WORKING PAPER 3 ON **cassava**

Trends and Prospects for Cassava in Indonesia

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TRENDS AND PROSPECTS FOR CASSAVA IN INDONESIA

by

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FOREWORD

Cassava is a staple food crop cultivated in several developing countries, largely by small farmers. It is a source of subsistence and of cash income for poor farmers as well as a source of rural employment, particularly of women. During the past 20 years, production of cassava has expanded rapidly in Asia, particularly in Thailand in response to expanded demand for its import in the European Community, where it is used as livestock feed. There are concerns, however, about the likely decline in demand for cassava as food as incomes rise in developing countries and also about the stability of the European demand. To assess the prospects for cassava in the future, IFPRI has examined the trends and prospects for production, utilization, and trade of cassava in Third World countries under a special project partially funded by the International Development Research Centre (IDRC) of Canada.

In addition to the analysis of international data at the global and regional levels, case studies were taken up in six countries: India, Indonesia, the Philippines, and Thailand in Asia and Nigeria and Zaire in Sub-Saharan Africa. The results of these studies were discussed at a workshop in Washington, D.C. in August 1987, where project researchers, selected cassava scientists, and representatives of international organizations participated. The report on the proceedings of the workshop will be published separately. The results of the individual case studies are being published as a series of working papers. Trends and Prospects for Cassava in Indonesia, by Faisal Kasryno, is the third in the series.

J. S. Sarma
Project Leader

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I am most grateful to J. S. Sarma who gave valuable comments and suggestions that improved the presentation of this work. I also would like to extend my sincere appreciation to the IFPRI reviewers for comments and suggestions made. Any shortcomings that may remain are my responsibility.

Faisal Kasryno

1. INTRODUCTION

In its Five-Year Development Plan (PELITA), the government of Indonesia has established policies designed to achieve self-sufficiency in both rice and secondary crops (maize, soybeans, cassava, sweet potatoes, and mung beans). Self-sufficiency has been achieved in rice; the results for other crops have been less impressive. Cassava is one of the most commonly cultivated secondary crops in rural areas throughout the country. As a source of carbohydrates, cassava can substitute for rice if the supply of rice is scarce.

Since cassava is the third most important staple food after rice and maize, it is given a high priority for development through technological improvement. Therefore, studies like this enrich the data base available, so that appropriate policy analyses can be made.

The main objectives of this study are, first, to analyze past trends in production, area, yield, and the domestic utilization of cassava. Second, to broadly indicate what the supply and demand prospects of cassava in 1990 and 2000 will be. Lastly, to suggest appropriate policies for cassava production, utilization, and trade in Indonesia.

The emphasis of this study will be on the scope for expanding the use of cassava as livestock feed. In this context, the study attempts to determine the prices of cassava and protein supplements at which cassava can be substituted economically for maize and sorghum as livestock and poultry feed, not only in domestic markets but also in export markets, especially in Asia. It will also examine the yields and prices that would make cassava profitable to the producers and examine the feasibility of reducing unit production costs through improved practices and the adoption of new technological inputs. Finally, the study will explore the feasibility of augmenting the supply of protein supplements for the cassava-feed industry. This study relies largely on secondary data, including national data series and the results of household surveys, and other studies. Data from research and experimental stations were also used.

2. THE CURRENT POSITION OF CASSAVA

Cassava (Manihot esculenta Crantz) is, with rice and maize, one of three staple foods for Indonesia's 160 million people. It is extremely perishable--it deteriorates in two-to-five days--and bulky, so that it must be consumed quickly or transformed into other forms, such as gaplek (dried cassava chips) or starch. These forms can be stored longer and consumed when rice, the primary staple, is scarce.

Cassava is grown throughout the country. It is easy to grow and can be cultivated in any soil, even if the soil is poor and badly eroded, and under any climatological condition in Indonesia. In fact, cassava is, in general, more important where agro-climatological conditions are poor. It is widely grown on marginal land, particularly on steep slopes where other crops cannot be grown efficiently. This practice may lead to serious soil erosion, particularly as cassava is planted with wide spaces left, which might expose the soil to rainfall and run-off during the early phases of cassava growth. Erosion could also occur after harvest, when the field has holes and the soil is loose. Improperly terraced fields could be extensively eroded by rain.[1]

AREA AND PRODUCTION

Cassava is very popular in rural areas, where the majority of people live, and is particularly popular in Java, where most of the population is concentrated, and in southern Sumatera. More area is planted with cassava than with any other tuber root crop--1.2 million hectares were planted with cassava in 1983 against 260,000 hectares planted with the next most important, sweet potatoes.[2] As Table 1 shows, cassava production is second only to that of rice. But the growth rate of cassava production between 1979 and 1984 was quite low. The major producing regions can be seen in Table 2 and Figure 1. They indicate that during 1969-83 Java was the center of cassava

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[1] J. A. Dixon, "Consumption," in Cassava Economy of Java, ed. Walter P. Falcon, William O. Jones, and Scott R. Pearson (Stanford, Cal.: Stanford University Press, 1985).

[2] Indonesia, Biro Pusat Statistik, Statistical Yearbook 1983 (Jakarta. BPS, 1984). The area for all crops in 1983 was 18 million hectares.

production and that East Java was the province producing the most. Lampung, on Sumatera, produced more than any other province outside Java; in 1986 it produced 47 percent of the cassava produced in Sumatera. As production nearly stagnated on Java, what increase there was came mainly from the outer islands, particularly from Sumatera.

Table 1--Production of selected crops, 1979-84

Commodity	1979	1983	1984	Annual Growth Rates 1979-84	1983-84
	(1,000 metric tons)			(percent/year)	
Rice	17,872	23,961	25,933	7.4	8.2
Maize	3,606	5,095	5,288	7.6	3.8
Cassava	13,726	12,103	14,167	0.6	17.1
Sweet potatoes	2,194	2,004	2,157	0.0	7.6
Peanuts	424	469	535	4.7	14.0
Soybeans	680	569	769	2.5	35.1

Source: Indonesia, Biro Pusat Statistik, Statistical Yearbook , 1970-86 (Biro Pusat Statistik, 1970-86); and Indonesia, Biro Pusat Statistik, Monthly Statistical Summary, May 1987.

Efforts to increase production of cassava have been made through intensification programs, which are only possible in areas where cassava is commercially grown. Usually, growing cassava is preferred on marginal lands where other crops do not perform well.

New technology has been introduced, especially through the research conducted by the Bogor Research Institute for Food Crops (BORIF). BORIF has been conducting its research on cassava breeding and cultural practices. Almost all research projects are designed to improve production, to develop new technology to increase yields.

Table 2--Production of cassava by region, 1969-86

Region	1969	1970	1971	1972	1973	1974	1975	1976	1977
	(1,000 metric tons)								
Java[a]	8,251	8,003	8,075	8,178	8,103	9,648	9,309	8,846	9,085
West Java	2,193	2,021	1,768	1,719	1,796	2,438	2,207	2,006	2,020
Central Java	2,403	2,403	2,463	2,422	2,734	2,866	2,694	2,596	2,699
East Java	3,348	3,156	3,333	3,713	3,112	3,897	3,938	3,766	3,758
Sumatera	934	804	911	959	1,326	1,228	1,282	1,349	1,399
Lampung	295	311	388	465	734	604	655	695	764
Kalimantan	295	293	288	268	284	326	278	271	274
Sulawesi	634	590	609	612	660	681	652	673	626
Bali and West Nusa Tenggara	317	329	343	271	349	502	341	377	311
East Nusa Tenggara	432	383	337	291	312	490	527	486	450
Total outer islands	2,664	2,475	2,614	2,808	3,082	3,381	3,235	3,344	3,550
Indonesia	10,917	10,478	10,690	10,385	11,186	13,031	12,546	12,191	12,488

Region	1978	1979	1980	1981	1982	1983	1984	1985	1986
	(1,000 metric tons)								
Java[a]	9,485	9,900	9,843	9,637	9,120	8,461	9,538	9,297	8,958
West Java	1,990	2,041	1,975	1,933	1,963	1,747	2,082	1,935	1,834
Central Java	2,944	3,131	2,971	3,006	2,829	2,772	3,135	3,010	3,069
East Java	3,948	4,117	4,190	4,040	3,758	3,349	3,715	3,753	3,476
Sumatera	1,497	1,496	1,601	1,441	1,522	1,495	2,160	1,769	1,680
Lampung	809	902	984	822	883	827	1,298	929	787
Kalimantan	294	319	303	313	287	313	358	473	561
Sulawesi	636	670	582	581	834	702	752	815	853
Bali and West Nusa Tenggara	302	447	448	364	390	324	371	362	321
East Nusa Tenggara	502	752	853	826	684	694	870	719	778
Total outer islands	3,417	3,851	3,931	3,664	3,878	3,642	119	621	134
Indonesia	12,902	13,751	13,726	13,301	12,988	12,103	14,167	14,057	13,312

Source: Indonesia, Biro Pusat Statistik, Statistical Yearbook, of Indonesia 1980 (Jakarta: Biro Pusat Statistik, 1980); Indonesia, Biro Pusat Statistik, Statistical Yearbook of Indonesia 1985 (Jakarta: Biro Pusat Statistik, 1985); and Indonesia, Biro Pusat Statistik, Monthly Statistical Summary, June 1986.

[a]Java includes Yogyakarta and Jakarta.

Figure 1--Major cassava-producing regions in Indonesia, 1985

Provinces with cassava areas more than 201,000 hectares (Jawa Timur and Jawa Tengah).

Provinces with cassava areas 101,000-200,000 hectares (Jawa Barat).

Provinces with cassava areas 51,000-100,000 hectares (Lampung, D.I. Yogyakarta, and Nusa Tenggara Timur).

The data in Table 2 suggest that the year-to-year fluctuations of cassava production are high. It is strongly presumed that production may have been affected by the rice intensification program that began in the early 1970s. Cassava competes with rice in production on upland unirrigated land, in rainfed regions, and in consumption, so higher rice production resulting from incentive policies may have reduced cassava consumption and production.

There are two main sets of problems in increasing cassava production. The first is the problems in improving production technology. The gap between research and farmer's yield is high, especially because of low fertilizer use. This gap will be discussed later in this report. The second is the problems in postharvest and processing techniques. Farmers are unable to see the importance of proper handling and processing due to a lack of knowledge of improved technologies, and the price differential between is relatively small. As a result, the revenue they earn may be far below their expectations. Prices may be lower if the quality of their products is lower than the standard demanded by the traders or factories. As a result, the farmers may not be interested in increasing production.

In addition, many farmers face serious problems in marketing. Many production sites are far from markets and processing centers. Abundant production and a lack of transportation reduces the net revenue farmers receive. In an extreme situation, the costs of harvesting and marketing may exceed the price offered in the markets. In a production center, Dampit Subdistrict in East Java, for example, the farmers' revenue was far below their expectation due to abundant production and processing problems.[3] Farmers' groups appeared to be ineffective in coping with these problems.

Traders or wholesalers may face similar problems. All of them are concerned about the perishability of cassava when it is not handled directly after the harvest. If the farmers or traders cannot get the crop to the factories within two days, a sizable part of their revenue might be lost. Therefore, infrastructure and marketing practices, including processing facilities, should be carefully considered in attempts to increase farm income.

UTILIZATION

Cassava is unique among tropical root crops because it can be used as food, in industry, and as animal feed. Nearly 65 percent is used as food, and only 2.5 percent of total production is used in

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[3] S. M. Pasaribu, Impact on Farmers' Income of Alternative Marketing and Post-Harvest Processing Possibilities: A Study of Rice and Cassava in East Java Province, Indonesia, RSPR No. HS-85-4 (Bangkok: Asian Institute of Technology, 1985).

feed mixes at present. About 35 percent is consumed on farms, 30 percent is marketed as food, 25 percent is sold to starch factories, and 10 percent is exported.[4]

As a food, cassava is a major calorie source, and a major staple for rural households, especially where the resource endowment and productivity are poor. The roots and leaves are edible, while its stalk can be used as seedlings or firewood. Bitter varieties are not eaten fresh, but are processed into gaplek or starch.

Cassava roots are consumed in many forms. The fresh root can be eaten boiled, steamed, or fried. Further processing is needed to produce gaplek and starch. Gaplek is produced in three steps. The cassava is peeled immediately after harvest, then sliced and dried. Drying is done in the field with or without a mat. Instead of mats, farmers sometimes use the cassava stalk, so that the commodity is dirty with soil spots on it. This affects the quality and reduces the price. Gaplek is normally stored in the house using plastic bags or baskets. It can be stored for several months and has a moisture content of 14-18 percent.

Other types of food using gaplek as raw material are gatot or tiwul, which are made by moisturizing the gaplek flour slightly and heating it in a flat pan until it beads into tiny kernels, and then steaming it. Gatot is usually consumed along with salt and rasp coconut, while tiwul is consumed by mixing it with rice. Another food, ojek, is prepared by grating the roots, steaming the mash, drying the product, and then reconstituting it with steam.[5]

Because people in rural areas eat cassava with rice, particularly where rice is not produced locally or is expensive, cassava may remain an important part of the diet for many of them, despite the increase in rice production. Nonetheless, per capita consumption of cassava in rural areas has fallen from 28 kilograms of fresh root equivalent in 1976 to 25 kilograms in 1980 to 23 kilograms in 1984.

Urban people consume little cassava, an average 8 kilograms in 1984, usually as snacks. These are most often small cakes made of starch or starch-based food. The urban-rural difference can be accounted for by the higher incomes that urban people have, which allows them to purchase more rice, and by the greater variability in the incomes of rural people.

Gaplek contains little protein, but it is an excellent energy source; it contains only 2.84 percent protein on a dry matter basis

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[4]Dixon, "Consumption."

[5]Ibid.

(compared to 11.86 for soft red winter wheat and 47.33 percent for expeller soybean meal), but 4,000 kilocalories per kilogram (compared to 4,254 for soft red winter wheat and 3,870 for expeller soybean meal).[6] This could make it important as animal feed, perhaps for export.

Dried cassava, such as gaplek, has long been exported in small quantities by some countries, but the quality has usually been poor.[7] Indonesia was once the world's largest exporter of processed cassava, but Thailand is now. Because of the rapid increase in domestic demand, Indonesia has not exported starch since 1980, but has imported large amounts of it, mainly from Thailand. It has exported gaplek for 20 years, mainly to the European Community. Exports of cassava have fluctuated greatly, from 710,000 tons of gaplek in 1979 to 156,000 tons in 1981, and back up to 385,000 tons in 1984.[8]

Although cassava is used primarily for consumption, industrial uses should command particular interest for future cassava development. Fresh cassava can be transformed into starch and alcohol, which are believed to have good prospects in the future. Studies have been conducted in several producing areas and followed by the establishment of some factories. Starch has been widely produced and used as a raw material for some industries. Only recently has alcohol been produced by two pilot plants organized and supervised by the Agency for Technology Research and Application (BPPT) located in Lampung.

In 1985, 160 large- and medium-scale starch factories were registered, with total capacities of 640,000 tons. However, they operated at 60 percent of their capacity.[9] This production, which

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[6]In this report, all calories are kilocalories. G. C. Nelson, "Gaplek", in Cassava Economy of Java, ed. Walter P. Falcon, William O. Jones, and Scott R. Pearson (Stanford, Cal.: Stanford University Press, 1985).

[7]D. G. Coursey, "Potential Utilization of Major Root Crops, With Special Emphasis on Human, Animal, and Industrial Uses," in Tropical Root Crops: Production and Uses in Africa, ed. E. R. Terry, et al. (Yaounde: Society for Tropical Root Crops, 1983).

[8]In this report, all tons are metric tons. Nelson, "Gaplek"; and Indonesia, Biro Pusat Statistik, Yearly Exports, 1981-1984 (Jakarta: Biro Pusat Statistik, 1981-84).

[9]Indonesia, Biro Pusat Statistik, "Statistics of Industry," Biro Pusat Statistik, Jakarta, March 1987.

could not meet the domestic demand for the products, amounted to 1.03 million tons of fresh cassava root equivalents per year.[10]

The demand for starch came from food and manufacture industries, such as those producing krupuk (chips), snacks, alcohol, plywood, and paper. In 1985 it was estimated that these industries used about 15,000 to 24,400 tons of cassava starch per month as a raw material.

The majority of starch-making firms in Indonesia are basically household industries. However, some can be categorized as large factories.

Two ethanol pilot plants were established in 1981 near the transmigration project in Central and North Lampung. Both plants use raw materials grown by the transmigrants. Starting in 1984, the plants began to produce alcohol. The capacity of the ethanol pilot plant in Central Lampung is 50 tons of cassava per day, and it will produce 8,000 kiloliters of alcohol per year. The capacity of the ethanol pilot plant in North Lampung is 90 tons of cassava per day; it will produce 15,000 kiloliters of alcohol per year.

Although the performance of these ethanol pilot plants is quite attractive, the project is not yet commercially feasible. The BPPT also plans to introduce high-yield varieties of cassava, and therefore it has started to grow cassava at its own research station in Lampung.

The plants will be operated at full capacity in 1987. This might be a good starting point for the cassava farmers to get additional benefits from the plants.

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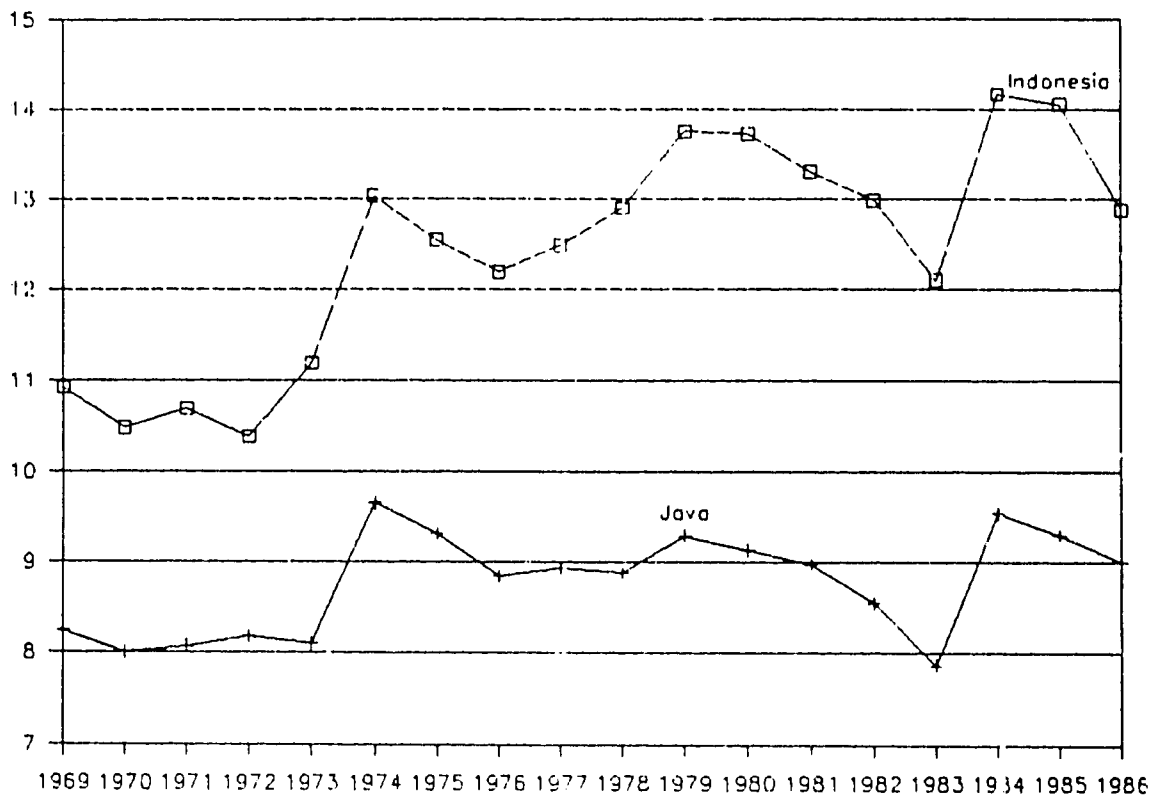
[10]R. Soenarjo, "Pengembangan Ubikayu dalam Rangka Menunjang Kebijaksanaan Nasional Komoditi Pertanian untuk Meningkatkan Penerimaan dan Penghematan Devisa." Paper presented at the workshop on National Policies in Agricultural Commodities, Indonesian Agronomists Association, Jakarta, 1986.

3. TRENDS IN CASSAVA PRODUCTION, TRADE, UTILIZATION, AND PRICES

TRENDS IN AREA, YIELD, AND PRODUCTION

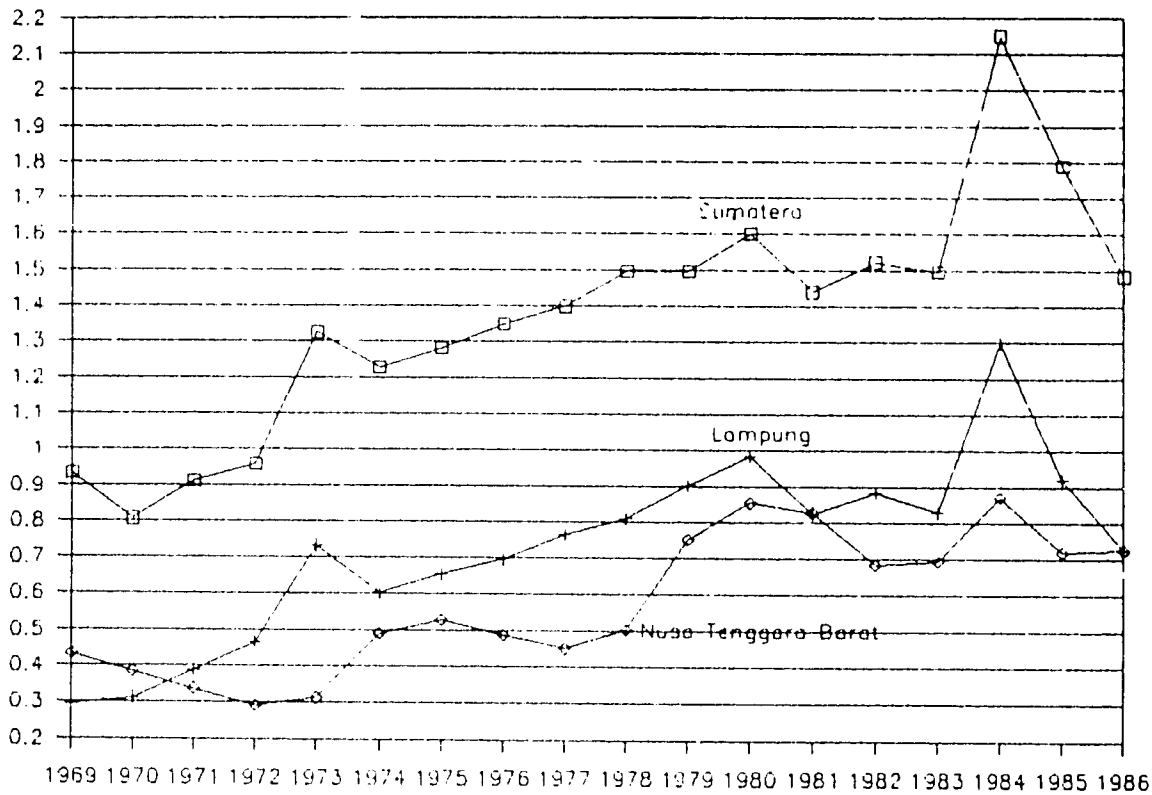
During 1969-85, the production of cassava rose 1.6 percent annually. In 1969 cassava production was 10.9 million tons, and by 1985 it had increased to 14 million tons (see Figure 2). Production of cassava in Java was nearly unchanged, whereas in Sumatera and Nusa Tenggara Timor production increased (Figure 3).

