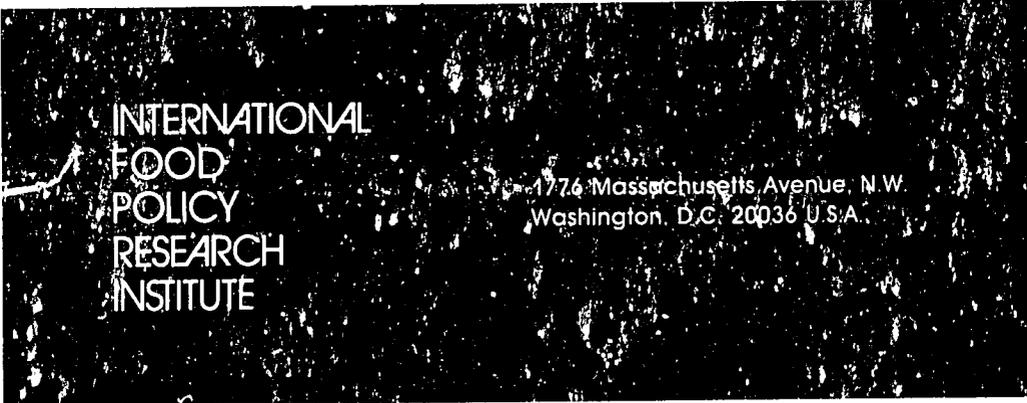

Trends in the Production and Use of Cassava and Other Selected Food Crops in Tropical Asia

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Reprinted from *Cassava in Asia, its Potential and Research Development Needs*, Proceedings of a Regional Workshop held in Bangkok, Thailand 5-8 June, 1984



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Introduction

This paper examines the trends in the production and use of root and tuber crops and food grains in tropical Asia. For purposes of this workshop, it would have been desirable to limit the paper to upland crops; however, the available statistics on production and area are aggregates from both upland and lowland areas, and so the trends presented in this paper are not separated by climate.

The root and tuber crops discussed here include potatoes, sweet potatoes, cassava, yams, and other root crops. Production data are in terms of fresh roots. Food grains include rice (unmilled, or paddy rice), wheat, maize, sorghum, millets, other cereals, and pulses.

By definition, tropical Asia covers all Asian countries between the Tropic of Cancer and the Tropic of Capricorn. Several countries lie partly within this band and thus are partly temperate and partly tropical. Production and area trends presented here relate to entire countries, including their temperate zones. The analysis covers Bangladesh, Burma, China, Hong Kong and Singapore, India, Indochina (comprising Laos, and Vietnam), Indonesia, Malaysia, the Pacific Islands (comprising Fiji and Papua New Guinea),* the Philippines, Sri Lanka, and Thailand. The data for China are presented separately (unless otherwise indicated) because information on this country's agricultural economy is still relatively sparse, and the reconstructed and revised estimates available probably do not give a complete picture.

* Fiji and Papua New Guinea have been included in the study although they belong geographically to Oceania

The source of data on harvested area, production, domestic utilization, and trade of the crops used in this paper is the Food and Agriculture Organization (FAO) data base comprising the supply utilization accounts and the production yearbooks. In several cases FAO data differ from those based on national sources, and the differences in some cases are quite large. Since this analysis is a comparative study at the regional level, the consistent set of FAO time series is used. It should be noted that the reliability of data on roots and tubers, including cassava, is less than that of food grains in some countries. It is also possible that improvements in the methodology effected in some countries might have introduced non-comparability over time.

Global Perspective, 1982

Cassava

In 1982 the world's cassava production, all of which came from developing countries, was estimated at 129 million tons, or a caloric equivalent of 39 million tons of wheat. About three-fourths of this production was shared almost equally between Asia and Africa; Latin America contributed the remaining one-fourth. More than half of the total cassava area of 14.6 million hectares was in sub-Saharan Africa, but the average yield in this region was much lower than in Asia and Latin America. Productivity in both Asia and Latin America was about 11 tons/ha compared to only 6.5 tons/ha in sub-Saharan Africa. Tropical Asia (including China) represented about 38% of the total production and 30% of the total area of world cassava (Figure 1). The region accounts for practically all of the cassava production of Asia.

Roots and tubers

Table 1 shows that the world production of fresh roots and tubers as a group in 1982 totaled 550 million tons, about 63% of which came from developing countries. Nearly all of the production from developed countries was potatoes, but that from developing countries consisted of about 37% cassava, 33% sweet potatoes, 20% potatoes, and 10% other roots and tubers. The developing countries accounted for more than 70% of the 47 million hectares of world harvest of these crops, but their average yield (10 tons/ha) was low compared to about 16 tons/ha in the developed countries. Among the developing regions, root and tuber yields were highest in Asia (12.6 tons/ha) and lowest in sub-Saharan Africa (6.6 tons/ha). Tropical Asia (including China) accounted for about 37% of the production and slightly over a third of the world's area in roots and tubers in 1982; these are 1% less than the shares of world production and area in all of Asia.

