capita Consumption of Gaplek by Area, 1976



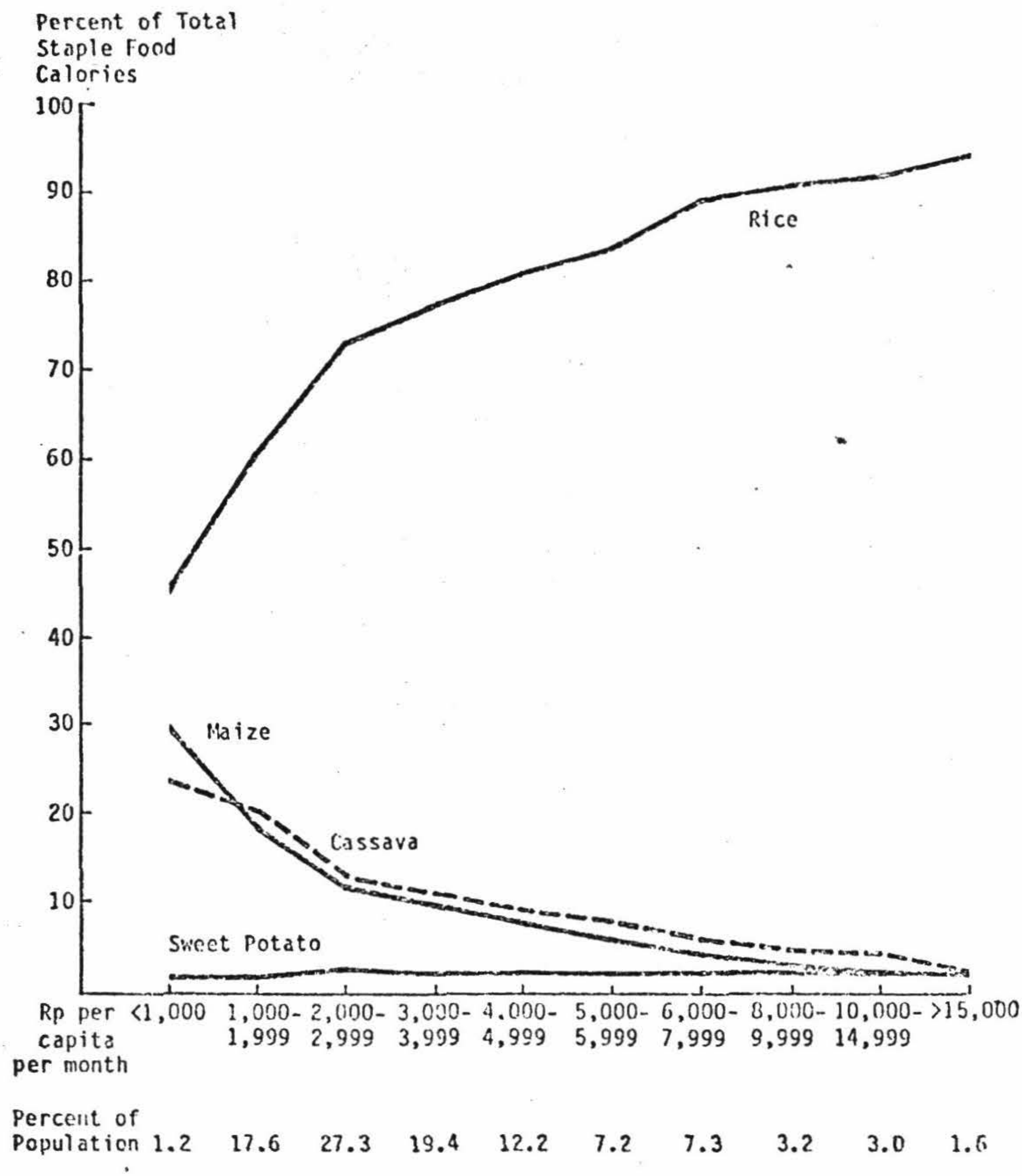
Source: Unnevehr; 1982

Figure 3.7. Map of Per Capita Consumption of Fresh Roots by Area, 1976



