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Cassava in Indonesia: A Historical Re-Appraisal of an Enigmatic Food Crop*

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I Introduction

Around 1900 the future of indigenous agriculture in densely populated Java was widely held to be gloomy. It was widely believed that rural prosperity was declining. The growing import of rice and the increasing share of maize and cassava in the diet of the Javanese were regarded as evidence for the thesis that population growth was outpacing the growth of food supply; Java was believed to be heading for a Malthusian catastrophe.

Cassava has long been admonished as an inferior food crop and as poor people's food [e. g. Napitupulu 1968: 65]. The increasing consumption of the tuber after 1900 is still interpreted as an indication of the declining standard of living in Indonesia [Booth 1988: 332]. The increasing consumption of rice since the 1960s is widely regarded as an indication of a turning tide in living standards. However, not much is actually known about the reasons why farmers took up growing cassava in Java in such a massive way after ca. 1900, or about the reasons why cassava consumption increased so rapidly in Indonesia to the extent that cassava products formed a major part of the staple diet, even today.

This article addresses these two issues, and therefore the question whether the increasing consumption of cassava after 1900 can be regarded as an indication of decreasing living standards. The argument is largely concentrated on late-colonial Java, although the presented data go up to 1995. Discussion of recent data is useful, because there are considerable discrepancies in the historical documentation of cassava production and consumption in Indonesia.

The next section discusses some quantitative facts about cassava production and

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consumption in Indonesia. The third part discusses the question why indigenous farm households increased the production of cassava, especially during the formative period 1900–1920. A fourth section concerns the question why there was a continuously increasing demand for cassava and cassava products. The last section explains that cassava was an enigmatic food crop, because the different ways in which it was consumed went unrecorded. This allows us to shed further light on the thesis that increasing cassava consumption has been a sign of decreasing living standards in Indonesia.

II Trends in Production, Exports and Consumption

Annual estimates of the area harvested with cassava in Java are not available until 1916, while reliable estimates of production do not start until 1922. During the nineteenth century cassava seems to have been a marginal food crop, which was rarely mentioned in colonial literature [Boomgaard 1989 : 89–91]. Discussions of roots and tubers generally concerned sweet potato. A rough estimate of the area harvested with cassava in 1880 is 85,000 ha.[1] This estimate can be corroborated with fragmented indications of areas planted with cassava in various parts of Java, which suggests averages of around 0.004 ha. per capita, or a total of 90,000 ha. in 1890.[2] Fig. 1 shows these estimates, together with other available data. Altogether, the chart suggests a very rapid increase of harvested area from ca. 1905 up to the 1920s, stagnation during the 1920s, on balance an increase during 1930–1965 and a sustained fall during 1965–1985. The chart also indicates that the share of the Outer Islands in harvested area increased during the last 30 years.

Table 1 confirms that Java dominated postwar cassava production in Indonesia. It also shows that cassava was produced throughout Java, from the relatively sparsely populated far West and far East to the densely populated centre. From 1903 to 1961 the area harvested with cassava continued to increase in most residencies. Similarly, harvested area decreased everywhere in Java during 1961–1985, with the exception of Yogyakarta, while it increased in the Outer Islands.

Fig. 2 shows trends in production and gross supply of cassava. It confirms the broad patterns in Fig. 1 up to the 1960s. In Java production stagnated at ca. 9 million tons per year, while harvested area decreased, which indicates that average yields have increased

1) The estimate is based on Boomgaard's [1989 : 90–91, 226] suggestion that in 1880 3 percent of land used for farm production was harvested with cassava and 5 percent with 'primitive roots and tubers', making a total of 69,350 ha. This estimate does not include the Principalities of Yogyakarta and Surakarta and the so-called private lands in Jakarta and Banten (West Java). The figure is multiplied by 1.15 [*Koloniaal Verslag* 1892 : Annex C] to include the principalities and 1.076 [*Aantooning van de Hoeveelheden* 1896 : 186 ; 1897 : 202] to include the private lands.

2) "Overzichten Betreffende den Oeconomischen Toestand van de Verschillende Gewesten van Java en Madoera" [*Koloniaal Verslag* 1892 : Annex C].