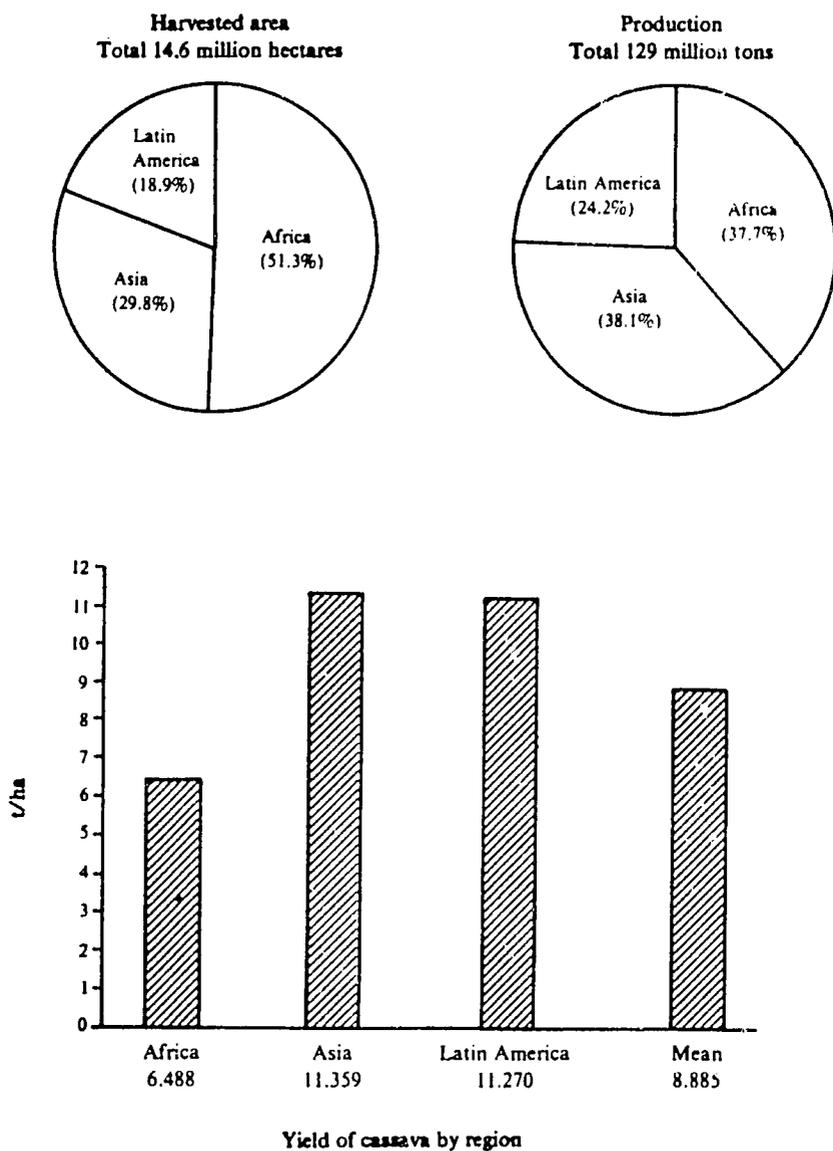


Figure 1. *World cassava area, production, and yield, 1982.*
Source: FAO Production yearbook, 1982

Table 1. World production and area of root and tuber crops and food grains by region, 1982.

Country group*	Roots and tubers				Food grains			
	Production		Area		Production		Area	
	(million tons)	(%)	(million ha)	(%)	(million tons)	(%)	(million ha)	(%)
Developed countries	206.8	37.4	13.3	28.0	885.0	50.7	324.1	40.6
Developing countries	345.6	62.6	34.2	72.0	859.4	49.3	474.5	59.4
Asia	208.5	37.7	16.6	34.9	632.9	36.3	300.2	37.6
North Africa/ Middle East	8.0	1.5	0.7	1.4	66.2	3.8	49.2	6.2
Sub-Saharan Africa	82.8	15.0	12.6	26.5	47.1	2.7	61.0	7.6
Latin America	46.3	8.4	4.3	9.2	113.2	6.5	64.1	8.0
World	552.4	100.0	47.5	100.0	1,744.4	100.0	798.6	100.0

* Following the FAO economic classification of world countries and the IFPRI regional grouping of developing countries.

Sources: Basic data are from the FAO *Production yearbook, 1982*. The estimates for China are from the data set assembled by Bruce Stone of IFPRI.

Food grains

World food grain production in 1982 was 97% cereals and 3% pulses. Total food grain output in that year, amounting to 1744 million tons, was about equally shared between the developed countries, 51%, and developing countries, 49%. (The relative share of developing countries may be a little overstated because rice, which is mostly grown in these countries, is expressed in paddy terms.) This output came from 800 million hectares, 60% of which was in the developing countries. Average yields calculated from these figures are 1.8 tons/ha for developing countries compared to 2.7 tons/ha for developed economies. Food grain production in the developed countries was almost wholly (99%) cereals, while about 4% of production in the developing countries was pulses. Asia, which accounted for about 36-37% of both production and area of the world's food grains, recorded a yield of 2.1 tons/ha. Tropical Asia (including China) contributed a third of the world's food grain production in 1982, or about 94% of the food grain output of Asia as a whole.

The Regional View, 1982

Cassava

Cassava production in tropical Asia was nearly 46 million tons in 1982, a little less than half of which was produced in Thailand. Indonesia (12.8 million tons) and India (5.6 million tons) were the other two major producers of cassava in tropical Asia (Table 2). Average yield of cassava was high in India at 18 tons/ha, followed by Thailand's 14 tons/ha; in Indonesia it was less than 10 tons/ha.

Roots and tubers

The harvested area under root and tuber crops as a group was about 6.4 million hectares, of which cassava accounted for a little more than 60%. A total of 67 million tons of roots and tubers was produced in tropical Asia during 1982. Thailand, India, and Indonesia were the major root and tuber crop producers, and shared 80% of the total output.

Food grains

Based on 1982 data, tropical Asia produced nearly 275 million tons of food grains, a little over half of which came from India. Paddy rice was the most important grain, constituting two-thirds of the output. Coarse grains comprising maize, sorghum, and millets contributed 38 million tons or 14% to the total. About 46% of the 185 million hectares of food grains was devoted to rice, with an average yield of a little more than 2 tons/ha. The

Table 2. Area and production of cassava, roots and tubers, and food grains in tropical Asia, 1982.