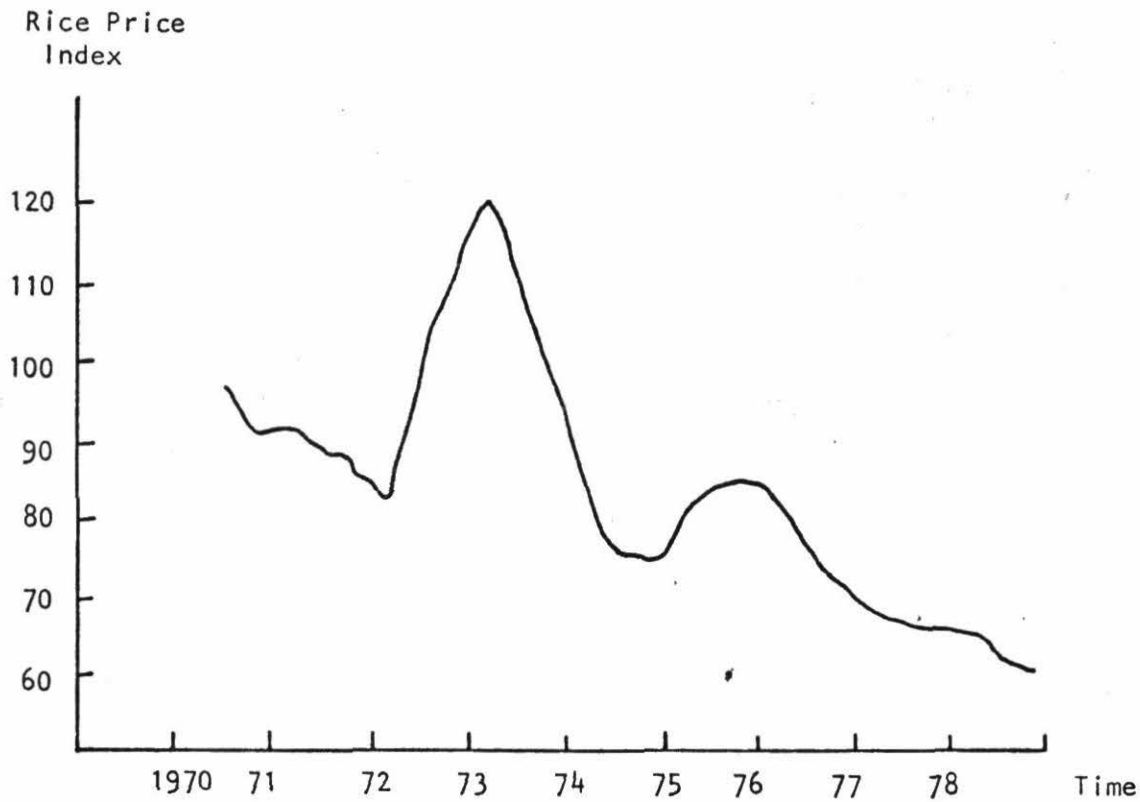
Source: Unnevehr, 1982

Figure 3.8. Distribution of staple food consumption, Java, 1976



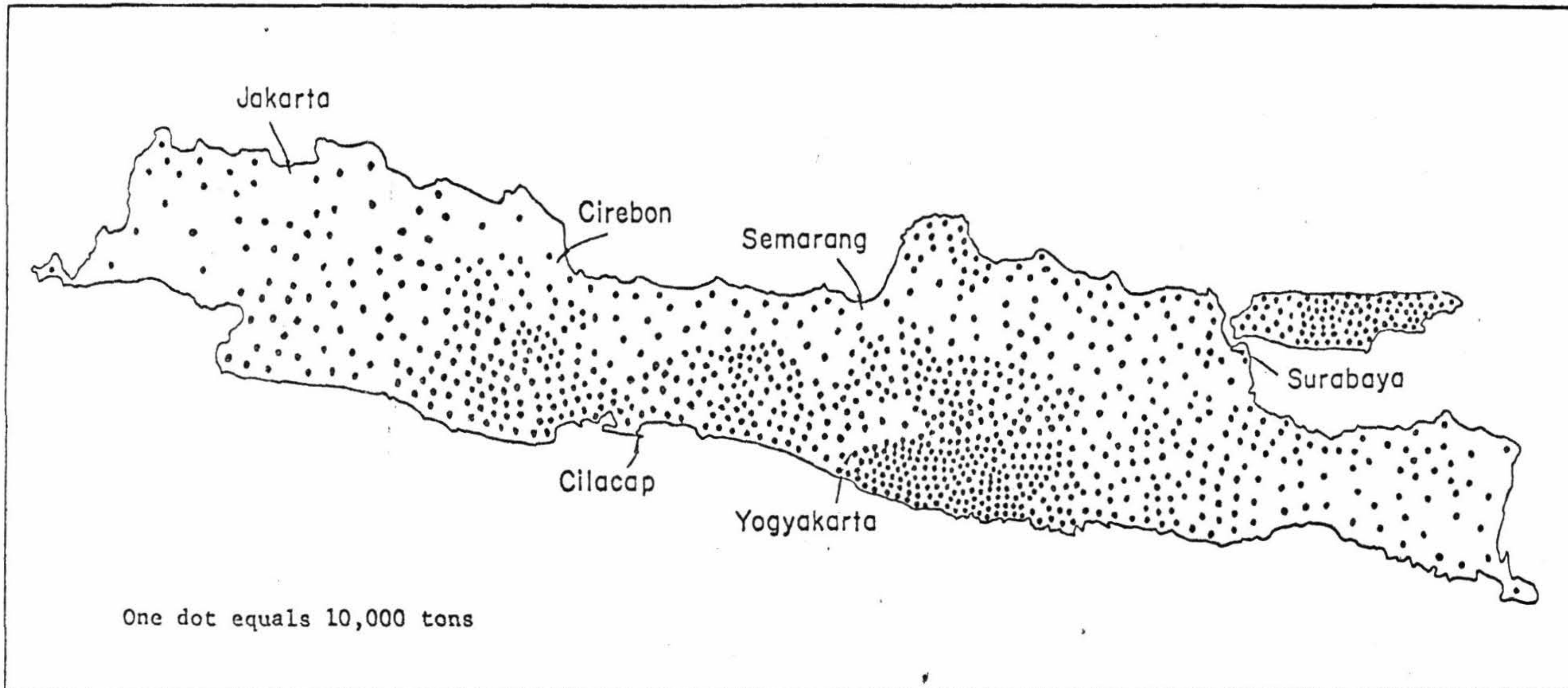