Figure 2--Production of cassava, Java and Indonesia, 1969-86



Source: Indonesia, Biro Pusat Statistik, Bulletin Ringkas BPS, monthly issues, 1969 to 1986.

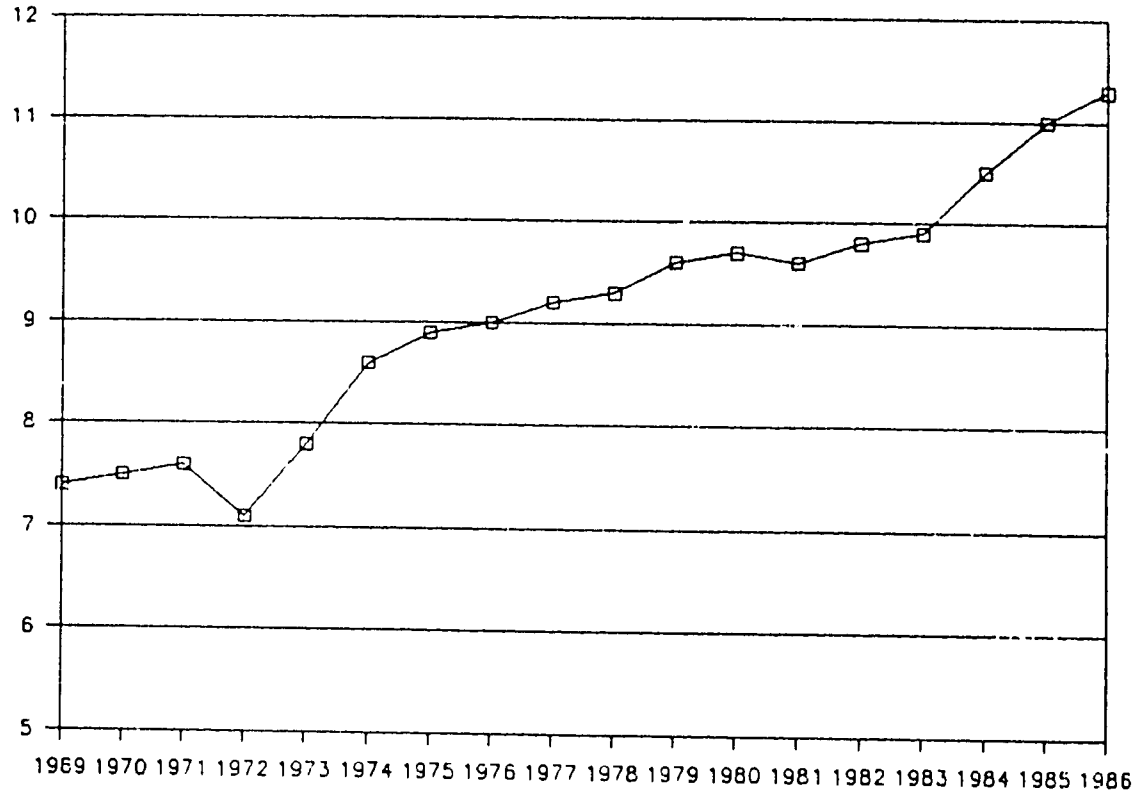
Figure 3--Production of cassava, Sumatera, Lampung, and Nusa Tenggara Timur, 1969-86



Source: Indonesia, Biro Pusat Statistik, Bulletin Ringkas BPS, monthly issues 1969 to 1986.

However, for all Indonesia, cassava area declined by 0.8 percent annually (Figure 4). This decrease was offset by a 2.5 percent annual increase in yield (see Figure 5). Part of the increase in yield was due to the intensification programs for cassava begun in 1975. The area planted with cassava covered by the intensification program increased dramatically from 5,000 hectares in 1975 to 67,000 hectares in 1984 (Table 3).

Figure 4--Yield of cassava in Indonesia, 1969-86

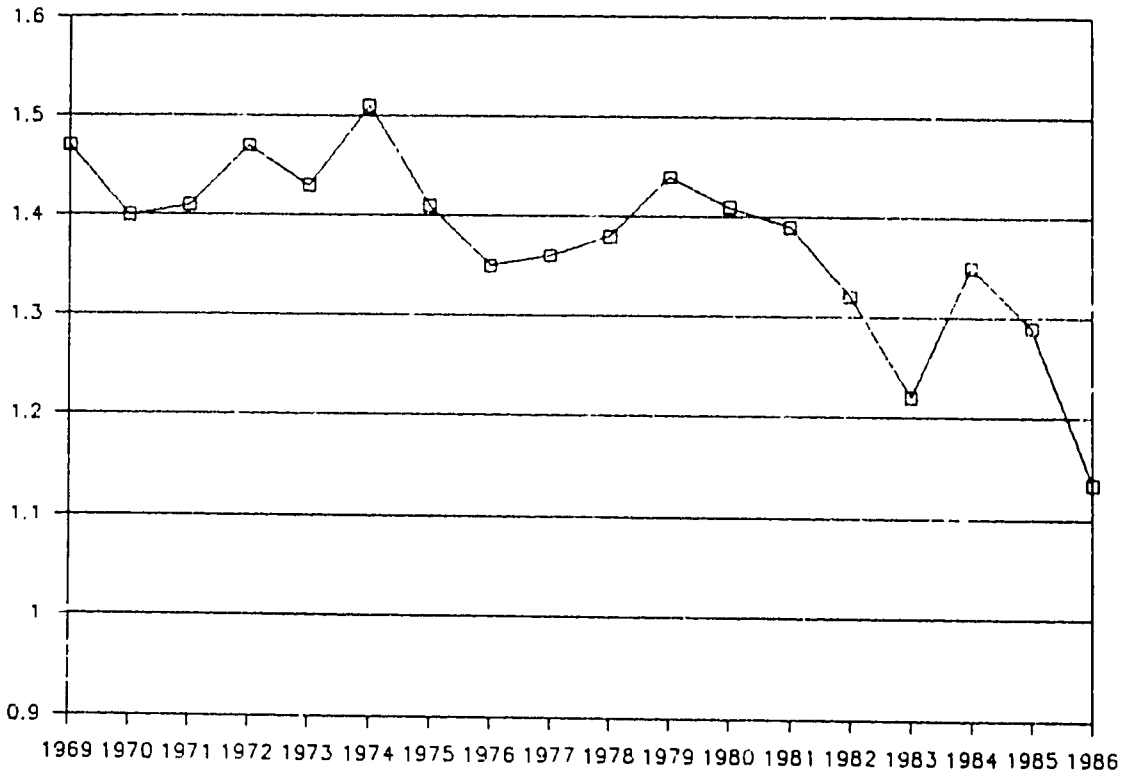


Source: Indonesia, Biro Pusat Statistik, Bulletin Ringkas BPS, monthly issues, from 1969 to 1986.

It is difficult to identify the factors affecting the reduction in cassava harvested area. Two of them were the government food crop intensification program and the decline in the rate of growth in domestic demand for cassava products. However, these two factors did not give enough incentive to farmers to produce cassava. Other factors eliminated those positive effects. Roche identifies several factors contributing to the decline in cassava-planted area.[11] First, irrigation construction expanded the amount of land suitable to grow

[11]F. C. Roche, "Production System," Cassava Economy of Java, ed. Walter P. Falcon, William O. Jones, and Scott R. Pearson (Stanford, Cal.: Stanford University Press, 1985).

Figure 5--Area of cassava in Indonesia, 1969-86



Source: Indonesia, Biro Pusat Statistik, Bulletin Ringkas BPS, monthly issues, 1969 to 1986.

rice at the expense of land available for cassava. Second, an afforestation program also reduced the amount of land available for cassava. Third, a decline in the price ratio of cassava to other crops also affected cassava area. His discussion deals primarily with Java, but since more than 70 percent of the area planted with cassava in Indonesia was on Java, those factors are applicable to Indonesia as a whole (see Figures 6 and 7).

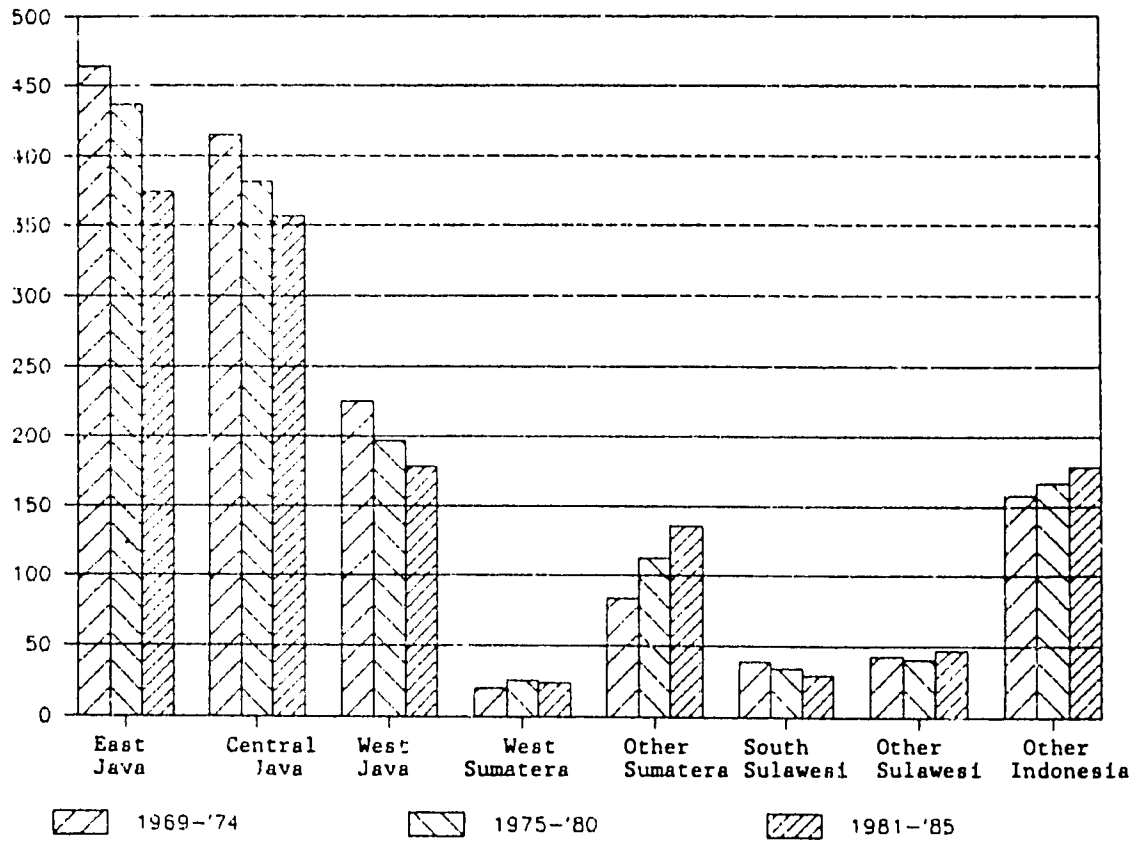
Table 3--Harvested area, area of intensification programs, yields, and production of cassava, 1969-85

Year	Harvested Area	Intensification Area	Yield	Production
	(million hectares)	(million hectares)	(metric tons)	(million metric tons)
1969	1.47	...	7.4	10.9
1970	1.40	...	7.5	10.5
1971	1.41	...	7.6	10.7
1972	1.47	...	7.1	10.4
1973	1.43	...	7.8	11.2
1974	1.51	...	8.6	13.0
1975	1.41	0.01	8.9	12.5
1976	1.35	0.03	9.0	12.2
1977	1.36	0.15	9.2	12.5
1978	1.38	0.23	9.3	12.9
1979	1.44	0.26	9.6	13.8
1980	1.41	0.33	9.7	13.7
1981	1.39	0.40	9.6	13.3
1982	1.32	0.43	9.8	13.0
1983	1.22	0.51	9.9	12.1
1984	1.35	0.67	10.5	14.2
1985	1.29	0.36	11.0	14.1
Rates of growth (percent/ year)	-0.81	52.73	2.50	1.62

Source: Indonesia, Biro Pusat Statistik, Statistical Yearbook 1976, 1980, 1982, 1986 (Jakarta: Biro Pusat Statistik, 1976, 1981, 1983, 1987); Indonesia, Sekretariat Pengendali Bimbingan Masal, unpublished data, 1986.

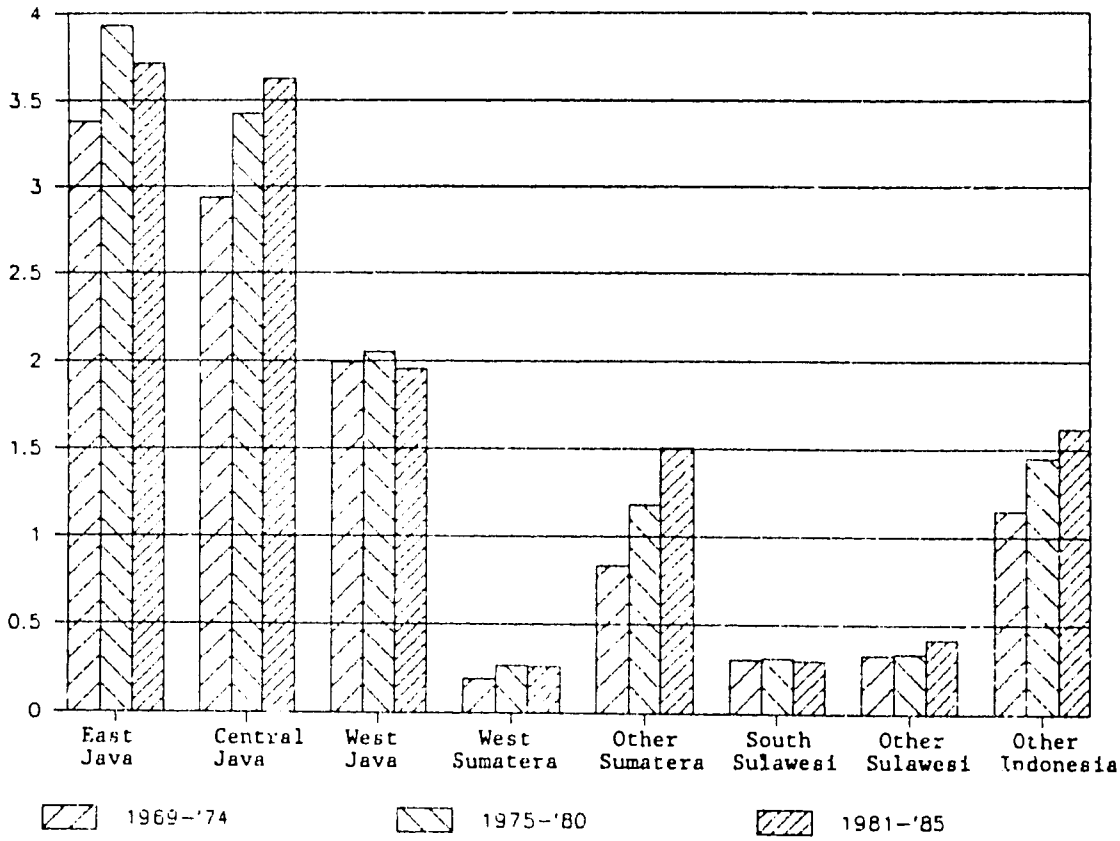
Figure 6--Average area of cassava by province, 1969-74, 1975-80, and 1981-85

(1,000 hectares)



Source: Indonesia, Biro Pusat Statistik, Bulletin Ringkas BPS, monthly issues, 1969 to 1986.

Figure 7--Average production of cassava by province, 1969-74, 1975-80, and 1981-85



Source: Indonesia, Biro Pusat Statistik, Bulletin Ringkas BPS, monthly issues, 1969 to 1986.

CHANGES IN DOMESTIC UTILIZATION

Domestic utilization of cassava in Indonesia can be classified into three groups, namely food, feed, and industrial uses, as shown in Table 4.

The table shows that most cassava was used as food. In the first half of the 1970s, food accounted for 50 percent of production. By the first half of the 1980s, it was 73 percent of production. On the other hand, cassava has not been used extensively as feed: only about 2.5 percent in both periods.

Table 4--Supply utilization of cassava, 1969-85

Year	Production	Net Imports	Total Supply	Domestic Use					
					Manufactured			Food Consumption	
				Feed	Food	Industry	Waste	Direct	Tapioca
	(1,000 metric tons of fresh root equivalent)								
1969	10,917	-930	9,987	200	60	313	999	5,556	2,859
1970	10,478	-945	9,533	191	58	289	953	5,123	2,919
1971	10,690	-1,494	9,196	184	125	281	920	4,989	2,697
1972	10,385	-1,007	9,378	188	125	285	938	5,057	2,785
1973	11,186	-210	10,976	220	221	324	1,098	5,761	3,352
1974	13,031	-1,160	11,871	239	221	346	1,193	6,128	3,744
1975	12,546	-303	12,243	245	150	354	1,224	6,356	3,914
1976	12,191	-174	12,017	240	422	363	1,202	6,415	3,375
1977	12,488	-472	12,016	240	218	359	1,202	5,881	4,116
1978	12,902	-856	12,046	241	244	359	1,205	5,179	4,818
1979	13,751	-1,972	11,779	234	229	348	1,524	4,584	4,860
1980	13,726	-1,073	12,653	253	311	375	1,645	4,244	5,825
1981	13,301	-1,036	12,265	245	372	359	1,594	4,341	5,354
1982	12,988	-616	12,372	247	293	369	1,608	4,438	5,417
1983	12,103	-748	11,355	227	293	340	1,476	4,537	4,482
1984	14,167	-1,125	13,042	261	292	332	1,695	4,637	5,825
1985	14,057	-1,586	12,471	249	289	360	1,621	4,738	5,214

Source: The figures for production, net imports, feed, waste, and food manufactured uses are from Indonesia, Biro Pusat Statistik. Neraca Bahan Makanan Indonesia, 1969 to 1985 (Jakarta: Biro Pusat Statistik 1969 to 1985). The figures for industry and direct consumption use are from Indonesia, Directorate General for Food Crops, "Supply and Demand for Food Crops in Indonesia," DGFC.Jakarta, January 1988.

Note: Tapioca consumption is defined as the total available for consumption minus direct cassava consumption.

Utilization of cassava for nonfood industrial use was estimated to be 3 percent of net production availability, based on utilization estimates derived in the Balance Sheet Handbook of the Central Bureau of Statistics.[12] Food industrial use of cassava was included in the tapioca product for consumption. Figures for human consumption of cassava as starch from 1969 to 1985 were derived from SUSENAS data for 1976, 1980, 1981, and 1984.[13]

The percentage of waste was relatively high, 9 percent in the first half of the 1970s and 12 percent in the first half of the 1980s. The perishability of cassava is the main factor causing this.

CONSUMPTION

Table 5 shows average consumption of all cassava products. In 1984 consumption was estimated to be 19.19 kilograms per capita per year. This was lower than in 1976 or in 1980. The data also show that consumption in rural areas was higher than in urban areas. Rural consumption per capita has fallen, but urban consumption has been almost unchanged.

Survey data give figures for the per capita consumption of cassava that are only about a third of consumption shown in the food balance sheet data presented in Table 4. This might be a result of underreporting of consumption. Also, the survey data only recorded direct consumption at home, whereas out-of-home consumption was excluded. Perhaps actual consumption lay between those figures.

Fresh cassava consumption in Indonesia in 1980 was more than three times higher in rural areas than in urban areas (Table 6). In urban areas small amounts of dried cassava and cassava flour were consumed; larger amounts were consumed in rural areas. For example, in 1980 consumption of dried cassava in urban areas was 0.10 kilogram per capita, while in rural areas the consumption was 4 kilograms per capita. In the same year, cassava flour consumption was 0.10 kilogram per capita in rural areas and 0.57 kilogram per capita in urban areas.

Table 7 indicates that in all regions, cassava consumption per capita fell as income rose, and the decline was much faster in rural areas than in urban.

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[12] Indonesia. Biro Pusat Statistik. Balance Sheet Handbook (Jakarta: Biro Pusat Statistik, 1985).

[13] Indonesia, Directorate General for Food Crops (DGFC), "Supply and Demand for Food Crops in Indonesia," DGFC, Jakarta, 1988.

Table 5--Average per capita consumption for all cassava products in Indonesia, 1976, 1980, and 1984

Region	1976	1980	1984
	(kilograms of fresh root equivalent)		
Rural	28.10	25.13	22.74
Urban	8.19	6.94	7.82
Rural and urban	24.46	21.07	19.19

Source: Indonesia, Biro Pusat Statistik, "Pengeluaran untuk Komsumsi Rumah Tangga Indonesia," Untuk 1976, 1980, dan 1984. Biro Pusat Statistik, Jakarta, 1980, 1984, dan 1986.

Table 6--Average per capita consumption of cassava products by product, according to survey data, 1976 and 1980

	1976				1980			
Region	Fresh Cassava	Gaplek	Starch	Total	Fresh Cassava	Gaplek	Starch	Total
	(kilograms/capita/year)							
Java								
Rural	13.88	8.99	1.19	24.06	21.66	4.37	1.16	27.19
Urban	5.20	0.10	0.16	5.46	6.78	0.15	0.10	7.03
Total	13.88	8.99	1.19	24.06	23.42	3.38	0.52	27.32
Off Java								
Rural	24.7	2.75	0.16	27.61	19.65	3.38	0.42	23.45
Urban	12.69	0.10	0.05	12.84	6.46	0.26	0.26	6.98
Total	22.46	2.29	0.17	24.92	17.26	2.86	0.36	20.48
Indonesia								
Rural	18.98	8.60	0.94	28.52	20.49	4.00	0.57	25.06
Urban	7.90	0.10	0.16	8.16	6.65	0.10	0.10	6.85
Total	16.95	6.60	0.60	24.35	17.37	3.17	0.10	20.64

Sources: Indonesia, Biro Pusat Statistik, Survey Social Ekonomi Nasional 1976 dan 1980 (Jakarta: Biro Pusat Statistik, 1976 and 1980).

Table 7--Annual per capita cassava consumption by expenditure class, 1981

Expenditure Class	Java			Off-Java			Indonesia		
	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
	(kilograms of fresh roots/capita/year)								
Low	25.43	5.21	22.50	21.81	8.67	19.90	23.69	6.87	21.25
Middle	17.84	5.05	13.44	15.79	5.13	12.48	16.52	5.10	12.83
High	13.72	3.26	6.80	14.08	4.42	8.76	13.99	3.99	8.12
Total	21.54	4.30	15.91	17.57	5.20	13.39	19.21	4.84	14.42

Sources: Indonesia, Biro Pusat Statistik, Survey Social Ekonomi Nasional 1980 (Jakarta: Biro Pusat Statistik, 1981).

Notes: Low expenditures are less than Rp 8,000; middle are between Rp 8,000 to Rp 15,000; and high are above Rp 15,000 per month.

PROCESSED CASSAVA PRODUCTS

Nelson has studied the gaplek and starch economies of Java in detail.[14] The following discussion of processed cassava products is based on his studies.

Gaplek making has been known to farmers for years. Most of the gaplek produced in Indonesia is consumed as food. Between 50 and 90 percent of the gaplek made in Java and 20 to 40 percent of that made in Lampung is used as food. Nelson estimates that in 1979 about 25 percent of the cassava production in Java was used in the starch industry. Proportionally, West Java allocated the largest amount--about 60 percent--of fresh roots to starch production. East Java allocated only 7 percent, and Central Java, only 23 percent.