Country	Area (000 ha)			Production (000 t)		
	Cassava	Roots & tubers	Food grains	Cassava	Roots & tubers	Food grains
Bangladesh	0	172	11382			
Burma	5	24	5996	0	1775	22233
Hong Kong & Singapore	0	1	0	50	186	14871
India	310	1235	126590	0	5	0
Indochina	512	1013	8009	5507	16767	145252
Indonesia	1300	1655	12353	2887	5311	17301
Malaysia	35	58	730	12300	15375	38219
Pacific Islands	17	182	20	375	553	2072
Philippines	200	483	6872	193	1282	30
Sri Lanka	51	70	907	2300	3576	11878
Thailand	1500	1540	11596	500	679	2214
Tropical Asia (excluding China)				21000	21363	21077
China	3930	6433	185255	45672	66872	275147
Tropical Asia (including China)	380	9743	95618	3300	136700	317715
	4310	16176	280873	48972	203572	592862

Note: Parts may not add to totals due to rounding.

Source: FAO Production yearbook, 1982.

area under coarse grains was 29 million hectares yielding an average of about 1.3 tons/ha. Wheat was the other important cereal but was grown exclusively in the temperate regions (mostly India) with a total output of 39 million tons.

Production Trends*

Cassava

Between the period 1961-65 and the period 1976-80, the production of cassava in tropical Asia more than doubled, reaching an annual average of 38 million tons during the later period (Table 3). Two countries contributed three-fourths to the increase in production: Thailand (56%) and India (20%). Indonesia's share in the production of the region declined sharply from two-thirds in 1961-65, to about one-third in 1976-80. This was due to a meager .5% annual growth in cassava production over this period. By contrast, Thailand's rapid growth in output improved its share from one-tenth to one-third. India and Indochina together accounted for a quarter of the region's cassava production in the late 1970s.

Assessing the growth rate trends from 1961-1980 (Table 4), cassava production expanded at an annual rate slightly less than 5% — a little more than half due to area expansion. Cassava yields increased at 2.2% per annum.

Looking at the data from 1961-1980 by decade, Table 5 shows that growth in area and production in tropical Asia was much higher in the 1970s than in the 1960s. Growth in area went from .69% per annum in the first decade to 5.64% in the second decade. Production growth went from 2.3% per annum in the 1960s to 8.2% in the 1970s.

Growth rates showed considerable variation among the countries in the region. The most rapid production increase was in Thailand, which nearly tripled its production growth rate from the 1960s to the 1970s, largely due to corresponding area increases. This production expansion was in response to the export demand from the EEC, and resulted in cassava cultivation being extended into areas with poorer soils. Consequently, average yields in Thailand essentially remained stagnant. The lack of increased yields may also be partly due to a need for technological improvements.

* The analysis of trends is generally based on the quinquennial averages for 1961-65 and 1976-80, the average growth rate being calculated as a compound growth rate between the mid-years of the two periods. However as indicated in some cases, especially for cassava, growth rates from semi-logarithmic equations for the periods 1961-80, 1961-70, and 1971-80 are used.

Table 3. Average annual area, production, and yield of cassava in tropical Asia, 1961-65 and 1976-80.

Country	1961-65			1976-80		
	Area (000 ha)	Production (000 t)	Yield (t/ha)	Area (000 ha)	Production (000 t)	Yield (t/ha)
Burma	1	5	10.675	2	22	9.117
Hong Kong & Singapore	0	0	0	neg.	1	n.a.
India	254	2295	9.036	374	6412	17.167
Indochina	155	1147	7.400	409	3332	8.147
Indonesia	1572	11833	7.529	1386	12662	9.138
Malaysia	23	218	9.478	38	387	10.214
Pacific Islands	13	137	10.538	16	182	11.375
Philippines	90	562	6.246	176	1759	9.975
Sri Lanka	44	328	7.465	86	591	6.873
Thailand	113	1789	15.808	971	13102	13.491
Tropical Asia	2264	18316	8.090	3459	38452	11.118

Note: Parts may not add to totals due to rounding.

n.a. = not available.

Source: FAO Production yearbook tapes, 1975, 1979, and 1980.

Table 4. Annual growth rates (%) in area, production, and yield of cassava in tropical Asia, 1961-80.

Country	Area	Production	Yield
Burma	11.36	10.24	-1.00
India	2.51	7.22	4.59
Indochina	6.06	6.85	0.74
Indonesia	-0.71	0.61	1.33
Malaysia	2.87	4.06	1.16
Pacific Islands	1.55	1.94	0.39
Philippines	4.27	7.21	2.82
Sri Lanka	4.71	4.43	-0.27
Thailand	15.34	13.94	-1.22
Tropical Asia	2.66	4.94	2.22

Source: FAO Production yearbook tapes, 1975, 1979, and 1980.

Table 5. Annual growth rates (%) in area, production, and yield of cassava in tropical Asia, 1961-70 and 1971-80.

Country	Area		Production		Yield	
	1961-70	1971-80	1961-70	1971-80	1961-70	1971-80
Burma	15.77	7.44	15.74	6.00	-0.003	-1.36
India	4.17	0.52	13.53	1.39	8.99	0.87
Indochina	-1.42	18.89	-1.90	20.82	-0.49	1.62
Indonesia	-0.59	-0.42	-0.93	2.23	-0.34	2.66
Malaysia	4.93	6.66	4.44	4.94	-0.47	-1.61
Pacific Islands	1.67	1.62	1.88	1.62	0.21	0
Philippines	-1.05	11.70	-2.16	23.41	-1.12	10.48
Sri Lanka	7.58	-4.03	2.93	3.59	-4.32	7.94
Thailand	7.87	18.76	6.95	18.89	-0.85	0.11
Tropical Asia	0.69	5.64	2.32	8.16	1.62	2.39

Source: FAO Production yearbook tapes, 1975, 1979, and 1980.

Both India and the Philippines recorded impressive production increases. In India the rapid increases occurred in the 1960s rather than the 1970s and were due more to increased yields, which contributed two-thirds to the production, than to increased area. In the Philippines, the rapid production growth occurred in the 1970s, when the growth rates for area and yield both exceeded 10%.

The yields in Indonesia during 1971-80 rose at an average rate of 2.7% per annum, compared to a slight decline in 1961-70. This growth in yield

more than compensated for the decline in cassava area in the 1970s, as evidenced by the annual 2.2% growth in production.