Source: Dixon, 1982

Figure 3.9. Indonesia: Index of Real Rice Price for Jakarta



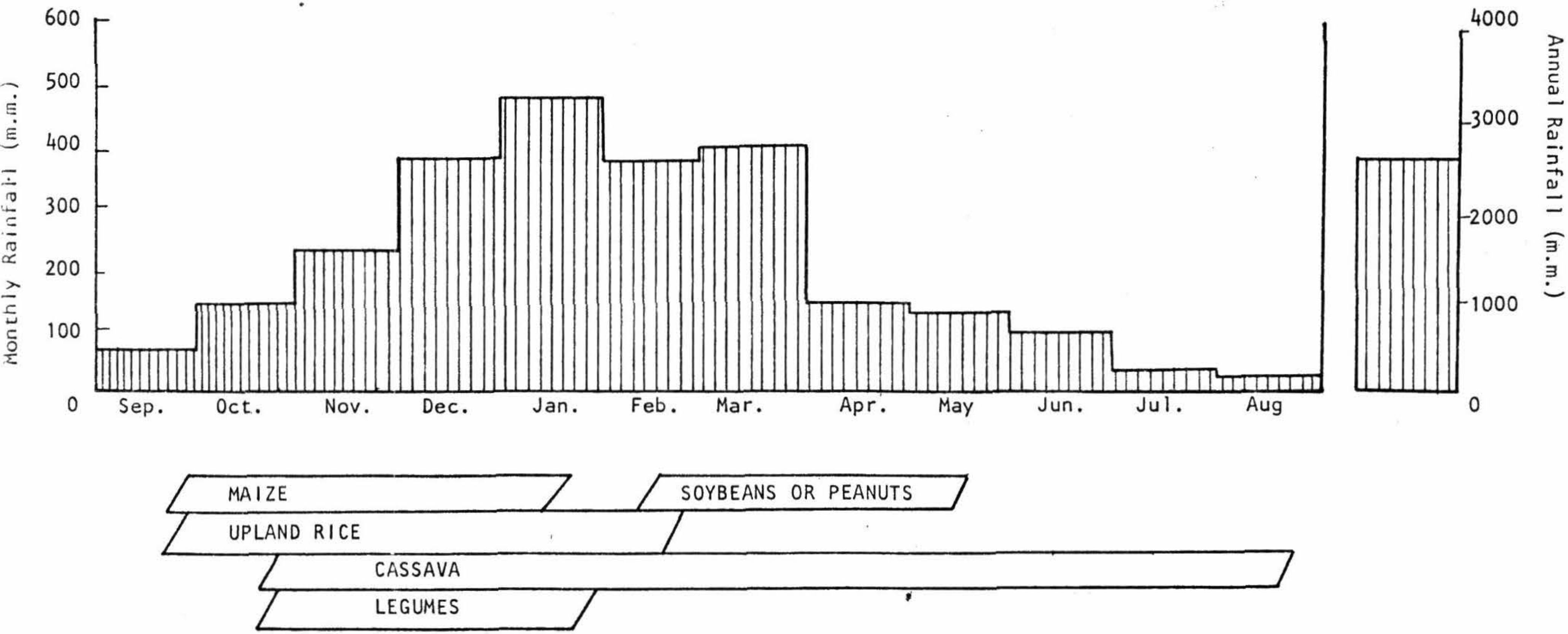
SOURCE: Unnevehr, 1982