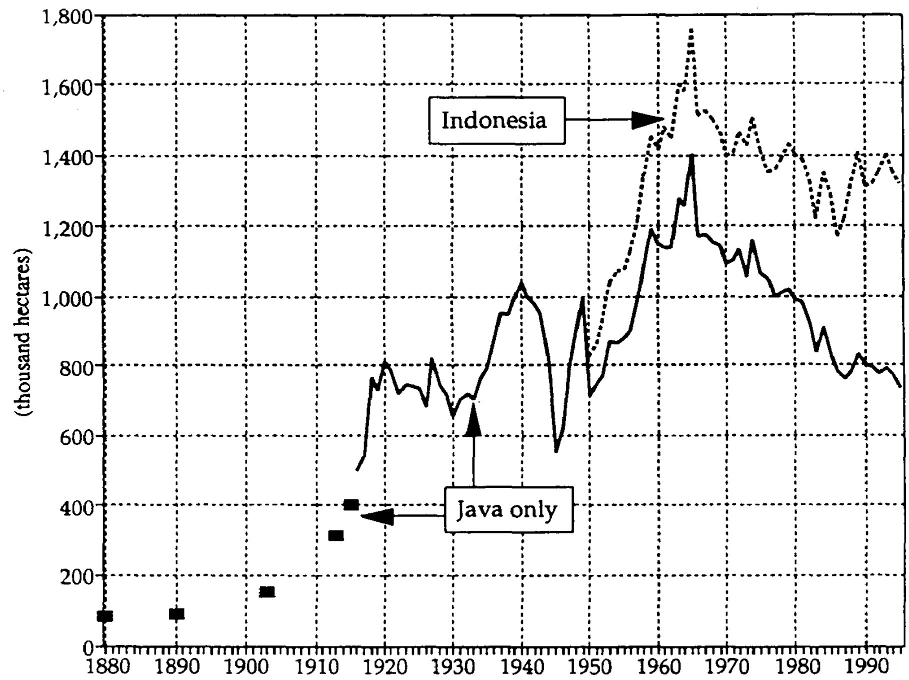

Fig. 1 Area Planted or Harvested with Cassava, 1880–1995

Sources: 1880–1890, see main text; 1903, Table 1 ; 1913 Blokzeijl [1916: 30]; 1915 *Producten van de Cassava* [1916: 13]; since 1916, Van der Eng [1996: Appendix 7], updated with *Produksi Tanaman Padi dan Palawaija di Jawa: di Indonesia* (1984–95).
Note: 1880–1949 refers to Java only, 1950–1995 to Indonesia as a whole.

steadily during the last 30 years. Indeed, the adoption of superior production systems and improved varieties enhanced the growth of average crop yields, which more than compensated a contraction in the harvested area [De Bruijn and Dharmaputra 1974]. Fig. 2 also indicates that most cassava was consumed domestically, despite the fact that the periods 1905–1941 and 1967–1995 saw a very significant increase in the export of cassava products.

In fact, during the interwar years Indonesia was the world's biggest cassava exporting country. The area harvested with cassava in Java was roughly equal to the harvested area in the entire rest of the world [Koch 1934: 4–5]. Indonesia exported tapioca to the United Kingdom and the United States, where starch found many applications. It was for instance used to produce starchy paste, but also in the production of textiles, paper, yeast, alcohol and biscuits and cakes.

The export of cassava products declined after World War II. One reason is that the pre-war exports concerned high-quality starch (tapioca). Many of the tapioca factories had been dismantled during the Japanese occupation and damaged during the war of independence in the 1940s. In the 1950s it appeared that Brazil had benefited from Java's forced retreat from the world starch market in the 1940s, when high starch prices had induced Brazilian producers to improve the quality of exported starch [Brautlecht 1953:

Table 1 Area Harvested with Cassava, 1903–1985 (hectares)

Region	1903	1920	1940	1961	1985
Banten	2,690	7,308	10,572	20,138	15,842
Jakarta	3,325[a]	12,570	31,953	87,413	29,605
Prianggan	8,667	88,414	80,757	125,247	104,916
Cirebon	5,973	22,687	22,551	31,536	19,590
West Java	20,655	130,979	145,833	264,384	169,953
Pekalongan	9,858	29,827	31,877	33,441	21,399
Semarang	14,049	83,607	64,174	53,706	44,864
Rembang	8,135	62,568	107,376	44,322	26,960
Banyumas	8,890	26,306	44,635	48,760	37,278
Kedu	25,205	59,005	64,219	72,605	46,246
Yogyakarta	6,650[a]	27,410	56,013	56,364	56,365
Surakarta	20,100[a]	95,511	119,932	136,679	101,136
Central Java	92,887	384,234	488,226	445,877	324,248
Surabaya	4,121	22,487	25,878	27,247	16,428
Madiun	4,975	56,004	107,575	119,036	87,612
Kediri	7,908	65,394	74,837	64,139	54,032
Pasuruan	6,853	36,176	37,962	75,624[b]	53,574
Besuki	4,337	14,297	41,004	28,201	26,821
Madura	12,185	102,166	119,932	117,354	81,687
East Java	40,379	296,529	407,188	431,603	320,154
Java	**153,921**	**811,737**	**1,041,247**	**1,141,864**	**819,812**
Sumatra	n. a.	n. a.	n. a.	64,048	154,677
Kalimantan	n. a.	n. a.	n. a.	32,717	45,278
Sulawesi	n. a.	n. a.	n. a.	75,922	81,561
Other	n. a.	n. a.	n. a.	163,761	179,905
Outer Islands	**n. a.**	**n. a.**	**n. a.**	**336,448**	**461,421**