Both area and production of cassava declined in Indochina in the first decade, and then underwent very rapid growth between 19-21% in the second decade. It is probable that data problems contributed to these exceedingly high figures.

Roots and tubers

The production of roots and tubers (which include cassava, potatoes, sweet potatoes, yams, and other roots) totaled 58 million tons annually during 1976-80 (Table 6), with cassava accounting for nearly two-thirds of this amount. The average output of potatoes and sweet potatoes was 10 and 8.5 million tons, respectively; together, they shared 32% of the root and tuber crop output. The major root and tuber producers during 1976-80 were India (16.2 million tons), Indonesia (15.4 million tons), and Thailand (13.4 million tons). These three countries accounted for 78% of the region's output. Nearly half of India's root and tuber crop production was potatoes, followed by cassava, which accounted for a little less than 40% of production. Cassava made up about 97% of the roots and tubers in Thailand. It is the major root crop in Indonesia (82%); sweet potatoes account for almost all the rest of root and tuber production there.

Table 6. Average annual area and production of roots and tubers in tropical Asia, 1961-65 and 1976-80.

Country	1961-65		1976-80	
	Area (000 ha)	Production (000 t)	Area (000 ha)	Production (000 t)
Bangladesh	100	786	164	1656
Burma	20	65	18	92
Hong Kong & Singapore	9	56	1	6
India	797	6225	1286	16241
Indochina	397	2388	827	5864
Indonesia	2227	23061	1776	15380
Malaysia	50	379	60	528
Pacific Islands	132	927	173	1217
Philippines	271	1469	456	2946
Sri Lanka	58	389	115	772
Thailand	140	1980	1007	13445
Tropical Asia	4201	37724	5881	58146

Source: FAO Production yearbook tapes, 1975, 1979, and 1980.

The production of these commodities as a group increased at an annual rate exceeding 2.9% between the early 1960s and late 1970s. Thailand experienced the highest growth in production, reaching a phenomenal 13.6% increase due mainly to the growth of cassava. India and Indochina recorded production growth rates exceeding 6% per annum. Potato production in India increased at 7% per annum.

The average annual harvested area under roots and tubers in tropical Asia was 5.9 million hectares during 1976-80, yielding a per hectare output of less than 10 tons. Nearly 70% of this area is shared by Indonesia, India, and Thailand. Average output per hectare in both Thailand and India was around 13 tons/ha, while that in Indonesia was less than 9 tons. The Philippines and Indochina also have significant areas under roots and tubers.

Growth of area under roots and tubers in the region between 1961-65 and 1976-80 was only 2.2% a year as compared to a 2.9% production growth. This suggests an improvement in yield of approximately 0.7% per annum, or less than a ton per hectare in absolute terms. Apart from Thailand, rapid growth in the area under roots and tubers was experienced by Indochina (5.0%) and Sri Lanka (4.7%). The Philippines, India, and Bangladesh exhibited growth rates ranging between 3.0% and 3.5% per annum.

Thailand and Indonesia recorded a decline in the overall yield of root and tuber crops between 1961-1980. On the other hand, India showed a remarkable improvement of about 60% (from 7.8 to 12.6 tons/ha), largely due to an increase in potato yields. Crop yields were stagnant in the Pacific Islands and Sri Lanka, but Bangladesh, Burma, Indochina, Malaysia, and the Philippines recorded yield improvements varying between 1 and 2 tons/ha.

Food grains

Total food grain production in tropical Asia, which averaged nearly 254 million tons a year during 1976-80 (Table 7), was composed of about 66% paddy rice, 13% wheat, 16% other cereals, and 5% pulses. As may be expected, India accounts for the largest portion (58%) of total production; Indonesia, Bangladesh, and Thailand have relatively lower production but are nevertheless significant producers. Paddy is widely grown, principally under irrigated conditions, and represents 80% or more of the national production in six countries of the region. Maize, like rice, is also widely grown, but here again India produces 40% of the output. Minor cereals including sorghum and millets, which together form 9% of food grain

Table 7. Average annual production of food grains (000 t) in tropical Asia, 1961-65 and 1976-80.

	1961-65			1976-80		
	Paddy	Wheat	Total food grains	Paddy	Wheat	Total food grains
Bangladesh	15,048	37	15,348	19,211	504	20,009
Burma	7,786	38	8,168	10,609	68	11,125
Hong Kong and Singapore	19		19			
India	52,733	11,191	99,382	73,866	31,335	146,433
Indochina	12,699		13,301	12,961		13,703
Indonesia	12,396		15,387	25,478		29,183
Malaysia	1,154		1,163	1,924		1,943
Pacific Islands	21		38	26		59
Philippines	3,957		5,264	7,043		10,045
Sri Lanka	967		1,002	1,824		1,886
Thailand	11,267		12,430	16,055		19,270
Tropical Asia	118,047	11,266	171,502	168,998	31,907	253,654

Source: FAO Production yearbook tapes, 1975, 1979, and 1980.

production in tropical Asia, are relatively important only in India. Most of the region's pulses are produced in India where the crop provides a major source of protein in the diet.

Wheat exhibited the fastest production growth, exceeding 7% annually during the 20 years ending in 1980 (Table 8). Very rapid increases in wheat production were achieved in Bangladesh and northern India. Maize production in the region expanded at a fairly rapid rate of nearly 3%. Rice, the major crop of tropical Asia, showed a slower yearly growth in total production of 2.5%, although individual production growth rates of 3.8% or more were recorded in Indonesia, Sri Lanka, the Philippines, and Malaysia.

The average annual production growth of food grains as a group in tropical Asia was 2.7%. Average annual production growth rates of 4% or more during 1961-80 were achieved in Indonesia, the Philippines, and Sri Lanka, while rates of 3-4% were recorded in Malaysia and Thailand. Yearly increases in food grain production between 2-3% occurred in Burma, India, and the Pacific Islands.