Figure 3.10 Map of Cassava Production on Java



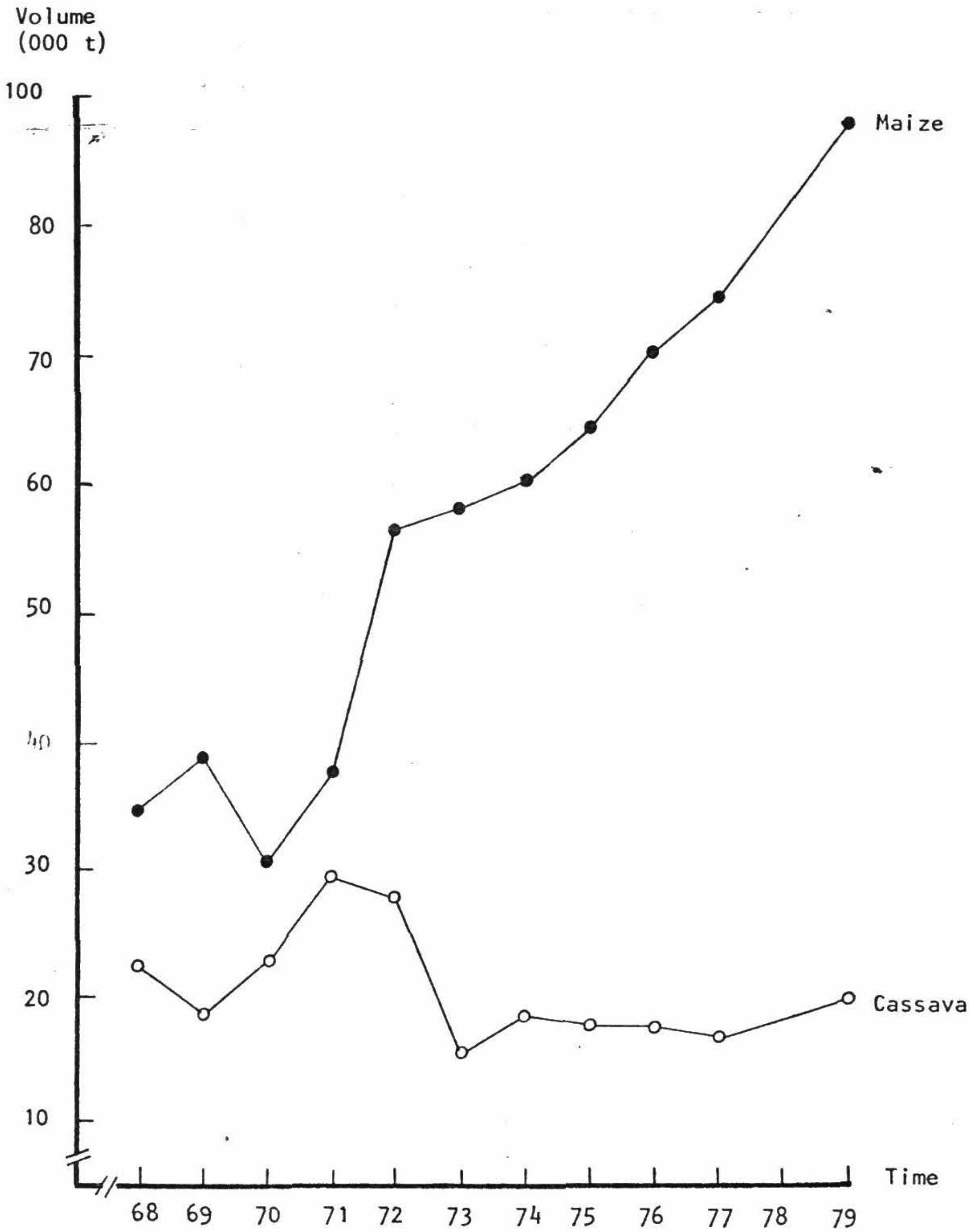
SOURCE: Roche, 1982

Figure 3.11 Indonesia: Intercropping Patterns for Level Land Types in Gunung Kidul.