Sources: *Onderzoek naar de Mindere Welvaart der Inlandsche Bevolking op Java en Madoera, Deel V: Landbouw* [1908: Annex 14]; *Statistisch Jaaroverzicht van Nederlandsch-Indië* (1922); *Indisch Verslag* (1941); *Luas Panen dan Produksi Tanam²an Rakjat Berumur Pendek Djawa dan Madura* (1961); *Produksi Bahan Makanan Utama di Indonesia* (1963); *Produksi Tanaman Padi dan Palawija* (1985).

[a]. Approximated.

[b]. Bojonegoro and Malang.

211–214]. Moreover, in the 1950s the European Community protected the potato and maize starch industries in Western Europe.

In addition, Indonesia's trade and processing of cassava products was dominated by Chinese entrepreneurs. The Indonesian government developed an increasingly hostile attitude towards the Chinese community, to the extent that the Chinese were expelled from rural areas and Chinese nationals were forced to repatriate to Taiwan in the early 1960s. This considerably paralysed rural business and export trade to a large extent.

In the 1960s Thailand took over Indonesia's position as Asia's main cassava exporter. Thailand exported most of its production in the form of dried chips (*gaplek*) and pellets, which were used as fodder. Thailand benefited from the 1962 decision of the European Community to replace imported maize and soybean cakes from the United States in the

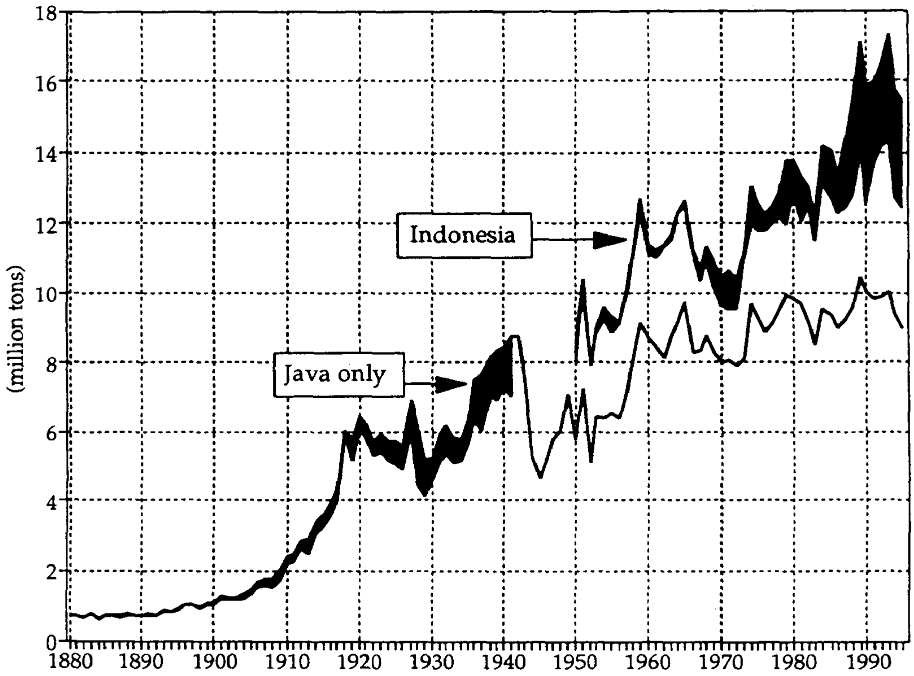

Fig. 2 Production and Gross Supply of Cassava, 1880–1995

Sources: See Fig. 1. The individual years 1880–1915 in Fig. 1 were interpolated and production 1880–1921 was estimated, assuming a yield of 7.95 ton/ha. (1923–1928 average). Exports from *Statistiek van den Handel, de Scheepvaart en de In- en Uitvoerrechten van Nederlandsch-Indië* (1880–1923), *Jaaroverzicht van de In- en Uitvoer van Nederlandsch-Indië* (1924–41), *Ichtisar Tahunan Impor dan Ekspor Indonesia* (1947–51), *Statistik Perdagangan Impor dan Ekspor Indonesia* (1952–53), *Impor dan Ekspor menurut Djenis Barang* (1954–66), *Ekspor menurut Jenis Barang* (1967–95).