Of the 82 million ton increase in tropical Asia's food grain production between 1961-65 and 1976-80, paddy accounted for over 60%. Wheat

Table 8. Annual growth rates (%) in area and production of food grains in tropical Asia, 1961-80.

	Area			Production		
	Paddy	Wheat	Food grains	Paddy	Wheat	Food grains
Bangladesh	0.81	9.39	0.91	1.66	*	1.79
Burma	0.27	2.14	0.41	2.20	3.99	2.19
Hong Kong and Singapore	**		**	**		**
India	0.70	3.34	0.50	2.32	7.27	2.63
Indochina	-0.57		-0.42	0.14		0.20
Indonesia	1.40		0.99	4.98		4.41
Malaysia	1.96		1.96	3.80		3.80
Pacific Islands	0.90		2.53	1.24		2.97
Philippines	0.68		1.83	3.81		4.31
Sri Lanka	2.95		3.10	3.99		4.00
Thailand	1.43		2.36	2.34		3.08
Tropical Asia	0.72	3.38	0.71	2.45	7.32	2.66

* More than 10 percent.

** Less than -10 percent.

Source: FAO Production yearbook tapes, 1975, 1979, and 1980

represented almost 25% of the total increase, although its relative share of production in the late 1970s was only 13%. In the case of the other food grain items, the relative contributions to the increase in total production during the period were around 7% for maize, and about 6% for other cereals and pulses combined.

About three-fourths of the growth of food grain production in the region during 1961-80 could be attributed to increases in crop yields, and one-fourth to area expansion. The major contribution of crop yields to production growth was especially evident in paddy and wheat. Area expansion contributed more than the growth of crop yield in maize. Crop yield was the major source of growth of total food grain production in Burma, India, Indonesia, and the Philippines. Growth of food grain production in Thailand, Sri Lanka, and the Pacific Islands was due more to area expansion than to improvements in yield. In Bangladesh and Malaysia, the contributions of crop yield and area to increased production were nearly equal.

Maize, sorghum, and millets. These upland crops with potential use in animal feed are of special interest in relation to cassava. The average production of maize, which is widely grown in tropical Asia, increased

from 10.1 million tons in the early 1960s to 15.9 million tons in the late 1970s (Table 9). India accounted for roughly 40% of the output during the later period, followed by Indonesia with 20%. The Philippines and Thailand were the other two major maize-growing countries with a share of 17-18% each. The rapid expansion of maize production in Thailand, at an average rate exceeding 8.5% (Table 10), was entirely due to area expansion. Like cassava, the yield of maize in Thailand declined as cultivation was extended to marginal lands. Similarly, the major contribution to production growth in India came from increases in area (79%), as maize yields rose by less than .5% per year over the 1961-80 period. The overall 3% average growth rate in maize production in tropical Asia (to which area expansion contributed about 60%) was generated by increased demand for animal feed in the region, except in India and Indonesia, and, in the particular case of Thailand, by the fast growth of maize exports.

Of the 12 million tons of sorghum produced annually in tropical Asia during 1976-80, 98% was produced in India (Table 9). Although small quantities of the crop also are grown in Sri Lanka, the Pacific Islands, Indochina, and Thailand, it was only in Thailand that average yearly output exceeded 220,000 tons during 1976-80. Sorghum production in tropical Asia increased at a slow 1.5% annual rate (Table 10). This was the

Table 9. Average annual production of maize, sorghum, and millets (000 t) in tropical Asia, 1961-65 and 1976-80.

	1961-65			1976-80		
	Maize	Sorghum	Millets	Maize	Sorghum	Millets
Bangladesh	4			2		
Burma	58		53	82		53
Hong Kong and Singapore						
India	4,593	8,848	7,728	6,102	11,629	9,539
Indochina	492			577	24	
Indonesia	2,804			3,390		
Malaysia	9			17		
Pacific Islands	1	1		5	5	
Philippines	1,273			2,950		
Sri Lanka	10	1	19	22	2	20
Thailand	816	47 ^a		2,718	221	
Tropical Asia	10,060	8,897	7,800	15,865	11,881	9,612

a) Average of 1964 and 1965.

Source: FAO Production yearbook tapes, 1975, 1979, and 1980.

Table 10. Annual growth rates (%) in area and production of maize, sorghum, and millets in tropical Asia, 1961-80.

	Area			Production		
	Maize	Sorghum	Millets	Maize	Sorghum	Millets
Bangladesh	-5.68	0.02	-5.57	-5.46	-1.52	-4.63
Burma	-1.01	-	1.38	2.60		0.56
Hong Kong and Singapore						
India	1.45	-0.81	-0.28	1.85	1.53	1.33
Indochina	1.35	6.93 ^a		0.78	7.07 ^a	
Indonesia	-0.61			1.30		
Malaysia	2.10			3.95		
Pacific Islands	11.26	10.11		14.97	12.38	
Philippines	3.37			5.70		
Sri Lanka	5.31	3.02	2.37	5.90	8.28	0.72
Thailand	8.66	18.76 ^b		8.57	12.30 ^b	
Tropical Asia	1.82	-0.81	-0.26	3.12	1.53	1.32

a) Relates to 1971-80.

b) Relates to 1964-80.

Source: FAO Production yearbook tapes, 1975, 1979, and 1980.

same growth rate for India, which was the major producer. Although sorghum yield improved at 2.4% in India, the area under the crop declined over the period, particularly in the early 1960s.

In the case of millets, tropical Asia produced an annual average of 9.6 million tons in 1976-80, most of which was again produced in India (Table 9). Burma and Sri Lanka also grew small quantities of millets. As in the case of sorghum, the area under millets declined over the 1961-80 period, although at a slower rate (Table 10). The crop's production growth of 1.3% per annum was a little less than the growth of sorghum (1.5%).