SOURCE: Roche, 1982

Figure 3.12. Philippines: Production of Maize and Cassava Starch, 1968-1979



SOURCE: Constantino, 1979

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Data Appendix 7
CASSAVA

(CIAT) CASSAVA TRENDS IN YIELD LEVEL BY COUNTRY 1960/81

COUNTRY	ANNUAL GROWTH RATE IN YIELD 1960/81 %	AVERAGE YIELD 1960/62 KG/HA	AVERAGE YIELD 1970/72 KG/HA	AVERAGE YIELD 1979/81 KG/HA
BRAZIL	-0.851709***	13214.7	14559.9	11820.5
MEXICO	-5.803100***	0.0	20000.0	11117.0
	-0.849723***	13214.7	14566.0	11819.9
BOLIVIA	0.428937	.	12936.8	12439.7
COLOMBIA	3.466400***	.	8000.0	9783.3
CUBA	0.033161	6750.0	6565.7	6923.5
DOMINICAN RP	-0.062408	.	11434.6	10442.4
ECUADOR	-0.291831	9006.9	10093.1	9108.2
PARAGUAY	0.270934	14213.1	13633.3	14906.0
PERU	-0.177055	13061.1	12876.5	11435.0
VENEZUELA	-0.716506	9027.3	8011.6	9503.3
TROPICAL SOUTH AMERICA	-0.552294	14352.0	9877.1	10983.8
COSTA RICA	4.004300***	4500.0	3641.3	6654.2
SALVADOR	1.748500***	9000.0	10739.2	11837.0
GUATEMALA	-0.001240	2500.0	2986.9	2577.8
HONDURAS	-3.223200***	4166.7	7215.2	3141.9
NICARAGUA	-0.264777*	4000.0	4071.1	4025.6
PANAMA	-0.790103***	.	8380.0	8339.1
CENTRAL AMERICA,PANAMA	0.705591**	4678.6	5927.3	5705.1
BARBADOS	-1.334800***	32258.1	26597.2	25042.7
GUYANA	-0.000000---	0.0	0.0	0.0
HAITI	0.812000***	3666.7	4160.4	4018.0
JAMAICA	7.140400***	2750.0	8639.6	10350.4
TRINIDAD ETC	2.331300***	8948.5	9308.3	12500.0
CARIBBEAN	1.132900***	3655.9	4397.0	4298.6
TROPICAL LATIN AMERICA	-0.833844***	13047.7	13401.6	11426.8
ARGENTINA	-1.458400***	12613.5	10949.5	9396.8
TEMPERATE SOUTH AMERICA	-1.458400***	12613.5	10949.5	9396.8
LATIN AMERICA	-0.836804***	13042.7	13378.3	11410.1

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 *P<0.05

(CIAT)   CASSAVA   ANNUAL GROWTH RATES

COUNTRY	PRODUCTION 1960/70	1971/81	1960/81	AREA 1960/70	1971/81	1960/81	YIELD 1960/70	1971/81	1960/81
BRAZIL	5.6***	-1.9***	1.1**	4.4***	0.2	1.9***	1.2***	-2.0***	-0.9***