Note: Gross supply is gross production before deduction of seed and losses, less exports. The shaded section in the chart indicates exports. Production and gross supply are expressed in fresh root equivalents, using conversion factors of 5 for tapioca and tapioca products and 2.5 for other products such as *gaplek* and pellets. 1880–1949 Refers to Java only, 1950–1995 to Indonesia as a whole.

production of fodder for the livestock industry with fodder imports from non-dollar countries. At that time the demand for fodder was also growing rapidly in Japan and the United States. Indonesia missed out on these opportunities.

Indonesia returned on the world market in the late 1960s, but Thai producers were in a much better position to meet expanding international demand. Export opportunities increased further due to the European Community's Common Agricultural Policy, which increased European feed grain prices and made the import of cassava and soymeal fodder more attractive. In the late 1980s a quota system between the European Community and the main exporting countries secured Indonesia's return as one of the world's main exporters of cassava products.

Fig. 3 shows that domestic gross supply (production less net exports, not corrected for losses, seed and feed) increased from 30 kg. of fresh-tuber per capita before 1900 to an average of 130 kg. per capita during the inter-war years. During 1940–1965 the average

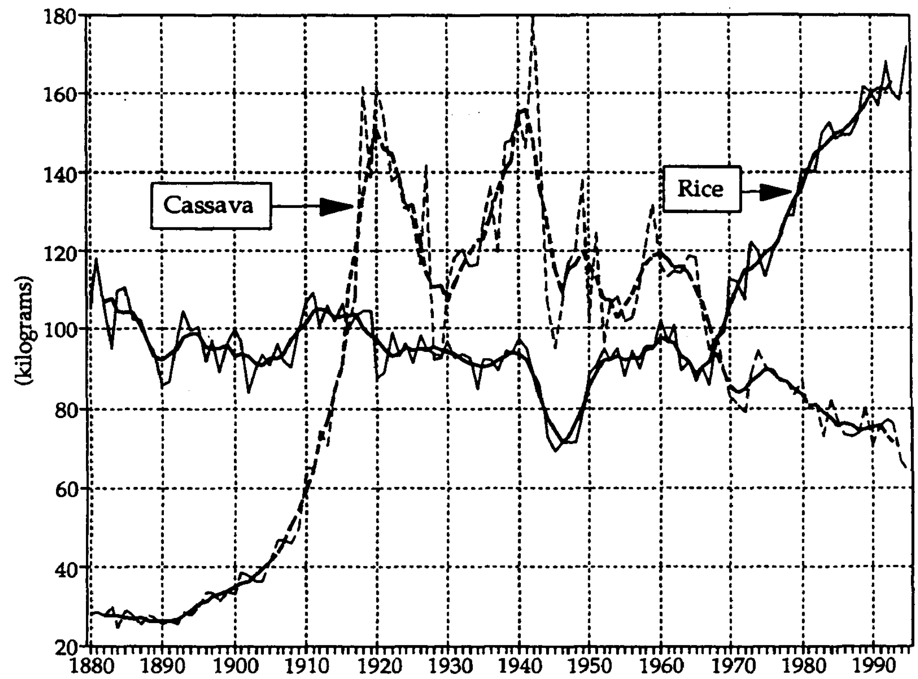

Fig. 3 Per Capita Gross Supply of Rice and Cassava, 1880–1995

Sources: Van der Eng [1996: Appendies 3 and 6], updated with *Produksi Tanaman Padi dan Palawaija di Jawa—di Indonesia* (1984–95) and *Statistik Indonesia* (1995); foreign trade data, see Fig. 2 and *Impor menurut Jenis Barang* (1967–95).

Note: Gross supply is gross production before deduction of seed and losses, less exports plus imports. 1880–1949 refers to Java only, 1950–1990 to Indonesia as a whole. The bold lines are five-year moving averages. The lines are continuous for rice and dashed for cassava.

fluctuated around 110 kg. per capita, after which it fell to an average of 80 kg. during 1970–1995. This development is contrasted with changes in the domestic gross supply of rice, which remained relatively constant at 90–100 kg. during 1880–1965, after which it increased rapidly to about 170 kg. per capita in 1995.