China

Cassava. In China, cassava is grown primarily on the dryland slopes of Guangdong province and the Guangxi Zhuang autonomous region. Data collected by Bruce Stone of the International Food Policy Research Institute (IFPRI) indicate that in 1964 the cassava production did not exceed 1 million tons cultivated over an area of about 100,000 ha. The corresponding figure in 1980 is estimated at 3 million tons from an area of about 350,000 ha, which would imply an average yield of 8.6 tons/ha. (Stone feels that the FAO's estimate of 226,000 ha in 1980 is too low.)

Roots and tubers. Available data on roots and tubers in the People's Republic of China indicate an average annual production of 148 million tons during 1976-80, from a harvest area of 11.2 million hectares. This would suggest a yield per hectare of 13 tons, or about the average level mentioned earlier for tropical Asia. The annual production growth in 1961-80 averaged 3.1%, which could be attributed wholly to increases in yield, since the area under tuber crops in the country showed an average decline of about 0.4 % per annum.

Food grains. During 1976-80, Chinese food grain production averaged almost 270 million tons. About half of the total production was paddy and a fifth was maize. Millet and sorghum together represented only 5%; other grains, mostly wheat, made up the rest of the country's grain production. Assembled time-series data suggest that food grain production in China expanded at an average rate of over 4% per annum during the 1961-80 period, resulting in a near doubling of the production between 1961-65 and 1976-80. (The early 1960s were years of exceedingly low output levels in China; consequently, production growth measured from this initial period would tend to be somewhat exaggerated.) Increases in the production of paddy, the principal food grain in China, determined the rate of production growth. Between the early 1960s and the late 1970s, the production of maize doubled but growth of sorghum production was very slow and that of millet stagnant.

Trends in Utilization

Cassava

About a third of the annual production of 38 million tons of cassava in tropical Asia during 1976-80 was exported. Of the balance, nearly four-fifths was consumed as food, directly or in processed form. Feed use represented nearly 3%, with the remaining balance being equally divided into other uses and allowance for waste. Among the individual countries, about 96% of the average production of 13.1 million tons of cassava in Thailand during 1976-80 was exported (Table 11). This left only half a million tons for domestic use, which was utilized wholly for food. The FAO data do not show any domestic feed use of cassava in Thailand, Burma, Sri Lanka, or India (Table 12). Nearly 20% of the domestic supply is used as feed in Malaysia, but less than 10% is used in the other countries. Utilization data for Sri Lanka show a large 30% allowance for wastage.

Of the total food use of 20 million tons of cassava in the region, 40% was consumed in Indonesia, followed by 30% in India. Indochina countries and the Philippines consumed 22% of the total. Hong Kong and Singapore imported about 100,000 tons of cassava in the form of starch and tapioca pearl, of which a little less than 60% was reported to be locally consumed.

Table 11. Average annual production, net trade, and domestic use of cassava (000 t) in tropical Asia, 1966-70 and 1976-80.

Country	1966-70			1976-80		
	Production	Net trade ^a	Domestic use	Production	Net trade ^a	Domestic Use
Burma	11	-2	13	22	0	22
Hong Kong & Singapore	3	-44	47	1	-82	75
India	4356	0	4355	6412	0	6412
Indochina	1012	0	1012	3332	0	3332
Indonesia	10946	621	10323	12662	1042	11619
Malaysia	260	64	195	387	64	324
Pacific Islands	151	0	151	182	0	182
Philippines	473	-2	475	1759	-3	1762
Sri Lanka	371	-5	376	591	0	591
Thailand	2615	2370	284	13102	12553	542
Tropical Asia	20198	3002	17233	38451	13574	24863

a) Net trade = exports - imports.

Source: FAO Supply utilization accounts tape, 1981.

Table 12. Distribution of total domestic use (%) of cassava in tropical Asia, 1966-70 and 1976-80.

Country	1966-70				1976-80			
	Food	Feed	Waste	Other ^a	Food	Feed	Waste	Other ^a
Burma	92	0	8	0	90	0	10	0
Hong Kong & Singapore	25	6	2	67	68	5	2	25
India	93	0	7	0	93	0	7	0
Indochina	80	10	10	0	81	10	10	0
Indonesia	68	2	10	21	69	2	11	18
Malaysia	75	21	3	1	78	18	3	1
Pacific Islands	77	8	15	0	77	8	15	0
Philippines	81	6	0	12	90	6	0	4
Sri Lanka	70	0	30	0	70	0	30	0
Thailand	99	0	0	1	100	0	0	0
Tropical Asia	76	2	9	13	79	3	9	9

a) Includes planting materials and non-food uses.

Source: FAO Supply utilization accounts tape, 1981.

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Domestic use of cassava in tropical Asia increased from 17 million tons in the early 1960s to 25 million tons in the late 1970s (Table 11), indicating an average growth rate of 3.7% a year. Relative to total production, the use of cassava directly as food declined from 65% during 1966-70 to 50% in 1976-80, as cassava exports increased from 15% to 35% over the same period. The domestic use of cassava for feed exhibited the most rapid growth of over 7%, nearly double that of the overall growth of total domestic utilization. Nearly half of the food use was in the form of roots, and the other half in the form of starch or tapioca pearl.

Most of cassava exports were in the form of dried cassava or pellets from Thailand and Indonesia. The average yearly exports of cassava flour, starch, and tapioca during 1976-80 totaled 630,000 tons of fresh root equivalent, mainly from Thailand and Malaysia; this represented a decline from the late 1960s, when the level of exports of these commodities was nearly 900,000 tons. During 1966-70 Indonesia exported 74,000 tons of cassava starch, but this dropped to 20,000 tons in the late 1970s.

Cassava imports by countries in tropical Asia increased about 100,000 tons over the referenced period (Table 13). Hong Kong and Singapore imported about 99,000 tons in the late 1970s, part of which was re-exported. Cassava imports by Hong Kong were in the form of tapioca while those by Singapore were starch. Indonesia also imported 62,000 tons of cassava, mainly in the form of starch.