In Java starch was produced mainly by households and small-scale industries. In the 1970s, the starch industry in Lampung grew dramatically. Large-scale factories were built in the province, and the share of cassava processed into starch increased from 20 percent in 1974 to 70 percent in 1979. For Indonesia as a whole it is estimated that in 1974 as much as 29 percent of cassava was processed

[14]Nelson, "Gaplek."

into cassava starch, and in 1979 the amount was increased to 35 percent. Furthermore it is estimated that around 37 percent of the cassava produced was processed into cassava starch in 1985.[15]

Almost all cassava starch produced in the 1970s was consumed domestically. Nelson estimated that in 1979, 65 percent of the starch available went to chip (krupuk) factories, 15 percent was used as raw material in cookies and snack industries, 10 percent went to textile manufactures, and 3 percent was used in glucose production. The remaining 7 percent went into home consumption and exports.

CHANGES IN TRADE

Before Indonesia's independence, the country was the largest exporter of cassava products. The largest volume of gaplek exports was 341,000 tons in 1928, and that of starch was 223,000 tons in 1937 (see Table 8). During the 1950s and 1960s gaplek exports fluctuated greatly and starch exports became almost negligible.[16]

Except in 1973, from 1970 onward Indonesia exports of gaplek ranged between 149,000 tons and 710,000 tons. In 1973 the government banned gaplek exports, so that the volume of exports fell to 75,000 tons.

During the 1970s Indonesia exported starch in small amounts. The largest volume was about 7,500 tons in 1974. But because of a shortfall in domestic production, Indonesia imported 64,000 tons of starch in 1976.[17] Then, because of the rapid increase in domestic demand, Indonesia became an importer of starch in the 1980s, importing 54,000 tons in 1982 and 64,000 tons in 1983.[18]

Most gaplek exports--97 percent in 1982-84--went to EC countries, the largest amount to the Federal Republic of Germany (Table 9). During 1982-84, 62 percent of the gaplek exported came from Java, and 34 percent originated in Lampung province (Table 10).

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[15]Indonesia, Directorate General for Food Crops, "Supply and Demand."

[16]Nelson, "Gaplek."

[17]Ibid.

[18]Soenarjo, "Pengembangan Ubikayu."

Table 8--Annual exports of gaplek and cassava starch, 1925-40 and 1950-84

Year	Gaplek	Starch	Year	Gaplek	Starch
	(1,000 metric tons)			(1,000 metric tons)	
1925	56	108	1959	145	1
1926	55	101	1960	102	3
1927	123	123	1961	80	...
1928	341	164	1962	6	3
1929	127	143	1963	94	7
1930	44	91	1964	n.a.	...
1931	73	120	1965	156	1
1932	122	104	1966	176	...
1933	48	124	1967	141	1
1934	32	113	1968	160	1
1935	41	116	1969	286	2
1936	108	177	1970	332	1.0
1937	194	223	1971	458	1.3
1938	106	157	1972	342	1.1
1939	65	221	1973	75	1.3
1940	44	194	1974	394	7.5
			1975	303	0.1
1950	71	18	1976	149	5.8
1951	76	24	1977	183	0.0
1952	...	...	1978	308	0.0
1953	21	11	1979	710	1.0
1954	141	3	1980	386	...
1955	174	8	1981	156	...
1956	17	1	1982	211	...
1957	43	...	1983	256	...
1958	21	1	1984	385	...

Sources: The figures for 1925-80 are from G. C. Nelson, "Gaplek," in Walter P. Falcon, William O. Jones, and Scott R. Pearson, Cassava Economy of Java (Stanford, Cal.: Stanford University Press, 1985). The data for 1981-84 are from Indonesia, Biro Pusat Statistik, Yearly Exports, 1981-84 (Jakarta: Biro Pusat Statistik, 1982, 1983, 1984, and 1984).

Table 9--Exports of gaplek by destination, 1982-84

Country	1982	1983	1984
	(1,000 metric tons of gaplek)		
Federal Republic of Germany	138.04	231.00	330.01
Netherlands	27.92	14.81	26.23
France	24.45	1.00	16.90
Belgium and Luxembourg	6.40	6.64	0.60
Greece	2.31	...	...
Others	12.22	3.50	12.15
Total	711.33	256.05	385.35

Source: R. Soenarjo, "Pengembangan Ubikayu dalam Rangka Menunjang Kebijaksanaan Nasional Komoditi Pertanian untuk Meningkatkan Penerimaan dan Penghematan Devisa," paper presented at the workshop on National Policies in Agricultural Commodities, Indonesian Agronomists Association, Jakarta, 1986.

Table 10--Exports of gaplek by port of origin, 1982-84

Port	Annual Average Volume	Percentage
	(1,000 metric tons of gaplek)	
Panjang, Lampung	97.75	34.4
Java ports	177.55	62.4
Others	9.24	3.2
Total	284.54	100.0

Source: Data from Indonesia, Biro Pusat Statistik, as cited in R. Soenarjo "Pengembangan Ubikayu dalam Rangka Menunjang Kebijaksanaan Nasional Komoditi Pertanian untuk Meningkatkan Penerimaan dan Penghematan Devisa," paper presented at the workshop on National Policies in Agricultural Commodities, Indonesian Agronomists Association, Jakarta, 1986.

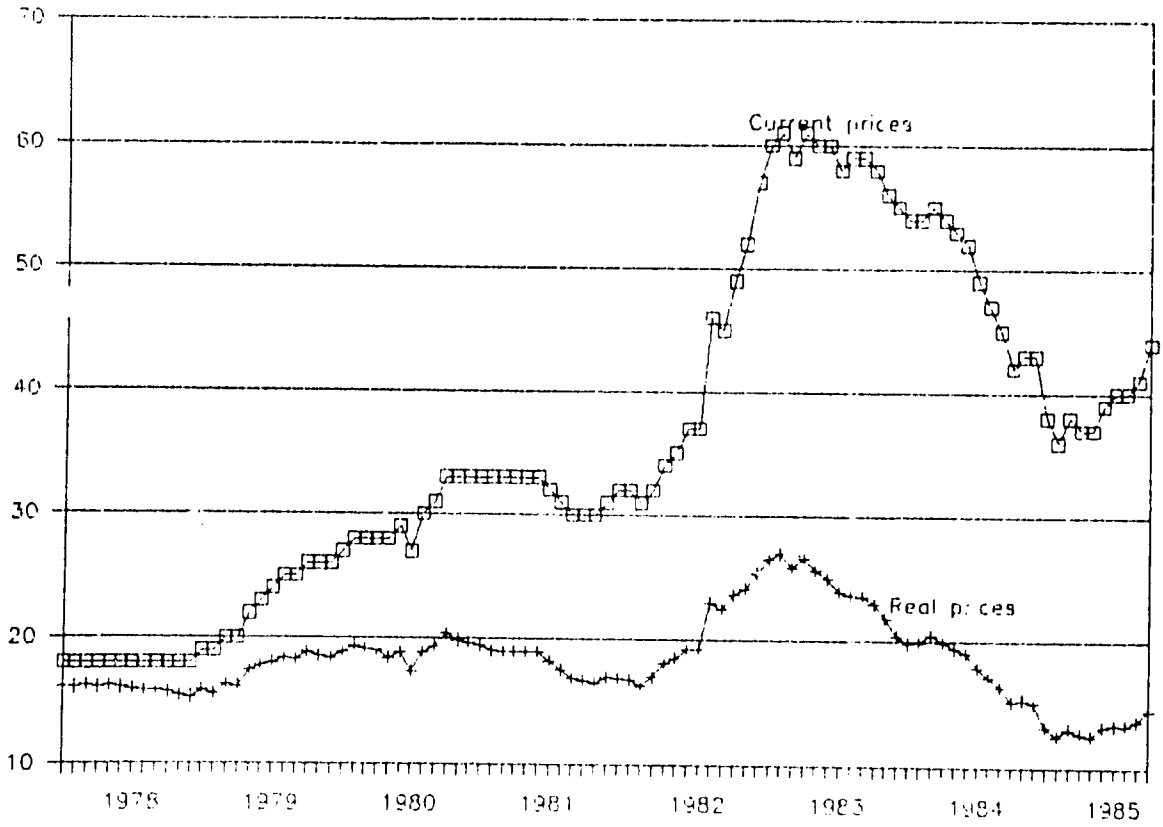
PRICES

Real prices of cassava remained nearly constant for 17 years. However, the trend of real prices declined after 1984 (see Figures 8 and 9).

The price of rice is affected by government intervention in rice price policy and trade. Until 1983, the real price of rice was nearly constant and so was the price of cassava as a substitute for rice. And before 1984 Indonesia was a deficit country for rice. After reaching self-sufficiency in rice in 1984 and achieving a large surplus in 1985, the domestic price of rice tended to fall (see Figure 10).

Figure 8--Current and real prices of cassava in East Java, 1978-85

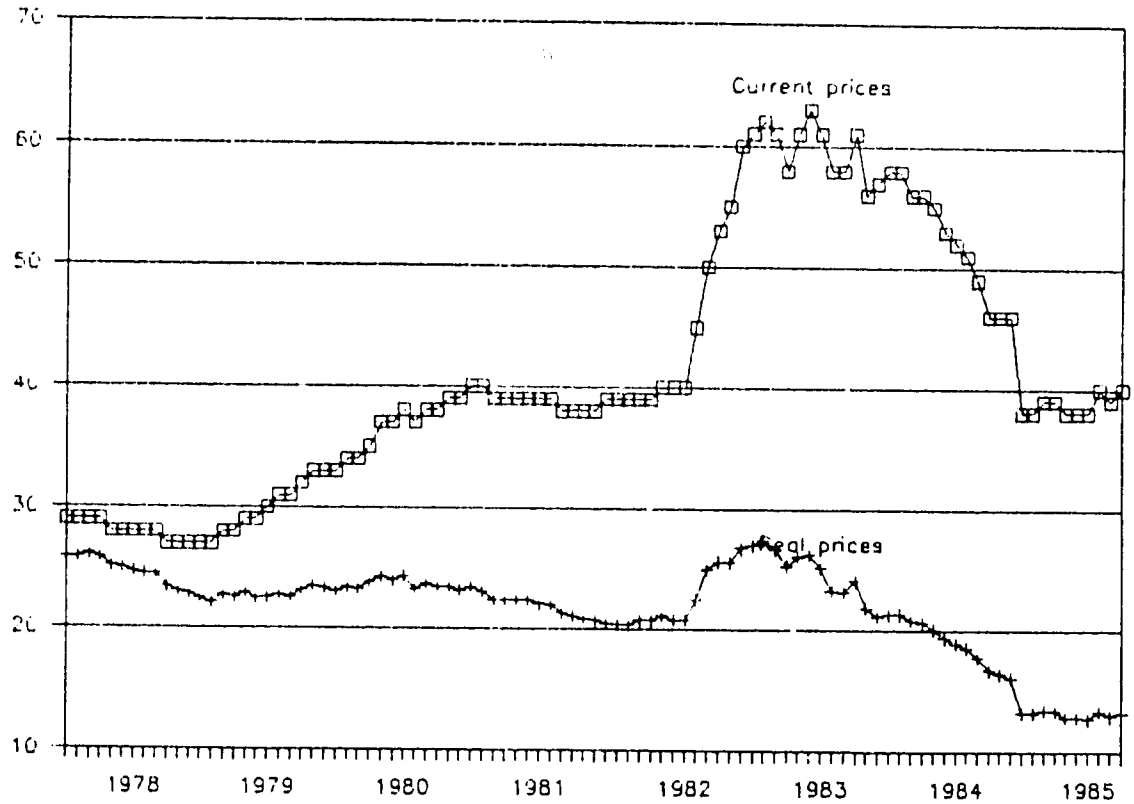
(Rp/kilogram)



Source: Data collected by the Centre for Agro Economic Research, Bogor, Indonesia, 1978-86.

Figure 9--Current and real prices of cassava in West Java, 1978-85

(Rp/kilogram)



Source: Data collected by the Centre for Agro Economic Research, Bogor, Indonesia, 1978-86.

Price comparisons shown by Dixon suggest two advantages of cassava over rice and maize.[19] First, cassava is a source of inexpensive calories. Second, the seasonal price changes of fresh cassava and gaplek are insignificant compared to those of maize (from 95 to 105 percent) and rice (from 88 to 112 percent).

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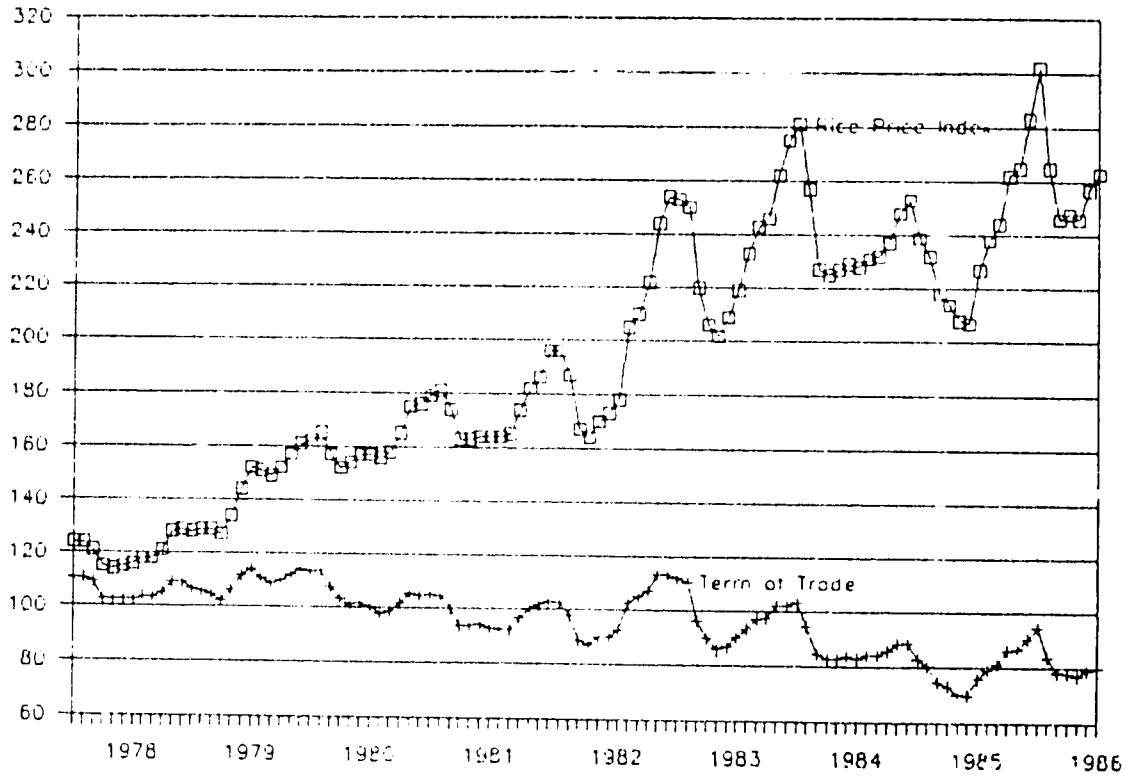
[19]Dixon, "Consumption."

Figure 10--Rice price index and the terms of trade for rice in West Java, 1978-86



Source: Data collected by the Centre for Agro Economic Research, Bogor, Indonesia, 1978-86.

CONCLUSION

The rate of growth in cassava production in the last 15 years (1969-85) has been very slow; on the average the rate was 1.6 percent a year. During that period the yield grew 2.50 percent annually, whereas the area declined by 0.81 percent a year. On a regional basis, the area planted with cassava fell in Java and grew only modestly in the outer islands. However, 68.7 percent of cassava production came from Java. The decline in the area planted with cassava on Java followed an increase in the area planted with rice and maize. Technological progress in rice and maize has improved production of those crops 3.9 percent and 4.1 percent annually during

the 1969-85 period. Therefore the substitution of cassava for production of other food crops was due to more favorable government research, price, marketing, and trade policies for rice and maize. With the current technology and economic environment, cassava might not be able to compete in production with other food crops, and in most regions, cassava grows on less favorable land.

The major use of cassava will continue to be for food, especially in rural areas. The amount going to industrial uses and feed mills is increasing, but it is still small, less than 10 percent of total production.

Food balance sheets and food consumption surveys were used to make estimates of cassava use. But different data sets have different definitions; therefore estimates of consumption based on them will not be the same. Per capita consumption of cassava based on food consumption surveys was only a third of the food balance sheet estimates. The difference may be due to underreporting of cassava consumption in the survey data and to the lack of reporting of consumption outside the home. Perhaps actual consumption is between the survey and balance sheet estimates.

Data on losses or waste should also be treated carefully. Included in the waste data are roots left in the soil, losses in the field after harvests, and cassava peeling. Cassava peels are often used to feed livestock in the rural areas; therefore actual waste may be lower than the food balance sheet data indicate. A similar problem for industrial uses of cassava is likely to result in underestimates in the food balance sheet data. Other alternative sources for the data will be from surveys of cassava starch factories. In Indonesia there are both traditional cassava starch factories and large factories. In the near future, the number and capacity of modern cassava starch factories will increase, as the government has attempted to integrate opening new land for transmigration area with the development of infrastructure and facilities for agricultural processing. Improvement of these infrastructures will reduce losses, improve the quality of cassava products, and increase cassava utilization for manufacture and feed uses.

Increases in income, mobility, and urbanization will reduce the direct consumption of cassava as food. Since cassava in general is considered to be a less preferred food than rice or maize, increases in the production of these commodities and a declining trend in their real prices will further reduce consumption of cassava as food. Income elasticities should be negative for middle- and high-income groups, and positive for the low-income group in the rural areas. Therefore, cassava will continue to be important in the diet, especially as a way of increasing food security.

4. EXISTING AND POTENTIAL YIELDS OF CASSAVA

The yield potential of cassava production in Indonesia is assessed in this chapter. The first part analyzes actual yields from farmers' fields, trends of area planted, and production during the last two decades. Some factors affecting yields are also highlighted. The second part of the section describes yields in on-farm trials and in research stations. Expected potential yields in farmers' fields in 1990 and 2000 are also discussed.

EXISTING YIELDS FROM FARMERS' FIELDS

Average cassava yields per hectare in Indonesia are less than 10 tons (see Figure 11). Figure 11 also shows that yields in all producing regions improved between 1969-74 and 1981-85. Data from 1982 show that yields were very low compared with yields for other cassava producers in Asia, such as Thailand (15.7 tons), Malaysia (22.0 tons), and India (19.0 tons).

Factors causing low yields include the cropping pattern, low fertility of land, planting practices, the variety grown, marketing problems, and lack of capital available to the farmers for adopting a package of improved technology. The increases in cassava production came about through increases in the average yield per hectare (at a rate of 2.5 percent per year), rather than through increases in the area cultivated (Table 11).

Yield has increased during the last two decades, even without a direct government program for cassava.[20] The government made only limited efforts to boost cassava production. A cassava intensification program has been implemented, but it is limited almost entirely to Java. The total cassava area under intensification programs

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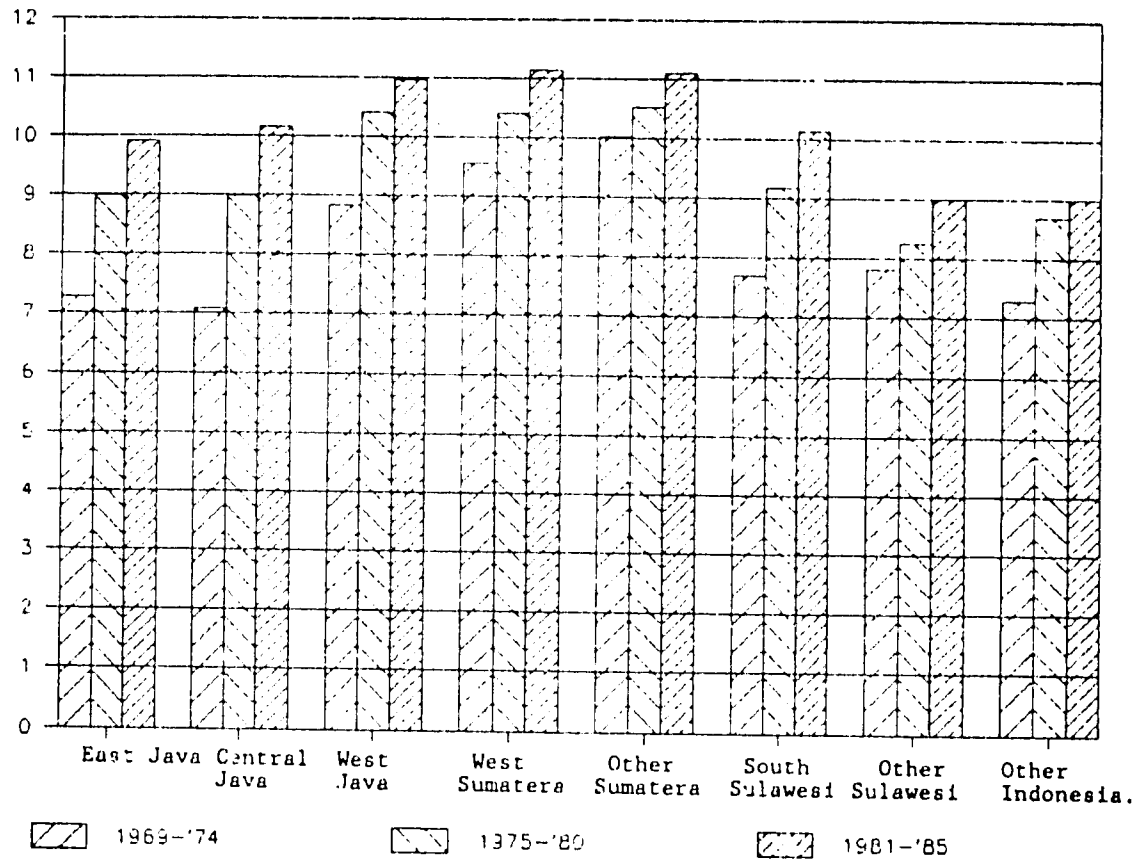
[20] B. Guritno and S. M. Sitompul, "Cassava in the Agricultural Economy of Indonesia," in Economic and Social Commission for Asia and the Pacific (ESCAP)/Coarse Grain, Pulse, Root, and Tuber Centre (CGPRT Centre), Cassava in Asia, Its Potential and Research Development Needs (Cali, Colombia: CIAT ESCAP/CGPRT Centre, 1984).

Figure 11--Average yield of cassava by province, 1969-74, 1975-80, and 1981-85



Source: Indonesia, Biro Pusat Statistik, Bulletin Ringkas BPS, monthly issues, 1969 to 1986.

reached only 36 percent in 1985. About 97 percent of the program area was in Java as a whole, and more than half was in East Java.[21]

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[21]Mark Rosegrant et al., "Price and Investment Policies in the Indonesia Food Crops Sector," International Food Policy Research Institute, Washington, D.C., and the Center for Agro-Economic Research, Bogor, Indonesia, August 1987.

Table 11--Annual growth of cassava area, yield, and production, 1969-85

Period	Area		Production		Yield	
	Average	Growth Rate	Average	Growth Rate	Average	Growth Rate
	(1,000 hectares/ year)	(percent/ year)	(1,000 metric tons/year)	(percent/ year)	(metric tons/ hectare/ year)	(percent/ year)
1969-74	1,446	...	11,114	...	7.68	...
1975-80	1,396	...	12,934	...	9.28	...
1981-85	1,323	...	13,380	...	10.11	...
1969-77	...	-0.59	...	2.60	...	3.21
1977-85	...	-0.92	...	0.88	...	1.82
1969-85	...	-0.64	...	1.79	...	2.45

Source: Computed in Centre for Agro Economic Research, Bogor, based on data in Indonesia, Biro Pusat Statistik, Statistical Yearbook 1976, 1980, 1982, 1986 (Jakarta: Biro Pusat Statistik, 1976, 1981, 1983, 1987); Indonesia, Sekretariat Pengendali Bimbingan Masal, unpublished data, 1986.

The cassava production system in Java differs from the systems in the outer islands. Most Javanese farmers grow cassava intercropped with other crops such as maize, upland rice, and legumes. In this way crop intensity is high. However, land productivity is still low with an average yield for cassava of only 9.8 tons per hectare. Monoculture plantings are most common near urban markets. In the outer islands most cassava is planted in pure stands, where farm holdings are larger and less intensively cultivated.