How can these trends in the production of cassava for domestic consumption be explained? The following two sections address several relevant aspects from the perspective of producers and consumers respectively.

III Why Did Farmers Produce Cassava?

Cassava was most likely introduced into the Malay archipelago from the Philippines, where it had been brought from South America by the Spanish during the sixteenth or seventeenth centuries. Cassava was added to a range of tuber crops (*ubi ubi*) which farm households in Southeast Asia already cultivated [Boomgaard 1989: 89–92]. It was widely known under several different names. Malay names were *ubi kayu*, *ubi prasman*, *sinkong* and *ketala pohon*. Cassava was known in Sundanese as *ubi dangdeur*, *sampeu* or *kecapen*, in Javanese as ***kaspe*** or ***budin*** and in Madurese as *menyok* or *saubi* [Ochse 1931 : 280–281].

Throughout the nineteenth century, regional civil administrators of the Dutch colonial government in Java urged farmers to cultivate cassava as a buffer food crop in case the main paddy harvest would fail or to overcome the lean season prior to the main rice harvest [Van Gorkom 1890 : Vol. 3, 271–272]. Cassava produced considerably more edible material per hectare than other food crops. Around 1850 this insistence had not yielded any lasting results. Cassava was mainly grown in the sub-district Pandeglang (Banten, West Java), where it yielded considerable financial returns to farm households [Teysmann 1851 : 312].

In 1852 the botanic garden in Bogor managed to acclimatise new 'sweet' cassava varieties from the Dutch colony Surinam in South America. These new varieties produced higher yields and proved to be better tasting [Van Swieten 1875 : 255 ; Wigman 1900 : 399]. Still, around 1875 cassava was still absent in most areas of Java although widely cultivated in several others, such as Trenggalek (Kediri, East Java) [Van Swieten 1875 : 253].

Cassava gradually spread as a cash crop in the less densely populated areas of West and East Java, where it replaced coffee on upland fields. Coffee shrubs were ravaged at that time by a coffee leaf disease [Paerels 1913 : Vol. 3, 300, 315]. The total area planted with coffee fell in Java from 170,000 ha. in 1880 to 62,000 in 1910 [Van der Eng 1990 : 55]. Still, by 1900 cassava was cultivated in only a few areas as a buffer food crop.

In the residencies of Banten, Jepara and Semarang cassava was mainly grown for the production of tapioca in small Chinese-owned factories. Tapioca from these factories was generally exported to Singapore [De Kruijff 1909 : 272]. The rapid expansion of tapioca manufacturing is important in explaining the growth of production. For instance, the production of cassava spread quickly in Prianggan during the decade preceding 1900, after tapioca factories had been established in Bandung and Garut [De Bie 1900 : 279].

There is no quantitative information on starch production in Java, because most tapioca was produced in small factories. These ventures did not require a license to operate and were not formally registered. Exports can be taken as an indicator, but, as Fig. 1 shows, only a minor part of production was eventually exported. Most tapioca may have been produced for domestic consumption. An indication of the rapid spread of tapioca manufacturing is that several technological improvements were reported during the decade after 1900. A major invention was a wheel-shaped drum propelled by the operator like a bicycle wheel by pushing two pedals on either side with his feet. The edge of the drum contained notches used to grate the peeled fresh cassava tuber.

The number of small indigenous tapioca factories increased quickly, while cassava producers themselves started to produce low-quality starch (*kampung* meal). Around 1907 small factories were engaged in heated competition. There are no exact price quotations, but the price of tapioca was said to have declined between late 1907 and 1916 due to over production [De Kruijff 1909 : 271 ; *Koloniaal Verslag* 1915 : 178]. Many small factories stopped production, when only the large scale production of high-quality tapioca was still profitable. Large factories specialised in the production of tapioca for export, using specially designed machinery [De Kruijff 1916: 245]. Some low-quality starch was purchased by Chinese merchants, for refinement to exportable quality starch. Still, most cassava was processed for domestic consumption. Processing was necessary, because cassava is highly perishable when fresh.

Advantages to Farmers of Producing Cassava

Cassava had several advantages over other crops, especially irrigated rice. Firstly, it can be grown on poor soils and even on steep slopes [Tjuhaja Suriaatmadja 1956]. This made it an ideal crop for cultivation on upland fields, where water supply was insufficient for paddy. Cassava was also a hardy plant, largely drought resistant, and requiring considerably less water per unit of edible product than rice. Moreover, cassava could be cultivated at up to 1,500 meters in mountainous areas.