Table 11 shows that the ratio of the total domestic utilization of cassava to its production in tropical Asia decreased from 85% in the early 1960s to 65% in the 1970s. This decline indicates that the ratio of net exports to total production rose from 15% to 35% during the period. Net exports as a percentage of total production in Indonesia increased marginally from 5.7% to 8.2%; in Malaysia, this proportion declines from 25% to 16%, indicating expanded domestic use of cassava in that country.

Roots and tubers

Of the average production of 58 million tons of roots and tubers in tropical Asia during 1976-80, 44 million tons, nearly three-fourths, was utilized domestically (Table 14). The balance of 14 million tons (largely cassava) represented net exports and changes in stocks. As indicated earlier, more than half of the region's consumption of roots and tubers was cassava, followed by potatoes with 24% and sweet potatoes with 18%. Other roots and tubers accounted for less than 3%.

The distribution of the domestic use of roots and tubers was 78% for food and 9% for seed and other uses (Table 15). Feed use of these commodities as a group was only 2%; about 10% was reported as waste.

Table 13. Average annual exports and imports of cassava (000 t) in tropical Asia, 1966-70 and 1976-80.

Country	1966-70		1976-80	
	Exports	Imports	Exports	Imports
Burma	-	2	-	-
Hong Kong & Singapore	3	47	17	99
India	neg.	-	neg.	-
Indochina	-	neg.	-	-
Indonesia	621	-	1104	62
Malaysia	69	5	66	2
Pacific Islands	-	-	-	-
Philippines	4	6	neg.	3
Sri Lanka	-	5	-	neg.
Thailand	2370	-	12553	neg.
Tropical Asia	3067	65	13740	166

Note: Figures of exports and imports refer to cassava flour, tapioca, starch, and dried cassava converted into fresh roots.

Source: FAO Supply utilization accounts tape, 1981.

Table 14. Average annual domestic use of roots and tubers and food grains (000 t) in tropical Asia, 1966-70 and 1976-80.

	1966-70		1976-80	
	Roots & tubers	Food grains	Roots & tubers	Food grains
Bangladesh	1,459	18,117	980	21,896
Burma	59	7,379	93	10,191
Hong Kong and Singapore	159	1,281	228	1,770
India	10,108	112,207	16,665	146,422
Indochina	2,239	14,451	5,862	15,241
Indonesia	13,813	20,258	14,308	31,510
Malaysia	273	2,364	408	3,490
Pacific Islands	1,009	145	1,236	237
Philippines	1,334	6,879	2,953	10,658
Sri Lanka	482	2,193	774	2,741
Thailand	548	11,520	886	14,747
Tropical Asia	31,483	196,854	44,393	258,903

Source: FAO Supply utilization accounts tape, 1981.

Table 15. Distribution of total domestic use (%) of roots and tubers in tropical Asia, 1966-70 and 1976-80.

Country	1966-70				1976-80			
	Food	Feed	Waste	Other	Food	Feed	Waste	Other
Bangladesh	80	0	10	10	78	0	15	6
Burma	81	0	10	10	82	0	10	8
Hong Kong and Singapore	47	21	4	27	60	20	4	16
India	83	0	11	7	81	0	11	8
Indochina	74	9	10	7	76	9	9	6
Indonesia	74	1	9	16	73	2	10	15
Malaysia	71	22	5	2	75	20	4	1
Pacific Islands	81	2	17	0	81	2	17	0
Philippines	85	5	3	6	89	5	2	3
Sri Lanka	71	0	28	1	70	0	29	1
Thailand	95	0	5	1	96	0	4	0
Tropical Asia	78	2	10	10	78	2	10	9

Note: Parts may not add to totals due to rounding

Source: FAO Supply utilization accounts tape, 1981.

As Table 14 shows, the two single largest consumers of root and tuber crops in tropical Asia are India (38%) and Indonesia (32%). Data for the 1976-80 period indicate that 81% of the total consumption of these commodities in India was for food, while in Indonesia this percentage was 73% (Table 15). In the Philippines 89% of the total domestic consumption of roots and tubers was for food. Potatoes composed half of the root and tuber consumption in India, and in Indonesia cassava was the main root and tuber crop consumed. Cassava accounted for 60% of the domestic use of roots and tubers in the Philippines.

Between 1966-70 and 1976-80, domestic use of roots and tubers in tropical Asia increased at 3.5% per annum, a slightly lower rate than that for cassava. Potato consumption showed the most rapid growth at an average rate of 7.2%, while sweet potatoes exhibited a very slow growth rate of less than 1% per annum. The growth rate of feed use at 6.2% per annum was much higher than that of food use, which expanded at a rate of 3.6% per annum.

The annual increase in the consumption of roots and tubers was about 5% for India, roughly half of the rapid increase of 10% found in Indochina. Consistent with the slow growth in the production of roots and tubers in Indonesia, consumption growth was also stagnant in this country between

the late 1960s and 1970s. Domestic consumption of potatoes doubled in India over this period. In the Philippines, the rapid growth in the consumption of total roots and tubers, more than 8% per annum between 1966-70 and 1976-80, was largely due to cassava. The only decrease in consumption during this period was in Bangladesh, where the domestic use dropped from 15 million tons to 10 million tons, an average annual decline of about 4%.

Food grains

Paddy, wheat, and maize are the principal components of food grain consumption in tropical Asia. Paddy, the main staple food of the region, represents the bulk of consumption in most of these countries, especially in Bangladesh, Burma, and Thailand. A significant portion of wheat consumption in tropical Asia is imported and supplements the amount produced in Bangladesh, Burma, and India, which are partly in the temperate zone. Maize, which is consumed in the region both directly for food and as animal feed, represents a significant portion of the domestic utilization of food grains in Hong Kong, the Philippines, Singapore, and Taiwan.