With regard to the use of irrigation in growing cassava in Asia, Lynam described cassava as essentially an upland crop.[22] Only rarely, as when water is a limiting factor during the second cropping season, is cassava planted on sawah soils (wetland ricefields) in irrigated

[22] J. K. Lynam, "A Comparative Analysis of Cassava Production and Utilization in Tropical Asia," in ESCAP/CGPRT Centre, Cassava in Asia, Its Potential and Research Development Needs.

areas in Java. In Asia, only in Tamil Nadu, India, is cassava reported to be grown mostly under irrigated conditions.[23]

According to Roche, in Indonesia,

> Cassava is less important in the irrigated and rain-fed sawah areas of Java. Where water supplies are adequate throughout the year, sawah soils are almost always planted continuously to rice or to a multiyear rotation of rice and sugarcane. However, on sawah that receives sufficient water for only one flooded paddy crop a year, lesser staple crops (palawija) with lower water requirements are planted following the rice harvest to grow on late-season rains, residual soil moisture, and irrigation water.[24]

Chemical fertilizer use is low, even though application levels on other crops, particularly rice, are high (Table 12). Farmers compensate for this to a significant extent by applying manures.

Table 12--Fertilizer use for food crops, 1983

Crop	Chemicals			Manure
	Urea	TSP/DAP	Others	
	(kilograms/hectare)			(Rp/hectare)
Wetland paddy	225	85	5.0	720
Dryland paddy	39	19	1.0	942
Maize	98	13	0.6	2,309
Cassava	34	5	0.1	2,672
Sweet potatoes	55	26	17.0	1,085
Ground nuts	42	33	0.7	2,945
Soybeans	39	29	2.0	972

Source: Indonesia, Biro Pusat Statistik, Struktur Ongkos Usahatani Padi dan Palawija 1983 (Jakarta: Biro Pusat Statistik, 1984).

Note: The fertilizer TSP/DAP is triple superphosphate and diammonium phosphate.

[23]S. R. Subramanian, "Cassava in the Agricultural Economy of India," in ESCAP/CGPRT Centre, Cassava in Asia, Its Potential and Research Development Needs.

[24]Roche, "Production System."

Although many fertilizer experiments have shown that yields of cassava respond to fertilizer applications, the fact remains that few farmers use chemical fertilizer in significant quantities.[25]

Fertilizer use is limited to nitrogen (principally urea) and phosphorus (concentrated superphosphate). Current farm practices are in contrast to experimental agronomic trials, which show a high profitability from fertilizer use on cassava.[26] One series of fertilizer tests in Lampung gave cassava yields of 22-33 tons per hectare; the total fertilizer applied ranged from 470 to 550 kilograms of urea, 300 to 370 kilograms of triple superphosphate (TSP), 210 kilograms of potassium chloride (KCL), and 300 to 375 kilograms of lime.[27]

YIELDS IN ON-FARM TRIALS AND IN RESEARCH STATIONS

Data in Table 11 reflect the average yields in farmers' fields. The average here is the average national yield for all of Indonesia, where data were collected from samples drawn from regions with or without a potential for specific crops by the Biro Pusat Statistik. Yields in on-farm trials were 10 tons above the average national yield in farmers' fields and, as expected, were much lower than the yields at research stations (Table 13). The yield potential varies by region (Table 14). The highest potential yield is in Kediri, while the highest yield gap is in Garut.

Muara, Gading, Adira I, and Adira II are among the improved varieties officially released by the BORIF in the last 10 years. Several other varieties such as M-30 and M-31 are now being developed in research stations that have potential yields up to 33-35 tons per hectare. These yields are 30-40 percent higher than yields from Adira I and 50-60 percent higher than yields from local cultivars. They have been included in breeding programs but have not yet been released.

A comparison of fertilizer tests on inferior and optimum soils and climatic conditions done by BORIF is presented in Table 15.

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[25]Lynam, "A Comparative Analysis of Cassava Production."

[26]Guritno and Sitompul, "Cassava in the Agricultural Economy of Indonesia."

[27]J. A. Dixon, "Production and Consumption of Cassava in Indonesia," Bulletin of Indonesian Economic Studies 15 (No. 3, 1979).

Table 13--Yields of cassava on farm trials and in research stations

Variety	Yields in on-farm trials	Yields from research stations
	(metric tons/hectare)	
Improved varieties		
Gading	19.13	21.00
Adira I	18.23	25.00
Adira II	19.28	23.00
Muara	23.60	25.00
Average	20.06	23.50
Local varieties		
Lampung	9.62	...
West Java	10-25	...
East Java		
intercropped	12.22	...
monoculture	22.61	...
On marginal areas in Garut of West and East Java	10-14	...

Source: The yields of improved varieties in on-farm trials are collected from various sources, cited in Centre for Agro Economic Research, "Assessment of Food Demand/Supply Prospects and Related Strategies for Indonesia," Bogor, 1986. The yields obtained on research stations are from the Central Research Institute for Food Crops in Bogor. The yields of local varieties in East Java are for cassava planted on ordinary land in Kabupaten Mojokerto. Lastly, the yield of the other local varieties are from F. C. Roche, "Production System," in Walter P. Falcon, William O. Jones, and Scott R. Pearson, Cassava Economy of Java (Stanford, Cal.: Stanford University Press, 1985).

Note: The yields for local varieties are those obtained on farmers' fields.

Table 14--Current and potential cassava yields in Garut, Gunung Kidul, and Kediri

Category	Garut	Gunung Kidul	Kediri
		(metric tons/hectare)	
Potential average cassava yield	16.0	6.6	17.5
Current average cassava yield	8.1	4.1	14.6
Yield gap[a]	7.9	2.5	2.9
Yield gap as a percentage of the current yield	97.5	61.0	19.9

Source: F.C. Roche, "Production System," in Walter P. Falcon, William O. Jones, and Scott R. Pearson, Cassava Economy of Java (Stanford, Cal.: Stanford University Press, 1985).

[a]The yield gap is the potential yield minus the current yield.

Fertilizer use varied from 60 to 230 kilograms per hectare. The differences in yields achieved using fertilizers in both soil conditions are quite significant. Yields without fertilizer on farmers' fields with inferior soils averaged 7.1 per hectare; with fertilizer they averaged 12 tons per hectare. Yields without fertilizer were 10.6 tons per hectare in on-farm trials and 15.4 tons per hectare at research stations; with fertilizers they were 40 to 50 percent higher, that is, 20.1 tons per hectare and 23.5 tons per hectare. On optimum soils and under optimum climatic conditions, the yields achieved were higher than on inferior soils. Yields in on-farm trials and in research stations were 40 to 50 percent higher with fertilizer than without. It can be concluded that there is ample potential for increasing yield through fertilizer use, especially with optimum soil and climatic conditions.

Local varieties are found to vary from one region to another. They include Mentega (Ambon) and Duru in East Java, which have yields of 19.0 tons per hectare at the research stations, close to the yields of improved varieties. In farmers' fields cassava yield varies from 6.4 to 11.9 tons per hectare. In Lampung, the local variety Balirante varies in yield from 12.0 to 23.5 tons per hectare, with an average of 9.6 tons per hectare.

Table 15--Yield tests on optimum and inferior soils

Type of Test	Low Fertilizer Soils			Optimum Soil and Climatic Conditions		
	Fertilizer Use	Average Yield	Yield Range	Fertilizer Use	Average Yield	Yield Range
	(kilograms/ hectare)	(metric tons/ hectare)		(kilograms/ hectare)	(metric tons/ hectare)	
With fertilizer, without irrigation						
Farmers fields	...	12.0	10.0-14.0	...	15.7	14.3-17.0
On-farm tests	60-230	20.1	18.2-23.6	60-230	30.7	24.8-36.6
Research stations	60-230	23.5	21.0-25.0	60-230	40.5	37.8-43.6
Without fertilizer or irrigation						
Farmers fields	...	7.1	4.1- 8.9	...	8.1	6.8-14.6
On-farm tests	...	10.6	7.6-12.1	...	17.8	14.3-19.8
Research stations	...	15.4	13.3-16.9	...	20.1	12.1-28.8

Source: The data were taken from the files of the Bogor Research Institute for Food Crops in 1986.

Note: Fertilizer use is for applications of nitrogen, P_2O_5 and K_2O.

POTENTIAL YIELDS IN 1990 AND 2000

Based on the recent trends of area and yield of cassava in farmers' fields shown in Table 11, projected yields are found to be about 12.6 tons per hectare in 1990 and 16.9 tons per hectare in 2000. It is expected that in Java the area planted with cassava will continue to decrease and yields will increase at a rate of 3.6 percent annually, while in the outer islands yields will continue to increase at a rate of 1.8 percent annually.[28]

Soenarjo and Noegroho stated that yields can be increased by 22 percent above the present national average (7.5 tons per hectare) through the application of improved cultural practices alone.[29] High-yielding varieties will increase yields by 73 percent, and, when

[28]Guritno and Sitompul, "Cassava in the Agricultural Economy of Indonesia."

[29]R. Soenarjo and J. H. Noegroho, "Improving the Productivity of Cassava in Indonesia," in ESCAP/CGPRT Centre, Cassava in Asia, Its Potential and Research Development Needs.

appropriate plant nutrients are added, yields can be increased up to 247 percent of the present average (26 tons per hectare).

If yields in farmers' fields now vary from 7 to 15 tons per hectare, in on-farm tests they vary from 10 to 20 tons per hectare, and at the research station from 15 to 40 tons per hectare on average, it is possible that, with a favorable environment and government intervention, yields from farmers' fields could reach 20 to 25 tons per hectare in 1990 or 25 to 30 tons per hectare in the year 2000.

Variations in cassava yields between producing regions are due mainly to variability in cropping practices, use of inputs, marketing and trade, and accessibility to processing centers. But the big gap in yields between farms and research experimental stations is due to the poor technological package adopted by the farmers and the unfavorable production environment in which the cassava was planted. Compared with other food crops, the relative price of cassava at the farm level was less profitable to farmers seeking to improve technology.

In the last decade the yield of cassava has increased at an annual rate of 2.5 percent. In the next decade, the yield may improve at an annual rate of 2.0 percent to 3.5 percent. Therefore the most likely yield of cassava at the farm level in 1990 will range between 12 and 15 tons per hectare, and by the year 2000 the yield could range between 17 and 20 tons per hectare.

To be able to improve cassava yields at the farm level, several government interventions need to be implemented. These include intensified extension services to promote the adoption of an improved package of cassava; an intensified cassava farming system to enable farmers to capture scale economies in processing centers and to become more efficient in marketing; the provision of credit to farmers; and improvements in the infrastructure of production centers of cassava.

5. TRENDS IN LIVESTOCK PRODUCTS AND PROJECTIONS OF THE COMMODITY BALANCE TO 1990 AND 2000

According to the 1983 agricultural census, there were 8.9 million beef cattle and 197,000 dairy cattle. Of these, 55 percent of beef cattle and 89 percent of dairy cattle were raised in Java. Chickens had the largest numbers, 142.7 million; followed by goats and sheep, 15.8 million; ducks, 12.4 million; beef cattle; pigs, 4.4 million; and buffalo, 2.4 million.

Almost all livestock and poultry were raised by smallholders.[30] They held all ducks and more than 99 percent of buffalo, beef cattle, and sheep and goats. They also held about 93 percent of pigs and chickens and 91 percent of dairy cattle.

Commercial or semicommercial farms managed only a small number of cattle and buffalo, about 40,000 head, or about 0.5 percent of total population. These enterprises produced only 1 percent of total meat production. So most meat was produced by smallholders. In 1980, it was specified through a President's Decision, that a farmer or an enterprise could not keep more than 5,000 birds. This means that poultry farms should be in the hands of smallholders.

TREND OF LIVESTOCK PRODUCTION

During the first and second five-year development plans (PELITA I [1968-73] and PELITA II [1973-78]), meat production increased at a rate of 4-5 percent annually. However, livestock numbers grew more slowly than meat demand. The population of cattle decreased 0.2 percent per year, while the rate of decrease of the buffalo population was larger than that of cattle, 1.00-4.20 percent per year.

The growth rates improved during PELITA III (1978-83) and PELITA IV (1984-87). The increases in meat production during these periods--9.0 and 8.2 percent per year--were greater than during the 1968-78

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[30]This chapter draws heavily on Faisal Kasryno et al. "Livestock Commodity Prospects and Strategic Issues for the Development of the Commodity," paper presented at the Conference of the Livestock and Feedgrains Study Programme, (Waitomo), New Zealand, June 30-July 2, 1986.

period. Cattle population increased by 1.0 percent per year and buffalo by 1.9 percent per year.[31]

The share of broilers in total meat production was significant. During the period 1974-83 the growth rate of chicken meat production was 16.34 percent per year, about three times larger than the growth rate of total meat production (5.77 percent per year). The share of chicken meat was 25 percent of total meat.

The annual growth rates of egg production during PELITA II, III, and IV were impressive, 13.3 percent, 19.9 percent, and 10.8 percent respectively, due to the increase in the population of birds, which ranged from 24 to 62 percent per year.[32]

During the 1973-87 period, the proportion of layer production to total egg production (including eggs from native chickens) was 39 percent, with a rate of growth around 1.8 times larger than the growth rate of total egg production. So the future development of layer production is highly encouraging.

The annual growth rate of milk production was 14.6 percent during PELITA II, 7.5 percent during PELITA III, and 16.9 percent during PELITA IV. These rates of growth seem large, but are due to the increase of the dairy cattle population and of intensification programs. Besides, the government has a policy of promoting a better relationship between dairy farmers and the milk processing industries.

Indonesia's dependence on the international market to fulfill its domestic demand for milk has recently become large. The volume of milk imports was 80-90 percent of total consumption. During PELITA II the rate of growth of imported milk was 23.26 percent per year; it was 3.77 percent per year during PELITA III. Although the rate of growth of imports declined, the volume of milk imports increased from 308,840 tons per year in PELITA II to 503,860 tons per year in PELITA III.

In the future, the government plans to increase the dairy cattle population by 14.4 percent per year by importation. With this effort it is expected that milk production will increase about 28.3 percent per year.

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[31]Indonesia, Directorate General for Livestock Services, unpublished data, Jakarta, January 1988.

[32]Ibid.

DEMAND TRENDS AND PROSPECTS

During the 15 years from 1968 to 1983 the growth rate of meat consumption was lower than the growth rate of egg and milk consumption. The trend growth rates for consumption ranged from 2 to 5 percent for meat, 12 to 20 percent for eggs, and 2 to 23 percent for milk.

The higher trend seems to be associated with low per capita consumption. Data on consumption during the 1971-81 decade showed that per capita annual consumption of meat was 3.36 kilograms; of milk, 2.77 kilograms; and of eggs, 0.73 kilograms. The difference in the consumption trend will be more significant for less consumed commodities such as meat, 2.98 percent per year; milk, 10.83 percent per year; and eggs, 16.44 percent per year.

More people consumed eggs than meat or milk. In urban areas 61.8 percent of the households reported consuming eggs, with little difference on or off Java. The percentage of people consuming fish was larger than the percentage consuming livestock products (Table 16).

Table 16--Share of households purchasing various food commodities, by region, 1980

Commodity	Java		Off-Java		Indonesia	
	Rural	Urban	Rural	Urban	Rural	Urban
	(percentage of households purchasing commodity)					
Meat and poultry	16.2	41.2	24.7	36.2	20.8	38.5
Eggs	35.4	62.8	40.1	60.9	38.0	61.8
Milk	7.6	34.5	18.2	45.0	13.4	40.0
Fish	81.9	83.2	94.3	96.5	88.8	90.2
Rice	94.8	97.3	98.8	99.0	96.9	98.1

Source: The data are taken from the Survey Ganda Sasaran (Surgasar) of 1980, made by the Biro Pusat Statistik, and cited in S.R. Johnson, William H. Meyers, Helen H. Jensen, Tesfaye Teklu, and Mohammad Wardhani, "Evaluating Food Policy in Indonesia Using Full Demand Systems," Iowa State University, Ames, Iowa, 1986 (mimeographed).

Consumption of livestock products also increases as consumers' income increases. Regardless of income group, the expenditure participation rates of rural households on livestock products consumption were lower than those of urban households. Food expenditures on eggs were larger than those for meat and milk. The reported household expenditures on fish were persistently larger than those on eggs and other livestock products (Table 17).

Table 17--Share of households purchasing various food commodities, by income group, 1980

Commodity	Income Group							
	Under Rp 7,200 per Person per Month		Rp 7,200-11,400 per Person per Month		Rp 11,400-19,000 per Person per Month		Above Rp 19,000 per Person per Month	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
	(percent of households purchasing commodity)							
Meat and poultry	9.9	15.7	24.5	31.6	41.6	50.2	52.2	67.4
Eggs	26.0	38.5	44.8	62.1	56.7	73.1	68.1	78.6
Milk	4.1	14.6	16.7	35.5	28.8	53.0	45.7	66.3
Fish	83.9	84.0	92.5	92.8	96.1	93.5	96.1	89.4
Rice	95.0	98.6	98.8	99.6	99.7	98.9	99.6	93.6

Source: The data are taken from the Survey Ganda Sasaran (Surgasar) of 1980, made by the Biro Pusat Statistik, and cited in S.R. Johnson, William H. Meyers, Helen H. Jensen, Tesfaye Teklu, and Mohammad Wardhani, "Evaluating Food Policy in Indonesia Using Full Demand Systems." Iowa Stat University, Ames, Iowa, 1986 (mimeographed).

An increase of household income both in urban and rural areas would be followed by an increase in the budget shares for meat, milk, eggs, or fish (Table 18). The budget shares of rice and other staple foods would decrease with an increase of household income. As the data in Table 19 indicate, over time the demand for livestock products

increases as income and population increase. This means that an increase of income will be followed by an improvement of nutrient intake, and more nonstaple food commodities will be bought. In the future, as household incomes improve, the ability to purchase livestock products will also increase.

Table 18--Share of various food commodities in household food expenditures by income group, 1980

Commodity	Income Group							
	Under Rp 7,200 per Person per Month		Rp 7,200-11,400 per Person per Month		Rp 11,400-19,000 per Person per Month		Above Rp 19,000 per Person per Month	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
	(percent)							
Meat and poultry	1.7	1.8	3.9	3.8	7.5	7.2	11.2	11.0
Eggs	1.0	1.7	1.7	2.6	2.1	3.5	3.7	3.9
Milk	0.3	1.2	1.1	2.1	1.5	3.3	2.1	4.4
Fish	8.3	7.8	11.4	11.3	12.7	11.6	12.0	10.8
Rice	42.8	41.2	34.8	31.7	27.6	23.7	19.2	16.2
Share of food expenditure in total household expenditures	79.0	74.0	76.8	70.2	72.6	63.8	62.8	53.6

Source: The data are taken from the Survey Ganda Sasaran (Surgasar) of 1980, made by the Biro Pusat Statistik, and cited in S.R. Johnson, William H. Meyers, Helen H. Jensen, Tesfaye Teklu, and Mohammad Wardhani, "Evaluating Food Policy in Indonesia Using Full Demand Systems," Iowa State University, Ames, Iowa, 1986 (mimeographed).

Table 19--Average food consumption in urban Java, urban Off-Java, and rural Indonesia, 1976, 1978, 1980

Food	Urban Java			Urban Off-Java			Rural Indonesia		
	1976	1978	1980	1976	1978	1980	1976	1978	1980
	(kilograms/capita/year)								
Rice	105.8	104.0	102.6	120.5	119.6	116.5	106.7	115.4	111.5
Maize	1.9	2.1	2.7	2.5	3.6	2.7	16.7	17.6	21.3
Wheat flour	1.0	1.0	1.1	3.1	2.6	2.1	0.8	1.0	0.9
Cassava	5.5	7.8	7.0	12.8	10.4	7.0	28.0	32.8	25.1
Sweet potatoes	3.4	2.6	3.6	4.3	2.6	2.5	10.3	6.2	6.8
Other tubers and roots	0.3	1.6	2.2	0.7	3.6	3.6	1.6	3.1	3.6
All fish	7.2	6.8	7.2	22.2	25.5	23.2	10.0	11.4	11.8
All meats	4.1	4.2	3.6	4.1	3.6	3.5	1.9	2.1	2.1
Eggs	2.7	3.5	4.1	2.5	2.6	3.6	1.0	1.3	1.9
Liquid milk	1.9	0.9	0.9	1.0	1.6	0.3	0.3	0.1	0.1
Powdered milk	0.5	2.6	2.0	0.5	2.6	2.8	0.1	0.5	0.6
Fats and oils	0.9	5.7	5.6	5.7	5.7	6.2	3.2	3.1	4.3

Source: Achmad Suryana and Yuni Marisa. "Patterns of Food Consumption and Expenditures in Jakarta Other, Urban and Rural Indonesia," Bogor, 1987.

Analysis of cross-section data for households shows that in 1980 the income elasticity of demand for livestock products was elastic. The income elasticity for rural areas was larger than for urban areas. The income elasticity of demand for livestock products of high-income groups (1.65) was higher than that of low-income groups (1.36). There was little difference in income elasticities between Java and outer-Java, either for rural or for urban areas (Table 20).

PRODUCTION OF COMPOUND AND MIXED FEEDS

In the last 10 years the annual rate of growth of demand for livestock feed mix has been about 7 percent. About 65 percent of the feed mix produced was for poultry. Feeding practices for commercial poultry are similar, with a feed component composed of 35-40 percent maize, as much as 45 percent rice bran, and other mixes including soybean meal, fish meal, bone meal, coconut meal, and cassava chips.

Table 20--Income elasticities of livestock products, 1980

Description	Rural	Urban
All households	1.68	1.53
Low-income households	...	1.36
High-income households	...	1.65
Java	1.66	1.54
Outer Java	1.63	1.57

Source: The data are taken from the Survey Ganda Sasaran (Surgasar) of 1980, made by the Biro Pusat Statistik, and cited in S.R. Johnson, William H. Meyers, Helen H. Jensen, Tesfaye Teklu, and Mohammad Wardhani, "Evaluating Food Policy in Indonesia Using Full Demand Systems" Iowa State University, Ames, Iowa, 1986 (mimeographed).

Wheat pollards (a wheat milling by-product) and sorghum are rarely used in feed mixes in Indonesia. According to Mink, wheat pollards have about 50 percent of the energy value of maize.[33] But Indonesia has only a limited production capacity for sorghum. Mink then concluded that with the current range of domestic prices (see Table 21), maize has advantages and will remain the most important component for feed mixes in Indonesia.

Based on information from the Directorate General of Livestock (DGLS), there were 71 registered feed mills in 1986 (excluding private farms that mixed feed for their own use). Of that number, 33 mills operated in West Java. None of the feedmills operated at full capacity. Of the total capacity of 304.3 tons per month, they produced only 126.1 tons per month, about 41 percent of their capacity (Table 22).

[33]S. D. Mink, "Corn in the Livestock Economy," The Corn Economy of Indonesia, ed. Paul A. Dorosh et al. (Stanford, Cal.:Food Research Institute, Stanford University, 1984).

Table 21--Prices of commercially available energy and protein sources for livestock feed, 1984

Product	Cost
	(Rp/kilogram)
Energy	
Rice bran	80
Rice brokens	155 - 175
Sorghum	100 - 150
Wheat pollards	95
Cassava chips	70
Molasses	50 - 70
Corn (maize)	115 - 150
Protein	
Soybean meal	335
Palm kernel meal	100
Fish meal	550 - 600
Copra meal	90
Kapok meal	89
Peanut meal	300
Peanut cake	400
Leucaena leaf meal	100
Rapeseed meal	240

Source: Data given by feed industry representatives, cited in S. D. Mink, "Corn in the Livestock Economy," in Paul A. Dorosh, Walter P. Falcon, Stephen D. Mink, Scott R. Pearson, and Douglas H. Perry. The Corn Economy of Indonesia (Stanford, Cal.: Food Research Institute, Stanford University, 1984).