Secondly, Table 2 shows that cassava required less labour than other crops, particularly rice. Total labour input per crop is higher than for maize, but labour input per month is much lower because cassava stands longer in the field. In terms of net returns per hour worked, both price-converted and calorie-converted, cassava appears to be a very attractive crop.

In rice production, flooded fields had to be ploughed and harrowed several times in order to obtain the soft mould in which to plant the paddy seedlings which had been

Table 2 Net Returns from Food Crops in Farm Agriculture, 1925–1928

Crop	Labour Input per Crop (hour/ /ha.) (1)	Gross Yield[a] per Crop (ton/ /ha.) (2)	Price[b] (guil- der/ /ton) (3)	Months in the Field (4)	Kcal per kg. (5)	Net Returns[d] (kg. rice) Price-Converted Per Ha. (6) (2×3)	Price-Converted Per Hour Worked (7) (6/1)	Price-Converted Per Crop-Month (8) (6/4)	Calorie-Converted Per Ha. (9) (2×5)	Calorie-Converted Per Hour Worked (10) (9/1)	Calorie-Converted Per Crop-Month (11) (9/4)
Irrigated Paddy	1,675	2.25	96.20	5.0	1,870[c]	1,958	1.2	392	1,040	0.6	208
Upland Paddy	1,320	1.20	96.20	4.5	1,870[c]	1,020	0.8	227	543	0.4	121
Maize	425	1.05	81.75	3.5	3,610	767	1.8	219	927	2.2	265
Cassava	1,025	8.15	25.90	8.0	1,460	1,865	1.8	233	2,818	2.7	352
Sweet Potatoes	1,050	6.60	27.35	4.5	1,230	1,482	1.4	329	1,810	1.7	402
Peanuts	900	0.75	116.80	4.0	4,520	810	0.9	203	801	0.9	200
Soybeans	900	0.60	172.00	3.0	3,310	923	1.0	308	480	0.5	160

Sources: Labour input, Smits [1926/27] and Vink [1941: 106]; average yields, prices, inputs, feed and losses Van der Eng [1990, revised and updated]; calorie conversion rates, *Daftar Komposisi Bahan Makanan* [1967].

[a]. Per crop, 1925–28 average.

[b]. 1925–28 average rural retail price. Price of stalk paddy is the pounded rice equivalent.

[c]. Nutritive value of stalk paddy is the pounded rice equivalent.

[d]. Net of current inputs. The calorie-converted values are net of feed and losses.

cultivated on special seedbeds. Cassava production was much simpler. Cuttings from other cassava plants were simply planted on fields which had undergone only shallow preparation. The cuttings were almost ideal planting material, because they were a waste product and farmers did not have to reserve a substantial part of the harvest as seed for the following season.

Moreover, timing was crucial in the production of rice. Farmers could not postpone the moment of transplanting seedlings too long, because it would affect the final yield. However, a farm household was not alone in its attempts to attract sufficient labour for field preparation and for transplanting. This period during the rice season was generally one of labour shortage. In contrast, cassava cuttings could be planted as soon as the field was available, or as soon as labour was available. In addition, cassava required on the whole less labour than other crops for weeding. The stem and leaves of the plant developed in the shape of an umbrella, which would take away sunlight for most weeds. Harvesting cassava was also simple. The roots were pulled out of the soil and the stem was cut off.

Thirdly, cassava could be grown on scattered small patches of unused land, where it did not require much attention during growth. Fourthly, cassava could be left in the ground anywhere between 6 to 24 months, albeit that the roots would become increasingly fibrous after a year. Hence, cassava could be harvested at will, depending on the supply of labour, the market conditions or the household requirements. The spread of the cassava harvest over the year was much more even than the harvest of other crops. The maximum of harvested area per month was only two times higher as the monthly minimum of harvested area, compared to 6 times for maize and 23 times for irrigated paddy. Lastly, cassava yielded much more calories per hectare than any other crop, especially paddy, as Table 2 indicates.

Disadvantages to Farmers of Producing Cassava

Unfortunately, cassava seems to have exhausted the soil quickly, especially when cultivated on poor soils. This made long fallow periods or fertilising with animal manure, green manure or compost necessary [Nijholt 1934 : 20]. Farm households were not ignorant about the impact of fertilising and it is likely that they applied manure if it was available [Van der Eng 1994 : 37–40]. But the application of manure required an extra effort for the transportation of manure to the field and for the distribution of manure on the field. Green manuring had to fit into the system of crop rotation and the preparation of compost required even more labour.