The average annual consumption of food grains in tropical Asia rose from 197 million tons in the late 1960s to 259 million tons during the late 1970s, representing a growth rate of 2.8% a year between these periods. Growth of food grain consumption was particularly rapid in Indonesia, Malaysia, the Pacific Islands, and the Philippines, where average annual increases of 4% or more occurred from 1966-70 to 1976-80. Fairly rapid increases in domestic utilization exceeding 3% annually were achieved in Burma, Hong Kong, and Singapore. The slowest growth rate in food grain consumption was registered by the Indochina countries at only .5% per year. India, where total domestic use rose at 2.7% per year during this period, accounted for about 57% of the total food grain consumption in tropical Asia during the late 1970s (Table 14).

About 65% of the food grains in tropical Asia during 1976-80 was consumed directly as food, 9% was used for animal feed, and the remaining 26% went to other uses such as seed and waste allowance (Table 16). Feed use of grains was highest in Hong Kong and Singapore at 45%; it was also high at 27% in Malaysia, 16% in Thailand, and 15% in the Philippines. The proportion of grain used as feed was higher for maize and other non-rice cereals in all countries except India. In fact, the feed use of these grains was even higher than their food use in Hong Kong, Singapore, and Malaysia. The percentages of food and feed uses of maize and other non-rice cereals were almost equal in Thailand and the Pacific Islands. In all other non-rice countries, major utilization of these grains was as a food source.

Table 16. Distribution of total domestic use (%) of food grains in tropical Asia, 1966-70 and 1976-80.

	1966-70			1976-80		
	Food	Feed	Other ^a	Food	Feed	Other ^a
Bangladesh	60	7	33	62	7	31
Burma	62	7	31	62	8	30
Hong Kong and Singapore	58	32	10	49	45	6
India	68	8	24	68	8	24
Indochina	58	8	34	59	8	33
Indonesia	71	6	23	71	7	22
Malaysia	57	22	21	54	27	19
Pacific Islands	84	5	11	80	11	9
Philippines	64	13	23	63	15	22
Sri Lanka	76	4	20	74	5	21
Thailand	49	15	36	48	16	36
Tropical Asia	66	8	26	65	9	26

a) Includes seed, non-food use, and waste allowance.

Source: FAO Supply utilization accounts tape, 1981.

Between 1966-70 and 1976-80, feed use of all food grains taken collectively in tropical Asia increased at a rate half a percent higher than their direct use as food. Utilization of food grains for animal feed exceeded 5% per annum in Hong Kong, Singapore, Malaysia, the Philippines, and Indonesia. However, with respect to maize and other non-rice cereals, feed use rose twice as rapidly as food use. Their use for feed increased at a very rapid annual rate of 9% in Malaysia and 10% in Thailand; the Philippines also recorded a rapid increase of 6.5%.

China

The primary use of cassava in China appears to be for animal feed, especially in hog production. In some poor communes where cassava is grown, it is consumed by the population as a staple food. In addition, China also exports cassava to the EEC and there is evidence that these exports alone formed about a third of production in 1980.

Available consumption data for China suggest that of the average 230 million tons of food grains consumed each year during the 1977-80 period, 43% was paddy, nearly one-fourth was wheat, and about a third was accounted for by other food grains. Direct food use represented the bulk of the total domestic use of food grains in the country; about 10% went to feed and other uses including seed, waste, and non-food purposes.

Conclusions and Implications

Cassava production in tropical Asia increased rapidly during the last two decades, largely due to the rapid growth rate in Thailand in response to the import demand by the EEC for cassava as animal feed. More than half of this growth output was achieved through increases in area.

Prospects for cassava production in the immediate future are not encouraging; import demands for cassava by the EEC are expected to decline considerably as a result of the quota agreement between the Community and Thailand. The other major market for cassava is in direct human consumption, essentially in tropical developing countries. But the growth in direct food demand also appears to be slowing down; the income elasticity of demand for cassava in many developing countries is low, declining, and, in several of these countries, already negative. Furthermore, expansion of cassava starch utilization faces problems of competition from substitutes.

However, there is reason to believe that the long-run future of cassava can improve. With increases in per capita incomes, the demand for livestock products is growing at a rapid rate in Asia and other developing countries. Evidence suggests that the derived demand for livestock feed is expanding at an even faster rate, principally due to growth in poultry and hog production, where modern techniques have become more feed-intensive. Consequently, maize and sorghum imports into Asia for animal feed have increased rapidly in recent years. Provided prices are competitive, there may be a considerable potential for cassava (with supplements of soymeal or groundnut cake) as a substitute for maize and sorghum in the domestic manufacture of livestock feed in East and Southeast Asia. If this can be accomplished, the demand for cassava will expand significantly.

Since the crop is cultivated in poor soils where few other crops can be grown, stimulating cassava production will help to improve the socio-economic conditions of the population in these areas, as has been experienced in the northeastern parts of Thailand. However, urgent steps are necessary to find alternative demands for this crop in order to mitigate the hardship that will result from the expected decline in import demands by the EEC for Thai cassava products.

The cassava yields in several countries of tropical Asia are presently low. There is also a large untapped genetic potential which can be exploited to make cheaper calories available per hectare through the adoption of improved technology. Improvement in yields and a decline in unit costs and prices will have large nutritional and income implications for the vulnerable sections of the population for whom cassava is a major staple food.

Increases in the future demand for cassava as feed will, apart from relative prices, depend on the supply of maize and sorghum, which are the major food grains used for animal feed. As shown in this paper, the production of food grains as a group in tropical Asia has expanded at a fairly rapid average rate of 2.7% per annum during the past two decades; maize production in particular increased at an even faster rate of more than 3%, in response to rising feed demand. The production of sorghum increased at a relatively slower annual rate of 1.5%. Preliminary findings of an IFPRI study of the future food grain supply/demand situation in Asian countries (excluding China) suggest a deficit of food grains as a whole in the year 2000.

In light of these implications, there appears to be an urgent need for more in-depth studies leading to a research and development program aimed at improved yields and increased use of cassava in tropical Asia.

Acknowledgement

The authors would like to thank Darunee Kunchai for her assistance in the study.