Notes: Price ranges indicate typical seasonal movements. Soybean meal is 41 percent protein; fish meal is 55 percent protein; peanut cake is 40 percent protein; and leucana leaf meal is 15-20 percent protein.

Table 22--Production capacity and output of registered feedmills

Province	Number of Mills	Production		Efficiency[a]
		Capacity	Actual	
		(metric tons/month)		(percent)
DKI Jakarta	3	18,450	13,850	75
West Java	33	120,300	46,518	39
Central Java	8	9,150	4,538	49
D.I. Yogyakarta	2	750	190	25
East Java	10	126,450	48,760	39
North Sumatera	7	16,960	8,580	51
West Sumatera	3	1,020	420	42
Lampung	4	10,800	3,140	20
Riau	1	300	30	10
Indonesia	71	304,280	126,148	42

Source: Indonesia, Directorate General of Livestock, unpublished data, Jakarta, 1986.

[a]Efficiency is capacity divided by actual production.

In terms of capacity, East Java had the largest. This is because the largest feed mills were operated in this province. The capacity of West Java was also high because this province is the largest producer of chicken meat and eggs.

All these feed mills produced mixed feed mainly for chickens because other animals were fed traditionally with no mixed feed in their ration.

MIXED FEED PRODUCTION TRENDS

The development of the feed industry was tied up with the development of the poultry sector. The feed industry became a

profitable business when modern poultry raising was introduced in the late 1960s. In the early 1970s the industry expanded very rapidly at an annual rate of about 20 percent.

Estimates of the growth rate of feed production in the 1980s and projections to the 1990s by various sources range from 4 to 8 percent. Table 23 shows the projection of mixed feed produced by the industry as reported by the Ministry of Agriculture in PELITA IV.

There are 12 components of feed commonly used in Indonesia. But the mixed feed produced by these industries consists of a limited number of components: maize, soybeans, coconut meal, rice bran, fish meal, bone meal, and vitamins (Table 24). A least-cost ration is a method of preparing mixed feed while minimizing total costs and meeting certain industrial requirements. A linear programming model is applied to get the optimal solution. This model is applied to feed formulae for layers, broilers, and swine. Sources included in this analysis are feedgrains and cassava.

Table 23--Mixed feed production, 1983-86, and projections to 1990, 1995, and 2000

Year	Production	Share of Total Capacity
	(1,000 metric tons)	(percent)
1983	1,323	
1984	1,400	49
1985	1,467	59
1986	1,750	73
1990 projected	2,251	80
1995 projected	3,701	91
2000 projected	3,900	86

Source: Computed by the Centre for Agro Economic Research, Bogor. The projection to 1990 was made by the Ministry of Agriculture. The projections to 1995 and 2000 were made by the Centre for Agro Economic Research.

Table 24--Nutritional composition of feed components

Feed Component	Crude Protein	Ether Extract	Crude Fiber	Crude Ash	Energy	Methionin	Premix
Maize	0.070	0.035	0.029	0.89	3,168	0.0009	0.0018
Rice bran	0.110	0.120	0.040	0.89	3,000	0.0018	0.0009
Soybean meal	0.420	0.035	0.065	0.89	2,990	0.0060	0.0270
Coconut meal	0.220	0.060	0.120	0.93	2,500	0.0053	0.0054
Fish meal	0.650	0.055	0.010	0.93	2,500	0.0200	0.0590
Gaplek	0.024	0.002	0.010	0.87	3,317	0.0010	0.0350
Bone meal	0.500	0.085	0.028	0.95	2,434	0.0050	0.0017
Tallow	...	...	...	...	7,900	...	...
Methionine	...	...	...	...	...	0.50	...
Premix	...	...	...	...	...	...	0.02

Source: Indonesia, Directorate of Program Development, Directorate General of Animal Husbandry, Statistik Peternakan (Jakarta: Directorate General of Animal Husbandry, 1986).

These models set upper limits for nutrient content for feed mixing, based on animal husbandry research and government recommendations (see Table 25). The results indicate that gaplek should be used for less than 10 percent of the ration for poultry and less than 50 percent of the ration for swine. Actually, gaplek is not usually used in these rations. Even though the potential use of cassava for swine is encouraging, the demand for swine in Indonesia is limited.

Another set of constraints based on government recommendations can be applied to this model. These constraints and results are presented in Table 26.

Table 25--Boundaries for each feed formula

Type of Animal	Maize	Rice Bran	Soybean Meal	Fish Meal	Gaplek	Tallow
Poultry						
0-6 weeks	200	50	100	100	100	50
Layer	300	50	100	80	100	50
Broiler						
0-4 weeks	200	100	100	100	100	100
More than 4 weeks	300	100	100	80	100	100
Swine	500	100	100	80	500	30

Source: Unpublished data from the Research Institute of Animal Production, Bogor, 1986.

Table 26--Nutritional requirement constraints

Type of Nutrition	Layer		Broiler		Swine
	0-6 Weeks	More than 6 Weeks	0-4 Weeks	4-8 Weeks	
			(Kilograms)		
Total quantity consumed	1,000	1,000	1,000	1,000	1,000
Crude protein	190	160	210	190	135
Fat	25	25	25	25	30
Crude fiber	55	60	40	45	60
Calcium	11	11	11	11	7
Phosphorus	8	9	9	9	6
Energy	2.800.000.00	2.700.000.00	3.600.000.00	3.000.000.00	2.900.000.00

Source: Indonesia, Directorate of Program Development, Directorate General of Animal Husbandry, Statistik Peternakan (Jakarta: Directorate General of Animal Husbandry, 1986).

Table 27 shows the result of the analyses of the least-cost combinations of feed mix. For poultry, the feed mix uses 100 kilograms of gaplek, or 10 percent of the total feed mix, but in the swine ration, only about 46 percent of the total limit of cassava is used. Actually, the price of gaplek was about half that of maize (see Table 16) and lower than other cereal prices, but the nutrients in gaplek were very poor, especially in protein content.

Table 27--Benchmark solutions of the least cost ration and the farmer's ration

Commodity	Layer		Broiler		Swine	
	Least Cost Ration	Farmer's Ration	Least Cost Ration	Farmer's Ration	Least Cost Ration	Farmer's Ration
	(kilograms)					
Maize	301	450	478	600	0	500
Rice bran	289	260	182	100	332	310
Soybean meal	75	60	75	50	100	90
Coconut meal	50	70	73	40	100	88
Fish meal	62	90	80	120	0	0
Gaplek	150	0	65	0	460	0
Tallow	0	0	30	20	0	0
Bone meal	51	60	37	60	0	0
Premix	12	10	12	10	12	12
Total	1,000	1,000	1,000	1,000	1,000	1,000
Price (Rp/kilogram)	227	269	326	328	146	246

Source: Computed by the Centre for Agro Economic Research, Bogor.

Note: Farmer's ration is based on current practices of the feed mills industry.

Table 27 also shows that the price of the current ration formulated without gaplek (Ration 2) was higher than the price of the minimum-cost ration with gaplek (Ration 1). However, since the fiber content of cassava is also higher and the protein content is lower, this makes the feed industry likely to use protein from soybean meals.

The total potential use of cassava for feed is about 500,000 tons of gaplek, the equivalent of 1.5 million tons of fresh cassava roots. As the yields of cassava and soybeans improve and prices decline, the use of cassava for feed increases to about 1.0-1.5 million tons of fresh cassava roots by the year 2000.

PROJECTIONS

Assuming population growth of 1.85 percent per year and income growth of 3.00 percent per year, the demand will increase at an annual rate of 9.54 percent for eggs; 7.32 percent for milk; and 4.83 to 5.50 percent for meat in the year 2000 (Table 28). In the same period, with income growth of 1.00 percent per year, demand for eggs, milk, and meat will increase at annual rates of 4.08 percent, 3.32 percent and 2.51-3.05 percent, respectively.

Table 28--Growth rates of demand for livestock products, 1985-2000

Income Growth Per Capita/Year	Meat		Eggs	Milk
	High	Low		
		(percent/year)		
3 percent/year				
1985	5.75	5.13	9.84	7.62
1990	5.65	5.03	9.74	7.52
1995	5.60	4.93	9.64	7.42
2000	5.50	4.83	9.54	7.32
1 percent/year				
1985	3.30	2.81	4.38	3.62
1990	3.25	2.71	4.28	3.52
1995	3.15	2.61	4.18	3.42
2000	3.05	2.51	4.08	3.32
Income elasticity	1.20	0.66	2.23	1.47

Source: Computed by the Centre for Agro Economic Research, Bogor, based on data from Indonesia, Biro Pusat Statistik, Survey Sosial Ekonomi Nasional 1980 (Jakarta: Biro Pusat Statistik, 1981).

Note: The assumed rates of population growth are 2.05 percent per year by 1990, 1.95 percent per year by 1995, and 1.85 percent per year by 2000.

The requirement for animal protein of livestock origin is 5 grams per capita per day. That requirement is met with a consumption structure of 8.1 kilograms of meat, 2.2 kilograms of eggs, and 2.2 kilograms of milk per capita per year. It is estimated that 8.1 kilograms of meat per capita per year will be consumed around 1995 with an income growth rate of 3 percent per year. At that growth rate for income, egg consumption will reach 2.2 kilograms per capita per year around 1990 (Table 29). Milk consumption has exceeded the standard requirement of 2.2 kilograms per capita per year since 1983.

Table 29--Per capita consumption of livestock products, 1985-2000

Income Growth Per Capita/Year	Population	Meat		Eggs	Milk
		High	Low		
	(million)	(kilograms/capita)			
3 percent/year					
1985	164.05	4.72	4.58	1.89	3.61
1990	181.57	6.24	5.88	2.94	4.78
1995	199.98	8.21	7.52	4.68	6.87
2000	219.18	10.78	9.57	7.41	9.83
1 percent/year					
1985	164.05	4.72	4.58	1.89	3.61
1990	181.57	5.55	5.26	2.34	4.31
1995	199.98	6.51	6.01	2.89	5.12
2000	219.18	7.57	6.84	3.55	6.06

Source: Computed by the Centre for Agro Economic Research, Bogor, based on data from Indonesia, Biro Pusat Statistik, Survey Sosial Ekonomi Nasional 1980 (Jakarta: Biro Pusat Statistik, 1981).

Notes: The amounts consumed in 1983, as given by the Directorate General of Livestock Services in 1986, are assumed. They were 4.40 kilograms of meat, 1.66 kilograms of eggs, and 3.31 kilograms of milk.

The assumed rates of population growth are 2.05 percent per year by 1990, 1.95 percent per year by 1995, and 1.85 percent per year by 2000.

Estimates of the consumption of animal protein of livestock origin show that the requirement of 5 grams of livestock protein per capita per day will be achieved about 1995 if income grows 3 percent per year. If it grows only 1 percent per year, this requirement will be achieved after the year 2000 (Table 30). This implies that in the future eggs and milk will substitute for meat in achieving the 5-gram requirement for protein (Table 31).

Table 30--Per capita protein consumption of livestock products, 1985-2000

Income Growth Per Capita/Year	High	Low
	(kilograms/capita/day)	
3 percent/year		
1985	3.39	3.33
1990	4.66	4.49
1995	6.52	6.18
2000	9.15	8.57
1 percent/year		
1985	3.39	3.33
1990	4.03	3.89
1995	4.81	4.57
2000	5.67	5.32

Source: Computed by the Centre for Agro Economic Research, Bogor, based on data from Indonesia, Biro Pusat Statistik, Survey Sosial Ekonomi Nasional 1980 (Jakarta: Biro Pusat Statistik, 1981).

Notes: It is assumed that the protein content of meat is 17.5 percent; of eggs, 15.0 percent; and of milk, 3.5 percent. The calculations are made assuming that consumption reaches sufficiency, 5 grams of protein of livestock origin per capita per day, which is equivalent to 8.1 kilograms per year of meat, 2.2 of eggs, and 2.2 of milk.

Table 31--Total demand for livestock products, 1985-2000.

Assumed Per Capita Income Growth/Year	Meat		Eggs	Milk
	High	Low		
		(1,000 metric tons/year)		
3 percent/year				
1985	774.32	751.35	310.05	592.22
1990	1,132.99	1,067.63	533.82	867.90
1995	1,641.84	1,503.85	935.91	1,293.87
2000	2,362.76	2,097.55	1,624.12	2,154.54
1 percent/year				
1985	774.32	751.35	310.05	592.22
1990	1,007.71	955.06	424.87	782.57
1995	1,301.87	1,201.88	577.94	1,023.90
2000	1,659.19	1,499.19	778.09	1,328.23

Source: Computed by the Centre for Agro Economic Research, Bogor, based on data from Indonesia, Biro Pusat Statistik, Survey Sosial Ekonomi Nasional 1980 (Jakarta: Biro Pusat Statistik, 1981).

PROSPECTS FOR SUPPLY

Development of the livestock sector in Indonesia is designed to satisfy domestic demand and to substitute for imports. Chicken meat and eggs are estimated to have good prospects for the future (Table 32). During 1974-83 and 1984-87, the growth rate of chicken meat production was about 11.0 percent, 25.5 percent higher than the production growth rate of total meat (6.0 and 8.0 percent). This means that chicken meat has a high potential for being a substitute for livestock meat. The rate of growth of production of eggs from high-yielding chickens is 8.95 percent, which is higher than production of all eggs, including eggs from native chickens and ducks.[34]

[34]DGLS, unpublished data, Jakarta, January 1988.

Table 32--Production growth of meat, eggs, and milk, 1974-83 and projections to 2000

Year	Meat		Eggs		Milk
	Poultry	Total	High-yielding Chickens	Total	
	(1,000 metric tons)				
1974	55.2	403.1	24.8	98.1	56.9
1975	66.2	435.0	28.0	112.2	51.1
1976	78.3	448.7	31.9	115.6	58.0
1977	92.0	467.7	39.4	131.4	60.7
1978	95.3	474.6	43.7	151.0	62.2
1979	100.3	486.5	50.3	163.9	72.2
1980	172.3	570.8	141.6	259.4	78.4
1981	183.0	596.0	151.7	175.2	85.8
1982	201.3	628.6	164.9	297.0	117.6
1983	253.2	684.7	176.6	316.0	142.9
1985	267.48	714.46	212.80	367.27	135.37
1990	373.45	864.38	310.88	502.10	179.06
1995	479.42	1,014.30	408.96	636.94	222.74
2000	585.39	1,164.22	507.04	771.78	266.43

Source: Indonesia. Directorate of Program Development, Directorate General of Animal Husbandry, unpublished data, Jakarta, 1986.

Note: The projections are based on semilog equations.

Some factors favor the development of production of broiler chickens and eggs over production of meat and milk. New technology for the former has been widely adopted. The farming system for poultry has been directed to modern enterprise, especially with regard to the economic aspect of production. Poultry production can be carried out on a large scale, is quick-yielding, and depends little on land. Lastly, a good relationship between the institutions in the production system has been developed.

Table 33 presents projections of meat, egg, and milk production in Indonesia based on the production trends of 1974-83, and the projections based on the planning program for increasing livestock production in PELITA IV. These projections show significant differences in their estimates of milk production. The government policy gives high priority to increasing domestic milk production, which is in line with the effort to reduce imports, which were six times domestic production during PELITA III.

PROJECTED BALANCE FOR LIVESTOCK

The high requirements for livestock products at an income growth rate of 3 percent per year produce a negative balance in the estimates of projection in Table 34. If the estimate of production is based on the production growth projected in PELITA IV with the base year 1983, Indonesia will not be self-sufficient in meat production. Self-sufficiency in milk production will be achieved before the year 1990 if production of milk can reach a steady rate of growth of 24.9 percent per year. On the other hand, the program to reach a growth rate of egg production of 7 percent per year will not be enough to meet the growth of demand. To achieve self-sufficiency in egg production, the growth rate must be derived from the growth of demand. Note also that during PELITA III, about 160,000 tons of eggs were imported per year, double the imports of PELITA II. At a growth rate of income of 1 percent per year and using the production scenario in projection I, Indonesia will not be free from dependence on imports to meet the domestic demand by 2000 (Table 35). The projected balance shows an egg surplus of about 59,000 tons in 1995. In projection II, with the same time (1995) the egg surplus was higher, that is, 133,790 tons. With income growth of 1 percent per year, a milk surplus of about 35,200 tons will be achieved in 1990 (see Table 35). In other words, milk self-sufficiency will be achieved early with a slow rate of income growth (see Tables 34 and 35). The projections in this chapter will be used to make the projections on feed demand discussed in the next chapter.

Table 33--Projections of meat, eggs, and milk production, 1985-2000

Projection/Year	Production		
	Meat	Eggs	Milk
	(1,000 metric tons)		
Projection I			
1985	714.46	367.27	135.37
1990	864.38	502.10	179.06
1995	1,014.30	636.94	222.74
2000	1,164.22	771.78	266.43
Projection II			
1985	770.78	361.79	235.23
1990	1,036.36	507.45	817.76
1995	1,393.44	711.73	2,842.90
2000	1,873.56	998.24	7,703.16

Source: Indonesia. Directorate of Program Development, Directorate General of Animal Husbandry, unpublished data, Jakarta, 1986.

Notes: Projection I is based on production data for 1974-83 (Table 32). Projection II assumes achievement of the target annual growth rates for production of meat (6.1 percent), eggs (7.0 percent), and milk (28.3 percent), with a base year of 1983 (beginning of Pelita IV).

Eggs include layer eggs, native chicken eggs, and duck eggs.

Table 34--Livestock commodity balances with an income growth rate of 3 percent per capita per year, 1985-2000

Projections/Year	Meat[a]		Eggs	Milk
	High	Low		
	(1,000 metric tons)			
Projection I				
1985	-58.86	-36.89	57.22	-456.85
1990	-268.61	-203.25	-31.72	-688.84
1995	-627.57	-489.55	-298.97	-1,071.13
2000	-1,198.54	-933.33	-852.37	-1,888.11
Projection II				
1985	-3.54	19.43	51.74	-592.22
1990	-96.63	-31.27	-26.37	-50.14
1995	-248.40	-101.41	-224.18	1,549.03
2000	-489.20	-223.99	-625.88	5,548.62

Source: Computed by the Centre for Agro Economic Research, Bogor, based on data from Indonesia, Biro Pusat Statistik, Survey Sosial Ekonomi Nasional 1980 (Jakarta: Biro Pusat Statistik, 1981).

Notes: Projection I is based on production data for 1974-83. Projection II assumes achievement of the target annual growth rates for production of meat (6.1 percent), eggs (7.0 percent), and milk (28.3 percent), with a base year of 1983 (beginning of Pelita IV).

[a]The high projections of the meat balance are based on an income elasticity of demand for meat of 1.2. The low projections assume an elasticity of 0.6.

Table 35--Livestock commodity balances with an economic growth rate of 1 percent per capita per year, 1985-2000

Projection/Year	Meat[a]		Eggs	Milk
	High	Low		
	(1,000 metric tons)			
Projection I				
1985	-58.86	-36.89	57.22	-456.85
1990	-143.33	-90.68	77.23	-603.51
1995	-287.57	-187.58	-59.00	-801.16
2000	-494.97	-334.97	-6.31	-1.061.80
Projection II				
1985	-58.86	-36.89	57.22	-456.85
1990	28.65	81.30	82.58	35.19
1995	91.74	191.56	133.79	1,819.00
2000	214.37	374.37	220.15	6,374.93

Source: Computed by the Centre for Agro Economic Research, Bogor, based on data from Indonesia, Biro Pusat Statistik, Survey Sosial Ekonomi Nasional 1980 (Jakarta: Biro Pusat Statistik, 1981).

Notes: Projection I is based on production data for 1974-83. Projection II assumes achievement of the target annual growth rates for production of meat (6.1 percent), eggs (7.0 percent), and milk (28.3 percent), with a base year of 1983 (beginning of Pelita IV).

[a]The high projections of the meat balance are based on an income elasticity of demand for meat of 1.2. The low projections assume an elasticity of 0.6.

CONCLUSION

Seen from the production side, chicken meat and high-yielding chicken eggs have good prospects for the future. Technological development should enable domestic production of broiler chickens and layers to accelerate. Rapid adoption of new technology can be achieved through the establishment of harmonious and complementary relations between farmers and the entrepreneurs in the agro-industrial complex of livestock production and utilization.

Consumption data show that the rate of growth of demand for eggs and milk is derived from the high income elasticity of both commodities. In the future, to achieve a nutrient standard of 5 grams of livestock protein per capita per day, eggs can make a large contribution. On the other hand, poultry meat can substitute for ruminant meat demand. The rate of growth of production of poultry meat is faster than that of ruminants or livestock.

In the future it will be important to give high priority to production of eggs and chicken meat. Therefore, the production program should be designed to reach a target above the projected demand. Milk production will have to slow down after reaching self-sufficiency and make its rate of growth equal to the growth rate of demand for it. Particular attention should be focused on reducing the cost of production, which is presently far greater than import prices.

Although the rate of growth of milk consumption is high, its contribution to the protein requirement is low, because of the low protein content of milk compared to meat and eggs. It is suggested that the target composition of livestock protein be changed in the future toward more consumption of eggs and chicken meat. This would make it more realistic and in accord with potential production capacity.

6. FEED DEMAND PROJECTIONS

The projections in Table 36 are based on conversion of feed to produce the amount of livestock products analyzed in Chapter 5. The estimated feed demand for producing the projected output of livestock products--meat, milk, and eggs--in 1990 is 2.25 million tons. The proportions of feed required would be 19 percent for meat, 14 percent for milk, and 67 percent for egg production. This demand for feed will increase to about 3.7 million tons by 2000.

Table 37 gives two projections of the demand for cereals and other feed components in 1990 and 2000, based on the usual feed components for each type of ration. The first projection is based on the feed requirements given in Table 36, whereas the second projection is based on those derived by the Ministry of Agriculture, which include feed needed for draft animals, village chickens, and traditionally raised swine.

Table 38 shows the demand for cereal and other components, projected to 1990 and 2000. The columns show feed composition, and a large figure means a high proportion used widely by feed manufacturers. The table indicates that cassava is not widely used as one of the feed components, but comprises only about 0.007 percent of the total feed used.

Other projections are given in Table 38, based on least-cost rations, with gaplek introduced as a component of livestock feed, and Table 39 using the projected demand for maize from Mink's study.[35] Mink's estimate is similar to the estimate presented in Table 38. He subdivided poultry into commercial or modern poultry, which is layers and broilers, and village chickens. Village chickens are common in rural Indonesia, where a household generally maintains 5 to 15 birds. Productivity is low. However, these chickens contribute about 45 percent of total egg production and 60 percent of total poultry meat.

Village chickens are scavengers, they receive only a small amount of maize, rice bran, and other waste products. Therefore the feed figure for village chickens can only be an estimate.

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[35]Mink, "Corn in the Livestock Economy."

Table 36--Projections of feed required in 1985, 1990, 1995, and 2000

Product/Year	Livestock Production	Demand for Feed
	(1,000 metric tons)	
Meat		
1985	714.5	353.43[a]
1990	864.3	427.53
1995	1,014.3	665.50
2000	1,164.2	763.82
Milk		
1985	135.4	230.18
1990	179.1	304.47
1995	222.7	378.59
2000	266.4	452.88
Eggs[b]		
1985	212.8	1,042.72
1990	310.0	1,519.00
1995	409.0	2,004.10
2000	507.0	2,484.30
Total		
1985	...	1,626.33
1990	...	2,251.00
1995	...	2,975.50
2000	...	3,701.00

Source: Computed by the Centre for Agro Economic Research, Bogor, based on data from Indonesia, Departemen Pertanian, Repelita IV, 1980, (Jakarta: Departemen Pertanian, 1980).