Secondly, the fresh tuber could only be kept for up to three days, after which its quality deteriorated quickly. That meant that the tuber had to be either consumed or processed within three days. There were two ways of processing. The tuber could be peeled, sliced or cut to chips and dried in the sun. If dried properly, this *gaplek* could be kept for several months. The other way was to produce *kampung* meal by grating the cassava, mixing it with water, and kneading it to dissolve the cellular tissue. The released starch could then be sifted from the mixture and dried. The remaining flour could be stored for a longer period and could be used to process a range of different flour-based products. Either way, the processing of cassava required knowledge of processing techniques and some investment in processing facilities. Moreover, clean water had to be available, which was especially a problem in the dry uplands.

Thirdly, the protein-calorie ratio of cassava was low compared to most other food crops [Tanahele 1950]. Moreover, several cassava varieties contained a high quantity of prussic acid, which could cause toxication leading to goitre and mental disorders. The toxic substances disappeared during the processing of tapioca, but for the consumption of fresh cassava both producers and consumers required some knowledge of cassava varieties.

Relative Returns from Cassava Production

It is difficult to evaluate the profitability of cassava, in the absence of conclusive data such as prices. Still, several sources maintain that both productivity and financial returns per hectare from cassava were much higher than the productivity and returns from rice up to about 1910.[3] Columns 7 and 10 in Table 2 confirm this suggestion for the late-1920s.

Unfortunately, similar data are not available until the 1970s. They are summarised in Table 3, and suggest that the net returns per hectare from cassava production relative to the returns per hectare from rice production were considerably lower in Java than before World War II, while the returns from peanuts and later also soybeans and to a lesser extent sweet potatoes were significantly higher. Consequently, farmers in some areas of Java were induced to shift resources, in particular land, out of cassava production, as Fig. 1 already demonstrated. In other areas cassava production expanded, but on the basis of land-replacing production techniques, which generated higher yields but also required a greater outlay for fertiliser and therefore impinged on net returns. Indeed, Table 4 shows that both yields and the application of chemical fertiliser in cassava production in Java increased significantly, particularly during the 1980s.

In contrast, Table 3 indicates that in the Outer Islands cassava held its position relative to irrigated rice in Java in terms of net returns per hectare, which was mainly due to the fact that cassava continued to be produced with more land-extensive techniques involving less current inputs, until the late 1980s.

3) E. g. Van Swieten [1875 : 269], Sollewijn Gelpke [1901 : 164], Jasper [1903 : 126], Ham [1908 : 41–43].

Table 3 Net Returns per Hectare from Food Crops, 1925–1994 (irrigated paddy in Java = 100)

Crop	1925–28	1971–75	1976–80	1981–85	1986–89	1990–94
Java:						
Irrigated paddy	100	100	100	100	100	100
Upland paddy	52	45	43	44	46	53
Maize	39	27	31	31	34	36
Cassava	95	72	77	55	68	68
Sweet potatoes	76	71	71	67	79	86
Peanuts	41	74	87	80	73	73
Soybeans	47	49	61	55	67	72
Outer Islands:						
Irrigated paddy		113	96	85	79	73
Upland paddy		55	45	43	41	44
Maize		26	28	29	27	31
Cassava		101	97	96	78	72
Sweet potatoes		83	90	93	87	83
Peanuts		73	84	81	80	65
Soybeans		49	53	44	54	56

Sources: 1925–28 from Table 2 ; 1971–94 calculated from *Survei Pertanian* and *Struktur Ongkos Usaha Tani Padi dan Palawija* (various years).
Note: Net returns after deduction of the cost of current inputs.

Table 4 Average Yields and Fertiliser Consumption in Cassava Production, 1971–1994

	Average Yield (ton/hectare)		Average Fertiliser Application (kg./hectare)	
Year	Java	Outer Islands	Java	Outer Islands
1971/74	7.6	8.5	7.2	0.2
1975/79	9.1	9.6	15.8	0.6
1980/84	10.0	9.6	26.4	8.7
1985/89	11.9	11.1	85.6	18.9
1990/94	12.5	11.4	116.0	63.5

Sources: Yields calculated from *Produksi Tanaman Bahan Makanan di Jawa—di Indonesia* (1971–83) and *Produksi Tanaman Padi dan Palawaija di Jawa—di Indonesia* (1984–94); fertiliser application calculated from *Survei Pertanian* and *Struktur Ongkos Usaha Tani Padi dan Palawija* (various years).
Note: Yield in terms of fresh tuber, fertiliser refers to chemical fertilisers only.