MEXICO	7.2	0.0	-4.8*	7.2	0.0	1.0	0.0	0.0	-5.8***
	5.6***	-1.9***	1.1**	4.4***	0.2	1.9***	1.2***	-2.0***	-0.8***
BOLIVIA	8.8***	-1.4	4.3***	6.5***	-1.0	2.9***	-0.6	-0.4	0.4
COLOMBIA	3.7***	0.4	6.5***	1.7**	-2.3***	3.4***	2.9**	2.6***	3.5***
CUBA	4.1***	4.9***	3.5***	4.2***	4.3***	3.4***	-0.1	0.6**	0.0
DOMINICAN RP	1.3***	-3.5*	0.5	-0.9	-2.5	0.4	2.4***	-1.0*	-0.1
ECUADOR	5.4***	-8.3***	0.4	2.9**	-7.5***	0.7	2.5**	-0.8	-0.3
PARAGUAY	5.6***	6.3***	2.7***	4.8***	4.9***	2.5***	0.8***	1.4**	0.3
PERU	2.7**	-1.7***	-0.0	3.2	-0.3	0.1	-0.6	-1.4***	-0.2
VENEZUELA	-0.2	2.0**	0.3	0.4	-0.4	1.0	-0.5	2.4***	-0.7
TROPICAL SOUTH AMERICA	4.5***	1.6***	3.4***	8.3***	-0.3	4.0***	-3.7*	1.9***	-0.6
COSTA RICA	3.9***	6.9***	2.7***	3.3*	0.0	-1.3*	0.6	6.9***	4.0***
SALVADOR	3.7***	4.8**	4.5***	5.8***	5.3***	2.7***	-2.1*	-0.5	1.7***
GUATEMALA	3.6***	1.8***	2.7***	0.5	3.3***	2.7***	3.1***	-1.5***	-0.0
HONDURAS	7.0***	-12.7***	-5.8***	0.8	-4.8***	-2.6***	6.2***	-7.8***	-3.2***
NICARAGUA	5.0***	3.9***	4.4***	4.8***	3.8***	4.7***	0.2	0.1	-0.3*
PANAMA	12.0***	0.8***	6.6***	7.0**	1.3***	6.0***	-0.2	-0.5	-0.8***
CENTRAL AMERICA,PANAMA	15.9***	1.1**	5.7***	13.3***	1.5***	5.0***	2.6**	-0.3	0.7**
BARBADOS	-3.9**	1.5***	0.2	-1.8	2.3***	1.5***	-2.1***	-0.8***	-1.3***
GUYANA	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	0.0	0.0
HAITI	8.2***	1.9***	4.6***	7.3***	2.3***	3.8***	0.0	-0.4	0.8***
JAMAICA	3.1	5.0*	5.5***	-11.6***	2.1	-1.6	14.8***	2.9***	7.1***
TRINIDAD ETC	-2.0*	2.8***	1.9***	-2.1**	0.4	-0.4	0.0	2.4**	2.3***
CARIBBEAN	14.6**	2.2***	6.7***	13.1**	2.3***	5.6***	1.5***	-0.1	1.1***
TROPICAL LATIN AMERICA	5.5***	-1.2***	1.5***	5.1***	0.1	2.3***	0.5	-1.4***	-0.8***
ARGENTINA	2.1**	-2.7	-1.0*	3.3***	-0.6	0.4	-1.2***	-2.1	-1.5***
TEMPERATE SOUTH AMERICA	2.1**	-2.7	-1.0*	3.3***	-0.6	0.4	-1.2***	-2.1	-1.5***
LATIN AMERICA	5.5***	-1.3***	1.4***	5.1***	0.1	2.3***	0.4	-1.4***	-0.8***