[a]These projections are for broilers only.
[b]Only layer eggs are included in these figures.

Table 37--Projections of requirements for cereals and other feed components in 1990, 1995, and 2000

Year/ Use of Feed	Maize	Soybean Meal	Coconut Meal	Fish	Rice Brand
			(1,000 metric tons)		
1983-86	794	253	160	96	121
1990					
Meat, milk, eggs	1,170	383.0	240.0	135	323.0
Draft animals, village chickens, eggs	36	48.5	132.7	0	1,136.4
Total	1,206	431.5	372.7	135	1,459.4
1995					
Meat, milk, eggs	1,547	506.0	320.0	178.5	424.0
Draft animals, village chickens, eggs	60	98.4	247.7	0.0	1,159.2
Total	1,607	604.4	567.7	178.5	1,583.2
2000					
Meat, milk, eggs	1,924	629.0	400.0	222	525.0
Draft animals, village chickens, eggs	84	148.3	263.7	0	1,182.7
Total	2,608	777.3	762.7	222	1,707.7

Source: Computed by the Centre for Agro Economic Research, Bogor, based on data from Indonesia, Departemen Pertanian, Repelita IV, 1980 (Jakarta: Departemen Pertanian, 1980).

Table 38--Projection of demand for cereals and other feed components to 1990 and 2000

Component	1984-86	1990	1995	2000
		(1,000 metric tons)		
Maize	794.7	965.4	1,286.1	1,606.7
Soybean meal	253.3	482.3	670.3	857.3
Rice bran	1,260.4	1,459.4	1,583.6	1,707.7
Coconut meal	163.6	372.7	567.7	762.7
Vitamins	17.7	39.4	59.7	79.9
Fish meal	96.2	160.3	222.4	284.6
Bone meal	17.6	39.3	59.6	79.8
Gaplek[a]	0.2	193.1	260.2	350.5

Source: Computed by the Centre for Agro Economic Research, Bogor, based on data from Indonesia, Departemen Pertanian, Repelita IV, 1980 (Jakarta: Departemen Pertanian, 1980).

Note: These projections are the requirements for feed for all animals, including draft animals.

[a]The gaplek figures are based on the data in Tables 36 and 37.

Two approaches were used by Mink in projecting the use of maize for feed mix. The derived demand approach is a projection using the trend of demand for livestock products; the supply approach uses the past trend for the production of livestock.[36] The annual rate of growth of demand for feed mix based on the two approaches given in Table 39 is nearly 7.0 percent. With a projected rate of growth of maize production of 4.5 percent a year, the demand for maize as feed will increase from 33.0 percent of total maize production in the period 1984-86 to 36.0 percent in the year 2000.

[36]In the derived demand approach, the growth of gross domestic product was assumed to be 5.0 percent annually; the income elasticity for meat to be 1.6, for eggs, 1.4, and for milk, 1.5; and the population growth rate to be 2.0 percent. In the supply approach a simple linear trend of livestock production was used.

Table 39--Use of maize for livestock feed, projected to 1985, 1990, 1995, and 2000

Approach/ Type of Animal	1983	1985	1990	1995	2000
		(1,000 metric tons)			
Derived demand approach					
Poultry					
Modern layers	198	227	315	437	607
Broilers	146	168	248	366	540
Village chickens	193	216	290	390	524
Swine	27	30	39	51	66
Dairy	16	22	47	100	213
Total	560	663	939	1,344	1,950
Supply approach					
Poultry					
Modern layers	280	331	484	708	1,035
Broilers	140	166	242	352	512
Village chickens	222	239	285	340	405
Swine	75	83	106	136	174
Dairy	16	22	28	36	46
Total	733	841	1,145	1,572	2,172

Source: Based on data from S. D. Mink, "Corn in the Livestock Economy," in Paul A. Dorosh, Walter P. Falcon , Stephen D. Mink, Scott R. Pearson, and Douglas H. Perry, The Corn Economy of Indonesia (Stanford, Cal.: Food Research Institute, Stanford University, 1984).

The estimates of maize feed use in Tables 38 and 39 were only half of the amount of maize used for feed estimated by the Directorate General of Food Crops (DGFC) and presented in Table 40. The DGFC figures were derived from a survey on the feed mix industries in Jakarta and Surabaya. The total capacity of feed mills in Indonesia

in 1985 was 3.7 million tons of feed mix. With a share of maize in the feed components of 40 percent, the potential use of maize in the feed mills industry would be 1.46 million tons. This estimate of feed use of maize is similar to the data in Table 40.

Table 40--Supply and utilization of maize, 1969-85

Year	Production	Changes in Stock	Net Imports	Total Supply	Domestic Use				
					Feed	Seed	Processed for Industry	Waste	Food
				(1,000 metric tons)					
1969	2,293	...	-156	2,137	340	70	30	43	1,645
1970	2,925	...	-253	2,572	368	50	37	51	2,066
1971	2,606	...	-219	2,387	362	66	44	48	1,867
1972	2,254	...	-78	2,176	323	56	54	44	1,699
1973	3,690	...	-181	3,509	481	72	66	70	2,820
1974	3,011	...	-197	2,814	412	60	80	56	2,206
1975	2,903	...	-51	2,852	431	46	97	57	2,221
1976	2,572	...	50	2,623	514	66	118	52	1,813
1977	3,143	...	0	3,142	591	73	144	63	2,271
1978	4,029	...	25	4,054	679	64	175	81	3,035
1979	3,724	...	77	3,901	781	65	213	189	2,539
1980	3,991	...	-1	3,990	899	65	259	197	2,522
1981	4,509	-17	-6	4,520	1,033	69	316	226	2,876
1982	3,235	26	76	3,284	1,188	63	230	164	1,639
1983	5,087	29	10	5,068	1,331	81	355	254	3,047
1984	5,288	58	-59	5,289	1,491	76	378	204	3,140
1985	4,556	15	-49	4,363	1,670	53	272	257	2,111
1986	5,620	10	56	5,666	1,870	96	281	279	3,122

Source: For production, net imports, seed, waste, and maize processed for industry, Indonesia, Biro Pusat Statistik, Neraca Bahan Makanan 1968-83 (Jakarta: Biro Pusat Statistik, 1984). For 1969-81 feed use, Indonesia, Directorate-General for Food Crops, "Supply and Demand for Food Crops in Indonesia," DGFC, Jakarta, 1988.

Estimates based on the analysis in Chapter 4 show that the potential use of cassava for poultry with the least-cost combination of the feed mix will be about 400,000 tons of gaplek by 2000. However, the demand for soybean meal will also increase by 100,000 tons for poultry feed. For swine, the potential use for feed is 100,000 tons of gaplek and 25,000 tons of soybean meal.

Feed mills and mixed feed production have grown at a very rapid rate of 7 percent annually, induced by the rapid development of poultry production in Indonesia. It is expected that this rate of growth will be the same in the future. The share of poultry meat and eggs for total meat and egg consumption will increase.

Maize has been used widely for feed in Indonesia, especially for modern poultry. Maize supplied 35 to 60 percent of the total feed requirement. And this came from only about 33 percent of total maize production in Indonesia. But the mixed feed industry has several problems in buying maize to fulfill its needs. First, maize is a major food, so that about 54 percent of total production is consumed as food (see Table 40). Second, maize is grown in widely separated areas by small farmers, so that the marketing cost is high. Therefore, either the factory-gate price will be high or the farm-gate price will be low.

To meet its needs, the mixed feed industry in Indonesia buys its maize from other countries through the government logistics agency, BULOG, which monopolizes imports of maize and a number of other products. However, Indonesia has also exported maize in some years.

Demand for feedgrains is a derived demand. With income and population increases, the demand for livestock products rises. The percentage of households consuming livestock products will also increase. Between 1968 and 1983, the demand for meat increased at an annual rate of 6.0 percent; that for eggs by 16.8 percent; and that for milk by 12.5 percent.

With rapid rates of growth in demand for livestock products, demand for feedgrains also increased rapidly. The use of maize by feed mills increased at a rate of 8 percent annually. Demand for maize for direct human consumption increased at a slow rate, however, as per capita consumption tends to decline as income rises. The share of the total supply of maize for feed mills increased from 10 percent in 1980 to 16 percent in 1984/85. With improvements in farming systems and the marketing of maize, and improvements in the feed mill industry, the use of domestic maize production by feed mills will increase rapidly. And maize will remain an important input into the feed mill industry in Indonesia. Substitution of maize with cassava depends upon the relative prices of cassava and soybeans to maize. Based on the nutritional value of feed, a mix of 4 kilograms of gaplek with 1 kilogram of soybean meal is similar to 5 kilograms of maize. Therefore, if the cost of 4 kilograms of gaplek and 1 kilogram of soybean meal becomes lower than the cost of 5 kilograms of maize, then substitution of maize with cassava and soybean meal will take place.

7. PRODUCTION AND FEED USE SUBSTITUTABILITY OF CASSAVA WITH FEEDGRAINS

The use of cassava as feed is not yet a common practice among smallholders. As discussed elsewhere in this report, more than 90 percent of livestock are in the hands of smallholders, mostly in rural areas. In these areas cassava is cultivated primarily as a source of food or as a cash crop. The price of cassava is relatively higher than other sources of feed, considering its nutritive and energy values. In rural areas, rice bran is abundant, so that its price is relatively low.

However, the tops and peelings of cassava plants are commonly used as roughage and starch waste is used as a concentrate. Cassava tops provide high quality roughage and have been widely used by smallholders to feed large and small ruminants. Cassava peelings have also been fed to livestock. But their quality is relatively low since the peelings are usually mixed with soil. Cassava starch waste is a by-product of the starch industry, so that production of this source of feed is tied up with the development of that industry. In the form of a watery product, cassava starch waste is bulky. If it is to be stored or transported, a dry form of the waste is economically attractive as a source of feed. In terms of nutrient value, cassava by-products are competitive with other feed sources (Table 41).

In PELITA IV, the government of Indonesia has set targets for the annual growth in population of livestock as follows: large ruminants, 1.0 percent; small ruminants, 3.0 percent; pigs, 6.6 percent; and poultry, 7.3 percent. After three years of PELITA IV (1983-87), the rates of growth of livestock products were 4.5 percent for large ruminants, 11.4 percent for pigs, and 11.5 percent for poultry.[37] The government expects to achieve annual increases in meat, eggs, and milk production of 6.1 percent, 6.6 percent, and 33.0 percent, respectively. If the targets are to be met, demand for feed will have to increase proportionally. However, since cassava is considered to be a staple food, prospects for the use of cassava tubers or gaplek in the feed industry will only increase if cassava and soybean prices decline relative to maize prices.

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[37]DGLS, unpublished data, Jakarta, January 1988.

Table 41--Composition of selected feeds commonly used

Feed	Dry Matter	Total Digestible Nutrients	Crude Protein	Crude Fiber	Ether Extract	Calcium	Phosphorus
	(percentage of dry matter)						
Roughage							
Cassava tops	23	66	17.6	22.9	7.4	1.30	0.28
Maize tops	31	68	8.0	25.7	2.3	0.60	0.10
Rice straw	86	39	3.7	35.9	1.7	0.41	0.29
Sugarcane tops	31	49	5.2	34.8	1.9	0.47	0.34
Concentrate materials							
Cassava starch waste	80	78	1.9	8.9	0.3	0.26	0.08
Maize bran	86	81	11.3	5.0	8.0	0.06	0.73
Rice bran	66	55	9.8	15.9	4.8	0.09	1.09
Soybean meal	86	84	51.9	5.9	1.3	0.38	0.72

Source: Unpublished data from the Research Institute for Animal Production, Bogor, 1986.

Most concentrate produced in Indonesia went to poultry. A consultant team reports that in 1985, 90 percent of concentrate went to feed poultry, 6 percent to pigs, 3 percent to dairy cattle, and 1 percent to the shrimp and fish industries.[38] The team also estimated that a sizable increase in the total volume of feed (concentrate) will occur from 1985 onward, and by 1990 the proportion of concentrate used by the livestock sectors will change as indicated in Table 42. The sharp increase in demand for concentrate in the shrimp and fish sector is a result of a vigorous government intensification project for shrimp aquaculture and fish cage culture.

[38]Asian Development Bank, Dairy Development Project in Indonesia (Jakarta: Asian Development Bank, 1986).

Table 42--Share of concentrate use in livestock and fishery sectors, 1985 and 1990

Types of Animals	1985	1990
	(percent)	
Poultry	90	80
Pigs	6	5
Dairy cattle	3	5
Shrimp/fish	1	9
Other	...	1

Source: Asian Development Bank, Dairy Development Project in Indonesia (Jakarta: Asian Development Bank, 1986).

A real competitor in the use of feed concentrate is exports. In 1983 Indonesia exported 220,000 tons of rice bran meal, flour, and pellets; 179,000 tons of cassava pellets; 257,000 tons of gaplek; and 4,000 tons of cassava starch waste pellets. In 1985, Indonesia exported 244,000 tons of gaplek and 299,000 tons of cassava pellets.

Some commodities that compete with cassava utilization for feed are maize, rice bran, and wheat pollards (a by-product of wheat milling). Since cassava has little protein, its use as a substitute for maize will require an increased use of soybean meal (200 kilograms of soybean meal and 800 kilograms of gaplek substitute for 1 ton of maize) or fish meal. Both soybean and fish meal are import commodities with prices much higher than world market prices due to a government imposed tariff to protect domestic producers. Cassava in the form of chips, pellets, and starch, and also maize and rice bran, are export commodities.

In Indonesia, cassava farming gives a higher return above variable costs than most other crops (see Table 43). However, the cultivation period is between 8 and 12 months, while other crops, such as peanuts, soybeans, and maize, need only about 3 months from planting to harvesting.

Table 43--Average returns of food crops on upland unirrigated land, 1983

Crop	Return above Variable Cost
	(Rp/hectare)
Rice	169,200
Maize	146,800
Cassava	349,200
Sweet potatoes	386,900
Peanuts	397,100
Soybeans	218,600

Source: Indonesia, Biro Pusat Statistik, Struktur Ongkos Usahatani Padi dan Palawija 1983 (Jakarta: Biro Pusat Statistik, 1984).

The price of fresh cassava relative to rice in Java increased during the period 1959-77 (Table 44). This has given an incentive to farmers to produce cassava. Moreover, the share of cassava in the production of all food crops is high in the principal cassava-growing areas, showing its importance in the economy. The data in Table 45 are obtained from the results of research conducted in three areas in Java.[39]

PRODUCTION SUBSTITUTABILITY

Cassava is usually planted on marginal upland areas where other food crops, especially rice, cannot be grown economically. The reasons for the reported reduction of the area planted to cassava since 1966 are difficult to quantify precisely. The progress of irrigation development since the 1970s has permitted the substitution of irrigated rice for rainfed crops like cassava and has extended the

[39]Roche, "Production System."

period of water availability for cultivation in existing fields. The government afforestation program has reduced the cultivable land for cassava production. The planting of perennials like cloves in West Java (Garut) and the high prices of competing staple crops like soybeans, peanuts, and maize during 1976-79 has had similar effects on the area planted to cassava. In addition, government intervention in prices, marketing, trade, and research and extension have been more favorable to rice, maize, and soybeans than to cassava.

Table 44--Ratio between market prices in rural Java and the retail price of rice in Jakarta, 1955-83

Years	Rural Fresh Cassava/ Urban Rice	Rural Rice/ Urban Rice[a]
1955-59	0.12	0.46
1960-64	0.14	0.47
1965-69	0.15	0.44
1970-74	0.20	0.54
1975	0.17	0.58
1977	0.23	0.56
1980	0.22	0.76
1983	0.20	0.75

Source: J. A. Dixon. "Production and Consumption of Cassava in Indonesia," Bulletin of Indonesian Economic Studies 15 (No. 3, 1979). The 1980 and 1983 figures are from the Centre for Agro Economic Research.

[a]It was not possible to use the rural price of rice for the whole period. There was, however, a close connection between urban and rural rice prices because of the extensive linkages between private traders and BULOG, the National Logistics Board.

Table 45--Shares of food crops in the total value of production and income, Garut, Gunung Kidul, and Kediri

Item	Garut	Gunung Kidul	Kediri
		(percent)	
Share of total food crop value			
Rice	64.2	16.3	22.3
Maize	3.7	9.2	12.2
Cassava	25.8	41.0	60.1
Legumes	3.7	32.7	4.2
Other food crops	2.6	0.8	1.2
Total	100.0	100.0	100.0
Marketed shares			
Rice	28.2	1.3	31.6
Maize	40.9	16.3	61.8
Cassava	88.9	36.3	96.3
Legumes	37.8	55.2	98.4
Total food crop output	53.4	37.8	81.6
Cassava sales as a share of total crop sales	43.0	39.9	70.4
Cassava sales as a share of average gross family income	14.5	8.9	32.7
Value of total cassava production as a share of gross family income	16.3	24.5	34.0

Source: F. C. Roche, "Production System," in Walter P. Falcon, William O. Jones, and Scott R. Pearson, Cassava Economy of Java (Stanford, CAl.: Stanford University Press, 1985).

Because cassava requires little labor and has no specific harvest time, it becomes a convenient crop to grow when alternative income-producing activities compete for the farmers' time, in particular off-farm job opportunities and irrigated rice, with its high demand for

labor. Other crops can be substituted for cassava if they are more economical to grow.

ACTUAL AND NORMATIVE PRODUCTION DATA

Actual production data for growing cassava in two production centers, Mojokerto and Lampung Tengah districts, are presented in Table 46. Mojokerto was selected to represent a production center in East Java, which figures so large in cassava-planted area and production in Indonesia. Lampung Tengah is in Lampung province, which produces more cassava than any other province outside Java.

Table 46--Cost of production in Mojokerto and Lampung Tengah districts

Input/Output Income	Mojokerto		Lampung Tengah	
	Monoculture	Inter-cropping	Monoculture	Inter-cropping
	(Rp/hectare)			
Input	172,900	186,800	90,800	273,100
Labor	163,800	170,000	85,200	242,100
Seed	6,000	11,000	5,600	14,400
Fertilizer	3,100	3,500	...	15,500
Pesticide	...	2,300	...	1,100
Output	793,300	876,700[a]	85,600	252,100
Rice	...	...	...	127,400
Maize	...	...	...	23,700
Cassava	793,300	...	85,600	101,000
Income	620,400	689,700	-5,200	-21,000

Source: H. Malian, "Sistim Komoditi Ubikayu di Indonesia," n.p., 1986 (mimeographed).

Notes: Mojokerto is in East Java Province; Lampung Tengah is in Lampung Province. The data for Mojokerto are from 1982/83; for Lampung Tengah they are from 1979/80. The prices have been adjusted to 1985. The intercropped combinations of crops are maize and legumes, each with cassava, and all three crops together. This is the total value of output of rice, maize, and cassava.

[a]The value of output from each commodity cannot be separated.

In both districts, cassava was grown alone as well as being intercropped on uplands. The intercropping system in Mojokerto consisted of maize and cassava, legumes and cassava, or maize, legumes, and cassava. In Lampung Tengah, cassava was intercropped with maize and upland rice. In the last couple of years, farmers have included legumes in their cropping systems.

Differences in farm size and farmgate prices had an influence on cassava production systems in both production areas. Table 46 shows that in Mojokerto, cassava was equally profitable when cultivated as a monoculture or when intercropped. In Lampung Tengah, the use of labor and current inputs was more than 200 percent higher for intercropped cassava than for cassava grown alone. Farmers did not usually apply fertilizer and pesticide for monoculture cassava; therefore the fertilizer applied on the intercropped plants might have been intended for other foodcrops in the cropping system. The average farm size in Lampung Tengah was 1.5 hectares, and the farmgate price of cassava was Rp 11 per kilogram. In Mojokerto, farmers sold cassava for Rp 43.75 per kilogram. This big price difference might be accounted for by the relatively poor infrastructure in Lampung Tengah to Mojokerto and by differences in access to processing centers.

The differences in cropping system, cost of production and productivity in each district caused large differences in farm income. This subsequently affected the motivation of farmers to plant cassava.

The data in Table 47 can be used to assess the comparative advantage of cassava cultivation and its competitiveness in relation to other crops. The cost structure for and income from each commodity were calculated to indicate which commodity gives the highest return and what the cost is to produce them. The net returns were calculated by deducting the total costs of production from the value of output.

The figures for the four crops indicate that soybeans gave the highest net return per unit of output. Total costs were highest for producing soybeans, though the differences were not pronounced. Considering that cassava cultivation needs 7 to 10 months between planting and harvest, and soybeans need only 3 months, soybeans were more profitable for the farmer to produce.

COMPARISON OF THE COSTS AND RETURNS OF CASSAVA PRODUCTION

Table 48 presents estimates of the expected return from actual and improved agronomic practices in two areas. The table shows that a substantial increase in yields and profitability could be achieved in both areas. Cassava production costs could be reduced by almost 50 percent, indicating that a large increase in cassava supply is likely to occur if the new cultivation practices were adopted.

Table 47--Per hectare costs of and returns from cassava production and its competing crops in upland and unirrigated rainfed areas, 1981 and 1983

Costs/ Returns	1981				1983			
	Cassava	Soybean	Maize	Rice	Cassava	Soybean	Maize	Rice
				(Rp)				
Current inputs								
Seeds	3,077	14,931	3,060	6,141	5,046	19,879	3,490	7,861
Pesticide	29	3,214	188	549	68	4,883	361	858
Fertilizer	1,967	4,165	8,314	4,130	3,624	6,217	10,137	5,659
Manure	1,742	597	1,686	638	2,672	972	2,309	942
Labor	23,386	34,184	22,009	27,973	31,593	49,170	27,770	33,219
Equipment	1,415	2,671	3,398	1,483	1,399	4,157	3,536	1,677
Taxes	1,047	1,274	916	879	1,492	1,254	1,352	1,066
Other costs	4,462	5,320	3,791	68,725	5,450	6,215	5,212	9,095
Total costs	37,125	66,356	43,354	48,774	59,344	92,747	54,164	60,377
Gross return	247,102	247,104	177,066	193,557	400,569	311,375	200,984	256,531
Net return	209,997	180,508	73,712	144,783	349,225	218,628	146,820	196,154
Net return/ unit of output	22	207	48	96	35	261	86	114
Cost/unit of of output as a share of its value	15	27	37	25	13	30	27	23
Price (Rp/ kilogram)	26	283	76	128	40	371	118	150
Total production (kilograms)	9,556	874	1,532	1,510	9,970	839	1,698	1,715

Source: Indonesia, Biro Pusat Statistik, Struktur Ongkos Usahatani Padi dan Palawija 1981, dan 1983 (Jakarta: Biro Pusat Statistik, 1982 and 1984).

Improved technology requires higher fertilizer inputs and labor. Variable costs increased by 46 percent in East Java and by 31 percent in Lampung. However, net income per hectare with the improved technology is nearly six times the income with the traditional technology; the cost of production per kilogram with improved technology is nearly half the cost with the traditional practices.

Table 48--Cost analysis of cassava production in East Java and Lampung provinces, 1983-84

Item	Farmers' Pattern		Recommended Pattern	
	East Java	Lampung	East Java	Lampung
	(percent)			
Share of total cost				
Labor	45.4	73.5	42.8	69.4
Labor rent	35.8	7.8	25.1	6.6
Fertilizer and manure	11.7	13.0	26.7	18.8
Interest, depreciation, taxes	7.1	5.7	5.4	5.2
Total	100.0	100.0	100.0	100.0
Total value (Rp 1,000)	204.0	188.0	566.0	448.0
Total cost (Rp 1,000)	142.2	140.9	207.3	184.6
Net income (Rp 1,000)	61.8	47.1	358.7	263.4
Production (Rp/kilogram)	13.9	15.0	7.3	8.2
Yield (tons/hectare)	10.2	9.4	28.3	22.4

Source: Achmad Suryana, "Domestic Resource Cost Analysis of Cassava and Corn Production and Marketing in East Java and Lampung." (M.A. thesis, Bogor Agricultural University, 1980).

Note: The exchange rate used was approximately US$1.00 = Rp960.00.

The slow rate of growth of cassava yields might be a result of the relatively high cost of new technology to farmers who had no credit or operating capital with which to purchase the fertilizer. Because it takes 8-12 months to harvest cassava, the costs of noninstitutional credit became high compared to rice, maize, and

soybeans. Most cassava-producing regions are in a less favorable environment where most farmers have limited or no operating capital.

The Central Research Institute for Food Crops has conducted research on cassava intercropping in the transmigration areas of Sumatera and, in collaboration with the International Rice Research Institute (IRRI), in Kalimantan. The new technology applied in this research has five elements: first, crop varieties that are suitable under local conditions; second, an early-maturing variety of upland rice that allows early planting of legumes during the latter part of the wet season; third, the spacing of crops in the field is designed to reduce competition for sunlight; fourth, substantially greater use of fertilizers and pesticides; and fifth, mulches to retard weed growth and conserve soil moisture during the dry season.

Substantial improvements in productivity and net farm income were achieved from these new practices, as shown by Table 49 in Lampung and Table 50 in Java. The results indicate that there is considerable potential for increasing productivity. Potential returns to the new cropping practices vary among the survey areas. Returns would be highest where present practices are least intensive. Data on the financial cost of cassava by region and using improved technology are presented in Table 51.

The information presented so far makes it clear that in Indonesia the scope for substitutability of cassava does not exist in terms of production and consumption as feed. There are many reasons for this, such as the growing need for the crop, labor use in producing cassava, and economic considerations. All of these have made cassava an undeveloped crop, with good potential to be exploited in the future.

FEED USE SUBSTITUTABILITY

Although cassava has a high energy content, its low protein content means that feed rations containing cassava require more protein supplements than maize-based feeds. The complementary protein sources are mainly imported soybean meal and fish meal. These commodities are highly protected as imports through BULOG. This protection makes it unprofitable to use cassava for feed rations.

Mink noted that gaplek is equivalent to maize in energy value, but that each ton has 70 kilograms less of crude protein than a ton of maize.[40] He further calculated that in 1983/84 the cost of crude protein was $82 per kilogram (using soybean meal with 41 percent protein at $335 per ton c.i.f. Jakarta). At this price of soybean meal, gaplek had to cost $57 less per ton than maize to be

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[40]Mink, "Corn in the Livestock Economy."

Table 49--Current farmer practices compared with the improved intercropping system, Lampung Province, Sumatera, 1977/78

Item	Current Practices for Intercropped Cassava, Maize, and Upland Rice	Selected Varieties and Cultivation Practices
	(kilograms/hectare)	
Fertilizer		
Urea	90	460
TSP (triple super phosphate)	225	470
ZK	0	149
Manure	0	0
Lime	0	200
Pesticide		
Furadan 3G	0.0	30.0
Zinc phosphide	1.0	0.0
Surecide (liter/hectare)	1.6	4.8
Nonlabor cash costs (Rp 1,000/hectare)[a]	39.5	161.7
Annual labor use (man-day/hectare)[b]	278.0	672.0
Yields		
Cassava	10,910.0	19,890.0
Rice	2,430.0	3,690.0
Maize	630.0	2,550.0
Peanut	...	970.0
Rice bean	...	280.0
Total output value (Rp 1,000/hectare)[a]	545.4	1,197.4
Profit (Rp 1,000/hectare)[c]	380.8	733.3

Source: F. C. Roche, "Production System," in Walter P. Falcon, William O. Jones, and Scott R. Pearson, Cassava Economy of Java (Stanford, Cal.: Stanford University Press, 1985).

Notes: The patterns are two variants of current and improved practices at the test site in Sumatera. They were chosen because they reflect present practices and the most successful cropping pattern of the Central Research Institute for Food Crops (CRIFC).

[a]Nonlabor input and output are valued at the approximate prices found in the survey areas during 1979/80.

[b]The report of the CRIFC does not distinguish between labor by men and by women.

[c]The profit figure is total output value less all labor and nonlabor costs. Hired and family labor are valued at Rp 450 per man-day, the average wage paid to male and female laboresses in Garut survey area during 1979/80.

Table 50--Measures of increased profitability for improved cassava cropping practices, Java

District/ Cropping System	Increase in Cash Costs[a]	Increase in Gross Value of Output		Increase in Profit[b]		Increase in Day Gain	Costs of Cassava Production	Change in Production Cost
		Percent	Value	Percent	Value			
	(1,000 Rp/ hectare)		(1,000 Rp/ hectare)		(1,000 Rp/ hectare)		(1,000 Rp/ hectare)	(percent)
Garut								
Pure-stand cassava, current fertilizer package	25.3	51.7	78.4	41.1	39.5	13.7	23.5	-16.1
Pure-stand cassava, Adira I variety, CRIA fertilizer package	29.8	111.1	168.4	120.1	115.5	46.1	18.2	-35.0
Intercropped cassava, CRIA fertilizer package	116.7	121.1	377.8	73.7	154.4	9.8	11.4	-29.2
Gunung Kidul								
Intercropped cassava, lowland fertilizer use, terraced hillsides	16.8	36.6	35.6	12.3	11.2	4.8	15.7	+7.9
Intercropped cassava, CRIA fertilizer package, level soils	65.7	45.1	198.0	30.7	110.8	11.1	10.4	-25.4
Kediri								
Pure-stand cassava, Adira I variety, lowland rain-fed soils	16.2 -8.1	20.2	74.0	20.5	42.3	2.9	17.6	
Pure-stand cassava, Adira I variety, terraced hillsides	13.3	30.1	56.0	31.1	33.1	13.0	17.9	-12.6

Source: F. C. Roche, "Production System," in Walter P. Falcon, William O. Jones, and Scott R. Pearson, Cassava Economy of Java (Stanford, Cal.: Stanford University Press, 1985).

[a]This is the increase in nonlabor cash input costs over the costs of the corresponding current cropping system.

[b]These are the net returns to land and family labor.

[c]These are the net returns to land and total labor, both family and hired.

Table 51--Financial costs and returns of cassava production, by technology and region, under an export promotion trade regime, 1985

Technology/ Region	Yield		Price of Output		Production Cost					Processing and Marketing Costs	Total Cost	Net Financial Profit	
	Fresh Cassava	Gaplek	Farmgate (Fresh Cassava)	Wholesale (Gaplek)	Current Input	Labor Cost	Land Rent	Other Costs	Total Production Costs			Farmgate	Wholesale
	(kilograms/hectare)		(Rp/kilogram)		(Rp/hectare)								
Average technology													
West Java	11,400	4,560	30.17	90.10	13,832	111,589	125,708	27,414	278,543	167,001	445,544	65,395	-34,688
Central Java	11,275	4,510	22.26	89.50	20,029	65,493	125,708	17,008	228,238	160,660	388,898	22,744	14,747
East Java	11,100	4,440	28.99	87.30	18,497	70,613	125,708	17,997	232,815	164,471	397,286	88,974	-9,674
Sumatera	9,855	3,942	38.98	82.70	7,563	81,078	48,694	19,801	157,136	159,190	316,326	227,012	9,677
Sulawesi	9,995	3,998	46.30	134.60	3,640	57,721	48,694	24,012	134,067	188,278	322,345	328,702	215,786
Kalimantan	10,457	4,183	49.96	100.00	3,765	102,603	48,694	22,236	177,298	159,762	337,060	345,134	81,240
Bali and Nusa Tenggara	9,656	3,862	61.41	112.50	3,372	115,717	48,694	23,927	191,710	168,626	360,336	401,265	74,139
Improved technology													
Central Java	22,000	8,800	22.26	89.50	38,350	210,734	125,708	24,469	399,261	313,482	712,743	96,459	74,857
East Java	22,000	8,800	28.99	87.30	36,638	210,734	125,708	23,970	397,050	325,978	723,028	240,730	45,212
Sumatera	22,000	8,800	38.98	82.70	38,067	210,734	48,694	32,323	329,818	355,370	685,188	527,742	42,572

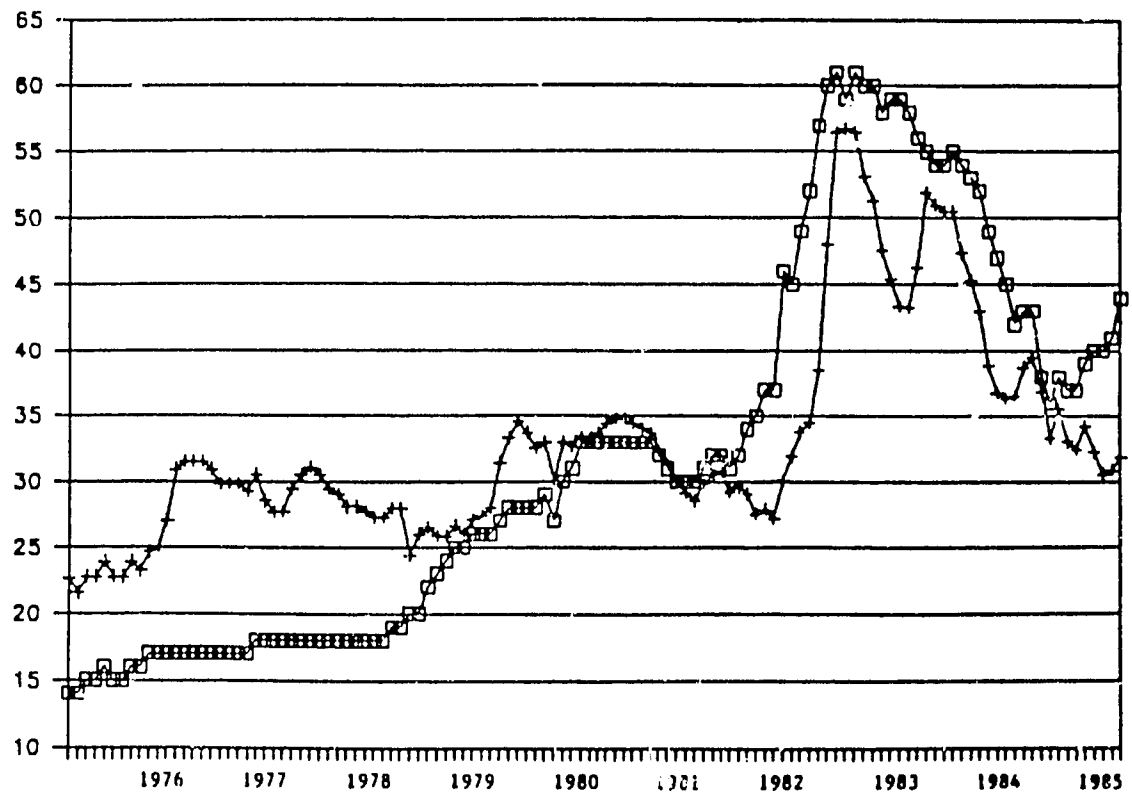
Source: Mark W. Rosegrant, Faisal Kasryno, Leonardo A. Gonzales, Chairul A. Rasahaan, and Yusuf Saefuddin, "Price and Investment Policies in the Indonesian Food Crop Sector," International Food Policy Research Institute, Washington, D.C.,Centre for Agro Economic Research, Bogor, August 1987.

competitive. For 1984 the f.o.b. prices of gaplek and maize were $82 and $114 per ton, respectively. If these prices change, the use of cassava as a substitute for feed rations might increase.

East Java is a major producer of both cassava and maize. As Figure 12 shows, until 1983 the ratio of cassava to maize prices was nearly constant, around 0.30. It increased to its highest level in 1983, 0.55, and declined to 0.30 again in 1985.

Figure 12--Ratio of current and real cassava prices in East Java, 1976-85

(Rp/kilogram)



Source: Data collected by the Centre for Agro Economic Research, Bogor, Indonesia, 1978-86.

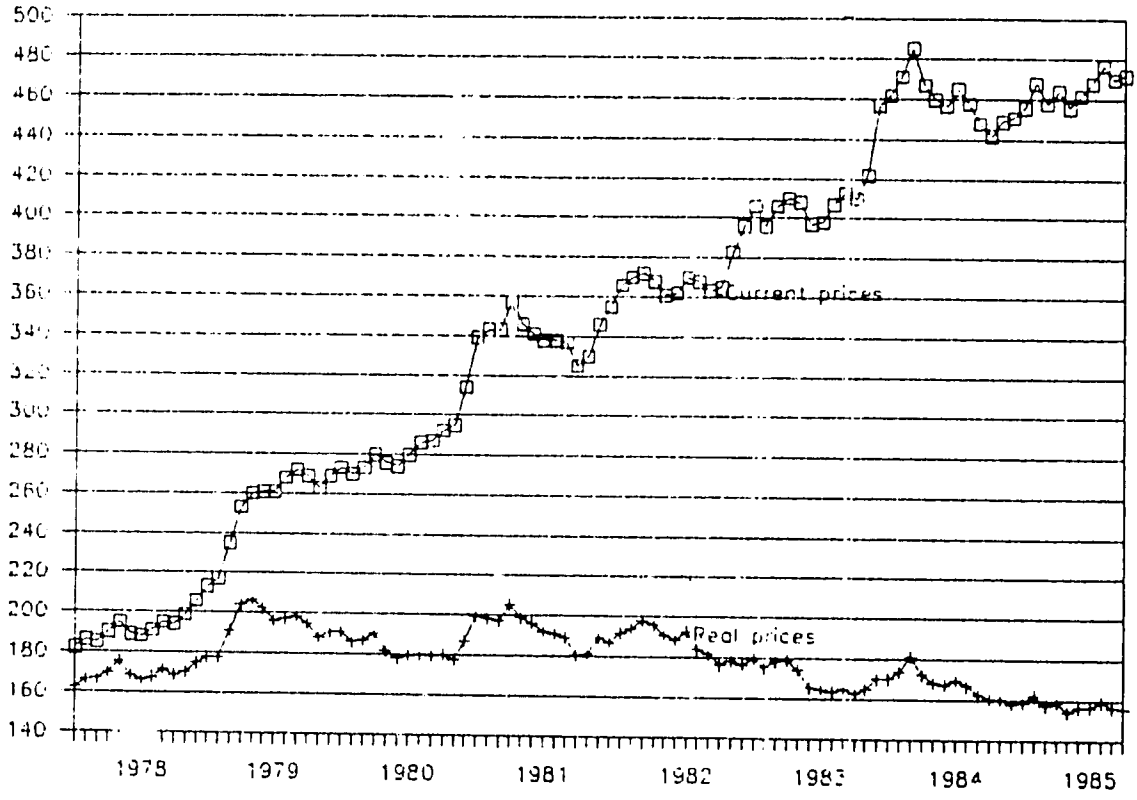
Even if the price of soybean meal or the price of cassava decline, the use of cassava as a substitute for maize might still be restricted at 15 to 20 percent of the feed ration for poultry. With an estimated demand for feed in the year 2000 of 3.7 million metric tons (Table 36), the maximum amount of gaplek demand for feed rations would be 740,000 tons. However, the demand for soybean meal as a protein supplement for the feed industry will increase by about 200,000 tons.

The price of soybeans in real terms was nearly constant between 1976 and 1985. Indonesia is still a net importer of soybeans, taking in 400,000 tons of soybeans and 250,000 tons of soybean meal in 1984/85, showing an increasing trend. Therefore, in the near future, because of government intervention and its monopoly on trade, there will be no dramatic changes in the soybean price.

The government's role in giving priority to developing food crops through market and trade interventions is widely understood. Various measures that have been taken to secure rice production range from input subsidies to price supports, for example. But there is no price guarantee or floor price for cassava roots and its products, so that prices sometimes fall so low that farmers may not even bother to harvest their cassava. Price differences between regions are relatively large compared with other food crops, as a result of differences in the infrastructures and processing facilities for cassava between regions. As shown in Figures 10 and 13, from 1978 to 1986, rice prices have tended to increase. The same trend can be seen in soybean prices.

Figure 13--Current and real soybean prices in East Java, 1978-85

(Rp/kilogram)



Source: Data collected by the Center for Agro Economic Research, Bogor, Indonesia, 1978-86.

From this information, it is easily understood why cassava production is not as developed as rice production. From the economic point of view, farmers prefer to grow rice and soybeans, commodities for which prices and markets are secure. From a nutritional point of view, cassava is an inferior good. As the production of rice has been good in the last few years, farmers have tended to consume more rice.

It will be difficult to encourage crop diversification if incentives are unequal or if adequate measures are not taken to encourage technical improvements.

Tables 52 and 53 show the regional comparative advantage of cassava production by presenting financial and economic indicators for cassava exports by province in 1985. The domestic resource cost (DRC) is the domestic cost (at economic prices) of earning a unit of net foreign exchange through domestic production of a commodity. It is worth noting that the ratio of the DRC over the shadow exchange rate (SER) in Java is greater than 1, while outside Java it is less than 1. This means that export promotion is more economically profitable outside Java than on Java. In other words, there is a bigger potential for cassava development in Central and East Java than in Sumatera, especially given improved technology. However, the EPR (effective protection rate), an indicator of the effect of government trade intervention on both outputs and inputs, shows a negative sign for Sumatera, which implies a net disincentive from economic prices.

CONCLUSIONS

Production of cassava, especially on Java, has been declining because of government incentive policies favoring other food crops. Technology has improved rapidly for rice and maize, and price policies have been favorable for rice, maize, and soybeans. The substitutability of cassava production for production of other crops is influenced by the relative prices of cassava to the prices of other food commodities, the structure of cassava use, technological development, and government market intervention. Cassava area, especially on Java, will continue to decline in the future at a rate of 1 percent a year, and the size of production will depend on technological progress in cassava production and the expansion of area on the outer islands.

The substitutability of cassava for other crops in livestock feed is influenced by the price of cassava relative to maize, soybean meal, fish meal, and rice bran. Maize is the second most important food commodity in Indonesia. Production increased rapidly at a rate of about 4.0 percent annually, whereas demand for food tends to decline as income of the household rises. The real price of maize tended to decline, and domestic prices were similar to world market prices. Indonesia is a net importer of maize, but the imports show a declining

trend. Therefore, the substitution of cassava for feedgrains will be limited by trends in the prices of maize, soybeans, and cassava.

The EC has given Indonesia an export quota of up to 1 million tons of gaplek, but in 1985, Indonesia exported only 535,000 tons of gaplek, and in 1986 exports reached only 425,000 tons of gaplek. The rate of growth of gaplek exports from 1978 to 1986 was 7.2 percent annually. Domestic demand for cassava starch is increasing. The Indonesian government has been inducing exports of agricultural products since 1983. It is estimated that if gaplek exports increase at a rate of 3 percent annually, exports could reach 830,000 tons of fresh cassava roots by the year 2000.

Table 52--Economic efficiency indicators in cassava production, by technology and region, under an export promotion trade regime, 1985

Technology/ Region	Border Price		Yield	Gross Economic Return	Economic Cost			Net Economic Profit (NEP)	Domestic Resource Cost (DRC)	Resource Cost Ration (RCR)
	Foreign Currency	Domestic Currency	(Gaplek)		Domestic	Foreign	Total			
	(US $/ metric ton)	(Rp/metric ton)	(kilogram/ hectare)		(Rp/hectare)			(Rp/US $)		
Average technology										
West Java	83.90	94,471	4,560	430,790	383,926	56,252	420,178	10,612	1,094	0.97
Central Java	83.90	94,471	4,510	426,066	309,766	57,282	367,084	59,018	946	0.84
East Java	83.90	94,471	4,440	419,453	313,883	61,547	375,430	44,023	988	0.88
Sumatera	83.90	94,471	3,942	372,406	249,744	49,839	299,583	72,823	872	0.77
Sulawesi	83.90	94,471	3,998	377,697	236,900	58,250	295,150	82,547	835	0.74
Kalimantan	83.90	94,471	3,862	364,849	286,393	50,906	337,299	72,767	891	0.79
Bali and Nusa Tenggara	83.90	94,471	3,862	384,849	286,393	50,906	337,299	27,550	1,027	0.91
Improved technology										
Central Java	83.90	94,471	8,800	831,348	570,694	138,290	708,984	122,364	927	0.82
East Java	83.90	94,471	8,800	831,348	578,811	143,737	722,548	108,800	948	0.84
Sumatera	83.90	94,471	8,800	831,348	529,821	154,740	684,561	146,787	882	0.78

Source: Mark W. Rosegrant, Faisal Kasryno, Leonardo A. Gonzales, Chairot A. Rasahaan, and Yusuf Saefuddin, "Price and Investment Policies in the Indonesian Food Crop Sector," International Food Policy Research Institute, Washington, D.C., Centre for Agro Economic Research, Bogor, August 1987.

Note: The exchange rate used was US $1.00 = Rp 1,126.

Table 53--Break-even yield and break-even border prices in cassava production, by region, under an export promotion trade regime, 1985

Technology/Region	Actual Yield (Tubers)	Break-even Yield (Tubers)	Break-even F.O.B.price (Gaplek)
	(metric tons/hectare)		(US $/ metric ton)
Average technology			
West Java	11.40	10.96	81.83
Central Java	11.28	8.88	72.28
East Java	11.10	9.28	75.00
Sumatera	9.86	6.68	67.49
Sulawesi	9.99	5.98	65.56
Kalimantan	10.46	7.40	68.45
Bali and Nusa Tenggara	9.66	8.39	77.56
Improved technology			
Central Java	22.00	17.04	71.55
East Java	22.00	17.50	72.92
Sumatera	22.00	15.61	69.09

Source: Mark W. Rosegrant, Faisal Kasryno, Leonardo A. Gonzales, Chairot A. Rasahaan and Yusuf Saefuddin, "Price and Investment Policies in the Indonesian Food Crop Sector," International Food Policy Research Institute, Washington, D.C., Centre for Agro Economic Research, Bogor, August 1987.

Note:The exchange rate used was U.S. $1.00 = Rp 1,126.

8. PROSPECTS FOR CASSAVA PRODUCTION AND UTILIZATION IN 1990 AND 2000

PROJECTED AREA

The 1988 DGFC study revealed that the area under cassava in Indonesia will decline from 1.16 million hectares in 1986 to just 1.07 million hectares by 2000.[41] The study by the International Food Policy Research Institute (IFPRI) and the Center for Agro-Economic Research (CAER) estimated that the area under cassava in Indonesia would be 1.12 million hectares in 1990 and 1.09 million hectares in 2000.[42] Both studies used multimarket econometric models to estimate food crop production structures.

This study uses a simple trend analysis of data given in Tables 3 and 4 to estimate cassava area in 1990 and 2000. The results are that area under cassava will be 1.23 million hectares in 1990 and 1.11 million hectares in 2000.

As stated earlier, cassava is generally planted on marginal land and the level of technology used is low. In the future, competition with other crops will increase. Therefore the projected area for cassava will most likely follow the past trend.

PROJECTED YIELDS PER HECTARE

Projected yields per hectare in 1990 and 2000 under existing or new varieties, with or without irrigation and fertilizer use, are presented in Table 54. The estimates are based on the data shown in Table 38. The past trend in yield between 1969-85 was growth of 2.5 percent per year. With current Indonesian government policy favoring more diversified agriculture with an emphasis on secondary food crops (maize, cassava, and soybeans) it is expected that cassava yields could be increased by 3.0 to 3.5 percent per year.

Based on the above discussion, the cassava yields per hectare are estimated to reach 12.6 tons of fresh cassava roots in 1990 and 16.9

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[41] DGFC, "Supply and Demand."

[42] Rosegrant et al., "Price and Investment Policies."