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005   ** P<0.01   * P<0.05

IAT) CASSAVA TRENDS IN AREA LEVEL BY COUNTRY 1960/81

UNTRY	ANNUAL GROWTH RATE IN AREA 1960/81 %	AVERAGE AREA 1960/62	AVERAGE AREA 1970/72	AVERAGE 1979
		-----------------1000 HA-----------------		
ASIL	1.903000***	1399.7	2049.5	207
ICO	1.014900	0.0	2.3	
	1.911600***	1399.7	2051.8	207
IVIA	2.865900***	10.5	18.0	1
OMBIA	3.377800***	138.0	216.7	21
IA	3.431100***	24.0	33.0	4
INICAN RP	0.386420	15.0	16.0	1
ADOR	0.662331	25.0	37.5	2
AGUAY	2.455500***	69.7	97.0	13
U	0.141305	29.3	36.9	3
EZUELA	1.015100	40.0	39.9	3
PICAL SOUTH AMERICA	3.969800***	230.0	495.0	51
TA RICA	-1.254800*	2.0	2.9	
SALVADOR	2.707500***	1.0	1.2	
TEMALA	2.713600***	2.0	2.2	
DURAS	-2.581600***	4.0	3.7	
ARAGUA	4.668900***	3.0	4.4	
AMA	5.980700***	2.0	4.4	
TRAL AMERICA,PANAMA	4.989500***	7.3	18.8	2
BADOS	1.510200***	0.0	0.0	
ANA	-0.000003	1.0	0.0	
TI	3.804900***	30.0	51.7	6
AICA	-1.640500	4.0	2.3	
NIDAD ETC	-0.417311	0.4	0.4	
IBBEAN	5.565800***	24.7	54.4	6
PICAL LATIN AMERICA	2.301300***	1661.7	2620.0	267
ENTINA	0.408735	19.7	25.2	2
PERATE SOUTH AMERICA	0.408735	19.7	25.2	2
IN AMERICA	2.283100***	1681.3	2645.2	270

L OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
P<0.005 ** P<0.01 * P<0.05