Table 54--Projected yields of cassava with existing varieties and new varieties, to 1990 and 2000

Fertilizer and Irrigation Use	1990		2000	
	Existing Varieties	New Varieties	Existing Varieties	New Varieties
	(metric tons of fresh roots/hectare)			
With fertilizer and irrigation	none	none	none	none
With fertilizer; without irrigation	16	24	20	30
Without fertilizer or irrigation	11	20	15	25

Source: Computed by the Centre for Agro Economic Research, Bogor, Indonesia.

Note: The projections using past trends are based on projected cassava area of 1,320,000 hectares in 1990 and 1,213,000 hectares in 2000. The projections using the trend of Pelita III are based on projected cassava area of 1,276,000 hectares in 1990 and 1,090,000 hectares in 2000.

tons in 2000. The IFPRI/CAER study estimated that yields would reach 12.05 tons of fresh cassava roots in 1990 and 15.39 tons in 2000, based on past trends.[43]

TOTAL PROJECTED OUTPUT

Using the projections of area and yield, the total output of cassava can be projected to 1990 and 2000. The results of these calculation are presented in Table 55. The projections of cassava production were slightly higher than in the IFPRI/CAER study due to differences in area and yield.[44]

[43] Ibid.

[44] Ibid.

Table 55--Projected output of cassava in 1990 and 2000

Projections of Fertilizer and Irrigation Use	1990		2000	
	Existing Varieties	New Varieties	Existing Varieties	New Varieties
	(1,000 metric tons of fresh cassava roots)			
Projection using past trends				
With fertilizer; without irrigation	21,120	31,680	24,260	36,390
Without fertilizer or irrigation	14,520	26,400	18,195	30,325
Projection using Pelita III trend				
With fertlizer; without irrigation	20,416	30,624	21,800	32,700
Without fertilizer or irrigation	14,036	25,520	16,350	27,250

Source: Computed by the Centre for Agro Economic Research, Bogor, Indonesia.

Note: The projections using past trends are based on projected cassava area of 1,320,000 hectares in 1990 and 1,213,000 hectares in 2000 The projections using the trend of Pelita III are based on projected cassava area of 1,276,000 hectares in 1990 and 1,090,000 hectares in 2000.

PROJECTED POPULATION

According to the 1971 census, the population in rural areas was 98 million and in urban areas was 21 million. By 1985 the population had increased to 121 million in rural areas and 43 million in urban areas. Average annual growth in rural areas was 1.33 percent; in urban areas, it was 4.89 percent, while the total growth rate in Indonesia was 2.15 percent.

According to the Biro Pusat Statistik, the Indonesian population in 1985 was 164 million, and the annual rate of growth of the population in 1985 was 2.11 percent, a decline from the rate of 2.34 percent in 1980. Therefore, it can be estimated that the annual rate of growth of population will be 2.05 percent by 1990, will decline to 1.95 percent by 1995, and to 1.85 percent by 2000. The population in 2000 would then be 219 million.

PROJECTED GROWTH RATE OF INCOME

To begin the analysis of household income changes, changes in per capita income in the period 1976-83 will be examined. The major objective here is to provide a broad picture of how household welfare changed during 1976-83, as a consequence of massive development in the past. Sample survey data carried out by the Agro-Economic Survey will be used.[45]

Per capita rather than total household income is chosen for the analysis, since the former is a more appropriate measure of welfare, and can give a quite different result when compared with changes in total income.

Table 56 shows that there was a large increase in per capita income during 1976-83. Overall increases in per capita income are broadly consistent with the macro trend: average income increased by 40 percent during 1976-83, a rate of just under 5 percent per year. The increase of per capita income among the bottom 40 percent was much higher than among the middle 40 percent, while per capita income among the top 20 percent decreased slightly. In general, these changes indicate better income distribution in 1983 than in 1976.

There were great variations in per capita income within the groups, as shown in Table 57. A substantial proportion of households registered a large increase in per capita income. Overall, one-third of households saw their per capita income more than double between 1976 and 1983. But not all households experienced the increase in per capita income. Indeed, 21 percent recorded a decline in per capita income of more than 20 percent. By contrast, a small proportion of households (17 percent) had a relatively stable income.

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[45]Yusuf Saefudin and Faisal Kasryno, "Structural Changes in Employment and Income of Low Income Rural Households in West Java, Indonesia," report submitted to the Asia and Pacific Development Centre, Kuala Lumpur, 1986.

Table 56--Changes in per capita income, 1976-83

Per Capita Income Group in 1976	Per Capita Income 1976	Per Capita Income 1983	Change
	(Rp 1,000/capita/year)		(percent)
Bottom 40 percent	44.8	124.6	178.2
40 percent	103.6	159.5	54.0
Top 20 percent	325.2	302.8	-6.9
Average	125.0	174.6	39.6

Source: Yusuf Saefudin and Faisal Kasryno, "Structural Changes in Employment and Income of Low Income Rural Households in West Java, Indonesia," report submitted to the Asia and Pacific Development Centre, Kuala Lumpur, 1986.

Notes: All income data are expressed in 1983 prices. The prices are based on an index of the prices of nine essential commodities in rural Java.

Table 57--Distribution of households by changes in per capita income, 1976-83

Per Capita Income Group in 1976	Per Capita Income Change			
	Loser	Stable	Gainer	Large Gainer
Bottom 40 percent	6.7	10.8	31.7	50.8
40 percent	23.3	21.7	33.3	21.7
Top 20 percent	44.3	21.3	16.4	18.0
Average	20.9	17.3	29.2	32.6

Source: Yusuf Saefudin and Faisal Kasryno, "Structural Changes in Employment and Income of Low Income Rural Households in West Java, Indonesia," report submitted to the Asia and Pacific Development Centre, Kuala Lumpur, 1986.

Notes: Losers were households whose incomes fell more than 20 percent. Stable households were those whose incomes did not change by more than 20 percent. Gainers were households whose incomes increased between 20 and 100 percent. Large gainers were households whose incomes increased by more than 100 percent.

Table 57 also shows that more than half of the households in the bottom 40 percent increased their per capita income by more than 100 percent, compared to only 18 percent of the households in the top 20 percent and 22 percent in the middle 40 percent. By contrast, 44 percent of households in the top 20 percent recorded a decline in their per capita income of more than 20 percent, compared to only 7 percent in the bottom 40 percent and 23 percent in the middle 40 percent of households. Low-income households consume more cassava than high-income households do; therefore, a changing income distribution will reduce demand for cassava.

For a micro-study done on Java, it was shown that rural per capita income grew 5.0 percent per year during 1976-83. The result is similar to the finding from macro data showing GNP per capita growth of 4.7 percent during the same period. The World Bank projected that GDP per capita will grow at rates of 1.95 percent by 1995 and 2.15 percent by 2000.[46]

INCOME ELASTICITY

In various studies on income elasticities, it has been shown that income elasticities for cassava range between 0.10 and 0.40. The elasticities are higher for low-income groups than for high-income groups. On a regional basis, the elasticities are larger off Java than on Java. Cassava appears to be favored by low-income households, reflecting the crop's inferior status. Cassava processed as a starch-based food has a higher income elasticity than does cassava consumed directly.

PROJECTED DEMAND FOR FOOD

In projecting demand of cassava for food in this paper, the following assumptions are made:

- Population growth is estimated to be 2.05 percent per year during 1980-90, 1.95 percent in 1991-95, and 1.85 percent to the year 2000, with the massive government efforts to decrease population growth through family planning program taken into consideration.

- Per capita income growth is assumed to be 1 and 3 percent a year during 1985-95, 3 and 5 percent in 1995-2000. The assumptions are based on past experience and the prospects for the future. Therefore, there are two projections of demand for food.

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[46]World Bank, Indonesia's Strategy for Economic Recovery (Washington, D.C.: World Bank, 1987).

- The income elasticities of demand for cassava are estimated to be 0.30 and 0.15 in 1980-90, and 0.20 and 0.10 in 1991-2000.

- Per capita consumption, which includes cassava consumed directly and as a starch-based food, in the base year is 60.8 kilograms of fresh cassava equivalent.

Based on these assumptions, projected total demand for cassava for food is presented in Table 58. It shows that the demand for cassava as food is projected to grow 1.2-1.9 percent per year during 1985-90, and 2.0 percent in 1990-2000.

Table 58--Projection of total demand of cassava for food

Year	Population	Cassava	
		Estimate 1	Estimate 2
	(million)	(1,000 metric tons of fresh roots)	
1985	164.05	9,952	9,952
1990	181.57	10,570	10,909
1995	199.98	11,387	11,989
2000	219.18	12,267	13,168

Source: Computed by the Centre for Agro Economic Research, Bogor.

Notes: Estimate 1 was made assuming that per capita income increased at an annual rate of 1 percent between 1985 and 1995 and at an annual rate of 5 percent between 1995 and 2000. Estimate 2 was made assuming that per capita income grew at an annual rate of 3 percent between 1995 and 2000.

The uses of cassava as human food include direct cassava food consumption, cassava starch-based food such as cassava chips (krupuk) and other cassava starch products. The National Food Expenditure Survey, SUSENAS, of 1984, revealed that the direct consumption of cassava as food represented about 55 percent of total cassava food consumption. In 1976 the share was 65 percent of total cassava consumption. By 1990 direct human food consumption of cassava is projected to decline to 45 percent, and a further decline to 43

percent is projected for 2000, while the share of consumption of cassava starch-based food is projected to increase to 55 percent in 1990 and 64 percent in the year 2000. Therefore as income rises cassava consumption as processed food will increase. However, total cassava consumption is also estimated to increase.

IMPROVEMENTS IN PROCESSING TECHNIQUES

Improvements in processing and storage techniques are needed to make it possible for farmers to obtain higher prices in the future. Processing and conserving cassava products make the commodities easier to handle and increase their nutritional and market values. In addition, these processes create jobs and encourage exports.

Indonesian farmers are often negligent about handling and processing techniques. The products are usually unclean because they are dried on the field without using any mats and stored in the farmers' houses using rattan or bamboo baskets or plastic bags. With these practices, crops cannot meet quality standards (especially those for export).

So far, postharvest processing has been neglected, although yields have increased. Farmers may not have skill or knowledge about the appropriate technology, or price differences between qualities may not be attractive enough to encourage farmers to be concerned about quality. Improvements in processing, particularly with regard to cleaning, drying, storage, and packing, should be carefully considered in attempting to improve farm income.

An example of one established starch factory, operated and supervised by the Village Unit Cooperative in Temanggung, in Central Java, illustrates some of the problems with the storage and processing of cassava in Indonesia.

This factory has had a particular problem in obtaining clean water to wash fresh cassava. The polluted water they used affected the quality of their product. The level of biological oxygen demand (BOD) detected in this area was 1,500 milligrams BOD/1, while less than 500 milligrams BOD/1 can be tolerated.[47] Perhaps drilling wells or installing water pumps could fulfill the need for clean water.

Also, the factory has not been able to reach its potential processing capacity due to lack of storage for fresh cassava and cassava starch, even though raw materials are abundant. Since fresh cassava should be processed as quickly as possible, the factory

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[47]Indonesia, Departemen Koperasi, unpublished staff paper, Jakarta, 1985.

cannot reach its potential unless adequate storage is available. Table 59 shows that in Central Java factories in general, there has been a sizable part of production that cannot be absorbed by the factories or household mills, assuming that 10 percent of cassava produced is to be processed.

Table 59--Area harvested, yield, production, and potential capacity of factory absorption in Central Java, 1982

Regency	Area Harvested	Yield	Production	Absorption	Number of Mills
	(hectares)	(kilograms/ hectare)	(metric tons)		
Pekalongan	19,427	93.49	181,631	4,250	2
Semarang	30,165	109.32	329,771	30,900	2
Pati	40,531	111.53	452,049	92,716	108
Banyumas	41,122	101.86	418,869	115,020	32
Kedu	51,646	90.99	469,953	12,255	5
Surakarta	116,065	73.07	848,115	800	1
Central Java	289,956	90.33	2,700,388	255,921	150

Source: Indonesia, Department Koperasi, "Tapioca Industry Project in Temanggung Regency," n.p.,1982 (mimeographed).

By and large, the way farmers dry the product shows that they fail to recognize the importance of handling. By cleaning and drying cassava properly, high quality gaplek can be produced.

Farmers in the future should be made aware of the importance of proper techniques for postharvest processing and trained in these skills. In addition, the price differential between qualities should be attractive enough to improve the quality. Improvements in water quality, such as those needed by the Temanggung factory, should also be made, which would be to the advantage of both farmers and factories.

But the per capita direct consumption of cassava for food has declined at a rate of 1.0 percent annually, and demand for starch-based food will increase at a rate higher than the rate of population growth. With the rural population increasing at a rate of 1.63 percent annually, the total cassava consumption for food will continue to increase. Urban consumption of cassava for food, even though low, has been nearly constant. Therefore total demand for cassava for food--consumed directly and processed--will increase slowly, about 1 percent a year. This indicates that in the future, in the year 2000, the share of cassava production used for food will remain high at about 40-60 percent of total production.

Since rice is preferred over cassava, the declining real price of rice seen since 1984 and a growth in per capita income of 1 percent by 1995 will further reduce cassava consumption. Therefore, the most likely total demand for cassava for food will be around 11.7 million tons of fresh cassava root equivalent in 1995 and 12.6 million tons in 2000. The IFPRI/CAER study estimated the total demand for cassava as food to be 10.9 million tons in 1990 and 12.9 million tons in 2000.[48]

PROSPECTS FOR CASSAVA AS FEED

It can be concluded that the prospects for the use of cassava as feed depend on the development on feed (concentrate) mixing technologies, the relative prices of cassava to other feed sources, and the prices of soybean meals and fish meals as protein sources. Therefore, if the price of cassava is competitive with other feed sources, in terms of nutritional value, one may expect that the use of cassava in the feed industry will increase. To achieve this objective, the following policies should be considered:

- Yields of cassava should be increased at the farm level through the adoption of an improved package of technology and an improved cropping pattern. In addition, technology on cassava processing should improve the quality of the product.

- Cropping patterns should be improved to encourage the development of cassava-producing regions together with the development of the agro-industries that process cassava. With this policy, marketing efficiency can be increased, price variability can be reduced, and farmgate prices can be improved.

- A credit facility might be needed to induce farmers to adopt an improved package of technology and to reduce the cost of production. The incomes of the farmers might then be improved.

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[48]Rosegrant et al., "Price and Investment Policies."

- Improvements in the technological package for soybeans will ultimately lower soybean prices as a complement to gaplek in a mix substituting for feedgrains.

In the last 15 years, the Indonesian government has been able to keep the price of rice nearly constant, because rice is the major food commodity. In 1984 Indonesia achieved self-sufficiency in rice production; since then there has been a trend for the real price of rice to decline. With the decline in rice price, its consumption will increase and consumption of cassava will decline. With continued increases in cassava production through increases in yields and reduced costs of production, the price of cassava will tend to decline.

Improvements in soybean yields through government policies on research, extension, input subsidy, price, and trade will probably cause the soybean price to decline. With declines in cassava and soybean prices, gaplek can become competitive with maize as feed. In addition, an increase in the export prospects of swine products will lead to an increase in demand for cassava.

Based on the above discussion, it is projected that the demand for cassava by the feed industry will increase at a rate of growth of about 5 percent by 1990, and will increase to about 10 percent by the year 2000.

9. CONCLUSIONS AND POLICY IMPLICATIONS

The rate of growth in cassava production in the last 15 years (1969-85) has been very slow--on average, 1.6 percent a year. During that period the yield grew at 2.5 percent annually, whereas the area declined 0.8 percent a year. On a regional basis, area has declined on Java and showed only a modest increase in the outer islands. However, 68.7 percent of cassava production comes from Java. The decline in cassava area in Java has been followed by an increase in rice and maize areas. Technological progress has led to production growth rates for rice and maize of 3.9 percent and 4.1 percent annually during the 1969-85 period. Therefore, it can be said that the substitution of production of other food crops for cassava in the past was due to more favorable government intervention for rice and maize. With the current level of technology and economic environment, cassava has difficulty in competing in production with other food crops, and in most regions cassava grows on less favorable land.

Variations in cassava yields between producing regions have been due mainly to variability in cropping practices, use of input factors, marketing and trade, and accessibility to processing centers. The big gap between yields on farms and at research experimental stations is due to differences in the technological packages adopted and in the production environments. Compared with other food crops, the relative prices of cassava at the farm level are low, which makes it less profitable for farmers to adopt improved technology. Besides, most cassava farmers lack capital to purchase modern farm inputs, and institutional credit is not available. Since the growing period for cassava is more than eight months, the cost of other credit is beyond the reach of farmers.

With special efforts and market interventions by the Indonesian government, rice yields have increased at a rate of 3.9 percent a year in the last 15 years. Cassava yields increased by 2.5 percent annually during that period. With special efforts by the government directed to cassava, in the future the yield of cassava will probably increase at a rate greater than 3 percent a year. With this scenario, it is expected that cassava yields will reach 12.6 tons per hectare in 1990, 14.6 tons per hectare in 1995, and 16.9 tons per hectare of fresh cassava roots by the year 2000.

Area planted with cassava will continue to decline at a rate of nearly 1 percent a year. And total production of cassava is projected to be 15.5 million tons in 1990 and 18.8 million tons of

fresh cassava roots by the year 2000 (see Table 60). To achieve this objective, government efforts and interventions should include: research on cassava commodity systems that would include technological packages and farming system innovations, postharvest and processing technology, marketing and trade, and alternative uses; intensive use of the extension service for the improved package of cassava technology; improvement of the cassava farming system to make it possible to capture the economies of scale in establishing processing centers and efficiency in marketing; provision of credit both for farmers and agribusinesses; and improvement of the infrastructure in the cassava production centers.

Table 60--Projection of supply and utilization of cassava to 1985, 1990, 1995, and 2000

Year	Area[a]	Yield[b]	Production	Net Imports[c]	Total Supply	Domestic Use			Food Consumption[f]	
						Feed[d]	Manufacture[e]	Waste	Direct	Tapioca
	(1,000 hectares)	(metric tons/ hectare)	(1,000 metric tons of fresh roots)							
1985	1,292	10.9	14,057	-1,586	12,471	249	649	1,621	4,738	5,214
1990	1,229	12.6	15,485	-1,839	13,646	318	790	1,549	4,944	6,045
1995	1,168	14.6	17,053	-2,132	14,921	512	960	1,535	4,907	7,007
2000	1,110	16.9	18,759	-2,472	16,287	825	1,168	1,680	4,491	8,123

Source: These are the author's estimates based on past trends and future prospects.
Notes: Net imports expressed in terms of gaplek would be: in 1985, -535,000 metric tons; in 2000, 890,000 metric tons.

[a]Area harvested with cassava is projected to decrease 1.0 percent annually, based on a 10-year trend.
[b]Yield is estimated to grow 3.0 percent per year with the addition of new varieties and greater use of fertilizer.
[c]Exports are projected to grow 3.0 percent annually.
[d]Demand for feed is estimated to grow at annual rates of 3.0 percent to 1990 and nearly 10 percent to 2000 as cassava becomes more competitive with maize and as swine production increases.
[e]The estimated use in manufacturing in 1985 is estimated to have been 20 percent of total production. Demand for cassava by industry is estimated to grow 10.0 percent annually. The biggest component would be starch as an import substitution policy is implemented.
[f]The per capita demand for direct human consumption is estimated to decline as income rises. The number of households eating cassava is also expected to decrease.

Substitutability of cassava in consumption for livestock production is influenced by the price of cassava relative to maize, soybean meal, and fish meal. Maize production increased rapidly at a rate of about 4.1 percent annually, whereas demand for food tends to decline as the income of a household rises. The real price of maize tends to decline, and the domestic price behaves similarly to the world market price. Indonesia is a net importer of maize, but at a declining trend, and is projected to become a net exporter by 1990. Therefore substitution of feedgrains by cassava will be limited by trends in the prices of maize, soybeans, and cassava. If the price ratio of gaplek to maize is below 0.5 with a constant or declining price of soybeans, then cassava will be able to substitute for maize in feed mixes.

The main use of cassava is for rural consumption. In 1984 the average consumption per capita for rural households in Indonesia was 22.7 kilograms of fresh cassava roots annually, whereas average urban consumption was only 7.8 kilograms of fresh cassava roots. Per capita consumption of cassava for food has declined, but with increases in the rural population, total cassava consumption for food will increase. Urban consumption of cassava for food, though low compared to rural consumption, was nearly constant. Consumption of cassava starch-based food will increase with increases in household income. Therefore, total demand of cassava for food will increase, though at a very slow rate--less than 2 percent a year. This indicates that in 2000, the share of cassava for food will remain high.

The nutritional energy value of cassava is nearly the same as other food crops. The protein content is low, however. Therefore consumption of cassava should be supplemented with higher protein foods such as soybeans, fish, and animal products.

Indonesia has been participating in cassava trade, and by 1990 it is projected to become a substantial net exporter of cassava products. Comparative advantage analysis reveals that Indonesia, especially the outer islands, has a comparative advantage in producing gaplek in an export promotion trade regime. However, financial analysis shows that growing cassava is less profitable for farmers because farm yields are still low. To sustain the comparative advantages in exporting these commodities, efforts to increase cassava production in major production centers of the crop (East Java, Central Java, Lampung, South Sulawesi, and Nusatenggara) with improved cassava technology should be intensified. In these major production centers the Indonesian government might consider developing an efficient commodity system to integrate the food crop production program with processing facilities and feed mills and with poultry and livestock development programs. With such an integrated development package, employment generation could be increased and rural income could be improved.

The use of cassava for industry and feed is increasing, but the amount involved is still small and is projected to be less than 10 percent of total production by the year 2000. The use of cassava for feed mills will increase with the increase in demand for livestock and poultry products (Table 60). As can be seen from this table, projected use of cassava for feed will be about 4 percent of total production in the year 2000.

Seen from the production side of livestock and poultry, chicken meat and high-yielding chicken eggs have good prospects in the future. Technological developments should make it possible for the production of broiler chickens and layers to meet the accelerated domestic demand. New technology can be adopted rapidly if harmonious and complementary relations can be established between farmers and entrepreneurs within the agro-industrial complex of livestock production and utilization.

Consumption data show that the growth of demand for eggs and milk is derived from the high income elasticity of both commodities. In the future, to achieve a nutrient standard of 5 grams of livestock protein per capita per day, eggs have the potential to make a high contribution. On the other hand, poultry can substitute for ruminant meat demand.

In the future it will be important to give high priority to production of eggs and chicken meat. Therefore, the production program should be designed to reach a target greater than projected demand. Particular attention should be focused on reducing the costs of production, which are presently far above import prices. Milk production growth will have to slow down after self-sufficiency is achieved, around 1995, and maintained at a rate equal to the growth rate of demand after that.

Although milk consumption is high, its contribution to the protein requirement is low, because of the low protein content of milk compared to meat and eggs. It is suggested that the target composition of livestock protein be changed in the future, to make it more realistic and in accord with potential production capacity. At present, the target composition of yearly consumption per capita should be shifted toward eggs and chicken meat.

The policy conclusions that emerge from this study include the following:

- Cassava will remain important for food security for the low-income population in rural areas and demand for cassava starch-based foods will increase as income rises.

- Utilization of cassava for feed and exports is likely to remain less than 15 percent of total production to the year 2000. The export potential will be about 13 percent.

- Improvement in postharvest and processing technologies is critically important.

- Unbiased government intervention in trade, marketing, prices, research, and extension is important for crop diversification in production and consumption.

- An integrated development policy should be established for cassava, maize, and soybean production with agroprocessing and feed mills together with livestock and poultry development.

- Product development, processing, and postharvest technologies for cassava should be emphasized to increase demand.

- Most postharvest technologies have economies of scale; therefore consolidation and regionalization of production together with group farming is important. The processing plants should be in the production centers.

- Substitution of feedgrains with gaplek leads to an increase in demand for protein supplements such as soybean meal and fish meal. The relative prices of these commodities are an important factor influencing the substitution.

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