(CIAT) CASSAVA ANNUAL GROWTH RATES

COUNTRY	PRODUCTION 1960/70	1970/81	1960/81	AREA 1960/70	1970/81	1960/81	YIELD 1960/70	1970/81	1960/81
BRUNEI	1.6	3.2*	3.4***	-1.1	1.6***	1.2*	2.6***	1.4	2.7***
BURMA	14.5**	10.5***	10.1***	11.8**	11.9***	10.3*	2.7	-1.4**	-0.1
CHINA	29.6***	4.1***	14.6***	30.3***	3.6***	14.8*	-0.7	0.6*	-0.2
INDIA	11.6***	0.7	6.3***	3.3**	0.1	2.1*	8.3***	0.6	4.2***
INDONESIA	-0.7	2.7***	0.8***	-0.1	-0.2	-0.5*	-0.6	2.8***	1.3***
KAMPUCHEA DM	12.0***	22.7***	13.0***	16.2***	28.9***	17.9*	-4.1*	-6.2***	-4.0***
LAO	3.5**	15.3***	10.8***	-5.4	14.7***	6.9*	8.9***	0.6*	3.0***
MALAYSIA	7.6***	4.3***	4.9***	8.1***	4.4**	3.5*	-0.4**	-0.1	1.4**
PHILIPPINES	-1.9	19.2***	7.1***	-1.4**	10.1***	4.1*	-0.5	9.0***	3.1***
EAST TIMUR	5.8	-0.4	2.6	2.7	4.0*	4.7*	3.1	-4.4	-2.1
SINGAPORE	4.0***	-10.0***	-5.1***	5.6***	-10.7**	-3.5*	-1.6**	0.7	-1.6***
SRI LANKA	2.9**	3.5	4.0***	6.5***	-2.5	3.9*	-3.7***	5.9**	0.1
THAILAND	7.6***	16.6***	13.1***	8.7***	16.1***	14.0*	-1.1*	0.5	-0.9***
VIET NAM	0.4	14.8***	6.3***	1.9	14.4***	6.4*	-1.5**	0.4	-0.1
ASIA	3.6***	7.1***	5.3***	2.0***	4.7***	3.2*	1.6***	2.4***	2.1***

CASSAVA — PRODUCTION, RELATIVE IMPORTANCE IN THE REGION AND PER CAPITA PRODUCTION LEVELS (CIAT)

COUNTRY	PRODUCTION 1000 MT 1960/62	1970/72	1979/81	PERCENTAGE OF TOTAL % 1979/81	PER CAPITA PRODUCTION KG 1979/81
BRAZIL	18505	29841	24474	79.430	232
MEXICO	0	46	25	0.081	0
	18505	29887	24499	79.511	149
BOLIVIA	114	232	217	0.704	46
COLOMBIA	758	1734	2070	6.717	91
CUBA	162	217	324	1.053	35
DOMINICAN RP	147	183	138	0.449	27
ECUADOR	225	377	216	0.701	32
PARAGUAY	990	1328	1973	6.403	758
PERU	368	475	404	1.312	27
VENEZUELA	321	319	357	1.159	28
TROPICAL SOUTH AMERICA	3085	4866	5699	18.497	72
COSTA RICA	9	10	17	0.055	9
EL SALVADOR	9	13	22	0.070	5
GUATEMALA	5	7	8	0.025	1
HONDURAS	17	27	8	0.025	3
NICARAGUA	12	18	26	0.083	11
PANAMA	12	37	41	0.133	24
CENTRAL AMERICA, PANAMA	64	112	120	0.390	6
BARBADOS	1	1	1	0.003	4
GUYANA	10	0	0	0.000	0
HAITI	110	215	253	0.821	50
JAMAICA	11	20	23	0.075	12
TRINIDAD TOB	4	4	5	0.016	5
CARIBBEAN	136	239	282	0.916	31
TROPICAL LATIN AMERICA	21789	35103	30601	99.313	143
ARGENTINA	248	277	212	0.687	8
TEMPERATE SOUTH AMERICA	248	277	212	0.687	6
LATIN AMERICA	22037	35380	30813	100.000	126

COLUMNS MAY NOT ADD EXACTLY DUE TO ROUNDING