Cassava and the Expansion of Upland Fields, 1905–1920

The above analysis is impaired by the fact that cassava and rice were generally not produced on the same fields. Only 5 percent of paddy fields in Java was harvested with cassava, generally as a secondary crop during the dry season. Cassava grown on paddy fields must have been harvested quite young. Hence, the argument should be restricted to farm households operating upland fields. They chose between several upland crops, especially upland paddy, maize, cassava, sweet potatoes and to a lesser extent peanuts. Still, Table 2 indicated that on upland fields cassava was far superior in economic terms in the late-1920s.

The growth of the area under cassava during 1905–1920 corresponds to a rapid expansion of arable upland fields during 1895–1920. This expansion was largely due to the fact that the possibilities for extending irrigated land in Java had largely been exhausted, while population growth necessitated the continued absorption of people in farm agriculture [Van der Eng 1996 : 24, 143–146]. Population pressure resulted in decreasing average holdings of irrigated land and increasing land productivity on these farms. It also resulted in a shift of the land frontier to upland areas which had hitherto been used in slash-and-burn cultivation patterns. This choice to populate the uplands may have been facilitated by the considerable improvements in transport facilities in Java after 1900. The expansion of upland fields may initially have taken place in sparsely populated areas, where labour supply may have been a bottleneck. Cassava was a fitting crop in those circumstances, requiring much less labour than all other food crops. The increase of upland area tapered off after 1920 when the limits of that phase in agricultural development were gradually reached, which corresponds to a stabilisation of cassava production during the 1920s.

The area harvested with cassava increased again during the 1930s and the 1950s, which, given the fact that the land frontier had been reached, indicates that the share of upland area under cassava increased. This trend was most likely driven by changes in the demand for food at a time when the gradual lifting of the technological ceiling in rice production only managed to keep rice supply per capita at level as Fig. 3 indicated. Economic recovery in the 1930s is likely to have lifted the demand for food, while in the 1950s and 1960s average incomes may have stagnated, while population growth accelerated and enhanced the overall demand for food. In both cases farmers operating upland fields may have been induced to shift resources, in particular land, into cassava production, as Fig. 1 showed.

IV Why Did Consumers Consume Cassava Products?

The distinction between producers and consumers of cassava is to some extent artificial, because many cassava producers consumed their own produce. Unfortunately, except for exports of cassava products, there are no data indicating the degree to which produced cassava was actually marketed, and therefore the degree to which cassava products and rice were mixed in the average diet in Java. Fig. 3 has indicated that up to the mid-1960s there was no trade-off between rice and cassava in the average diet. Per capita consumption of rice remained roughly constant, which implies that the increasing average consumption of cassava enhanced per capita calorie consumption during the period 1895–1920. During 1920–1965 there were considerable fluctuations in the degree to which cassava contributed to the average diet, but on balance the role of cassava did not decrease until after 1965.

Several explanations can be given for the dramatic increase during 1895–1920, such as a slow-down of population growth after 1900 which gradually increased the average age of the population and therefore the average demand for calories. However, it is difficult to indicate the significance of such explanations in the absence of conclusive data. This section will argue that cassava was largely an addition to the average diet. The increasing consumption of calories can be interpreted as a consequence of falling transport costs, and/or an increase in the purchasing power of the average income.

An Addition to the Average Diet

Transport and trade in rural Java had long been impeded due to the absence of good communication facilities. In the late nineteenth and early twentieth centuries the colonial government used a large part of its budget for the construction of roads and bridges and the extension of the network of tram and railway lines [Knaap 1989 : 26–30]. Improved communications facilitated the movement of people from the lowlands to the uplands, and must have furthered economic integration and possibly economic growth. Hence, improved transport facilities must have expanded the market for cassava products, such as fresh cassava, tapioca and *gaplek*.

A flow of goods from the uplands to the lowlands and urban areas may have generated a flow of goods and services in the other direction. In part this may have been surplus rice from the irrigated lowlands. If so, the increasing production of cassava did not necessarily imply the emergence of a cleft between rice consumers and cassava consumers, but could imply increasing specialisation in production in the agricultural economy and increasing exchange of produce. In that case cassava can be regarded as an addition to the average diet, and not necessarily as a replacement for rice.

Exact and detailed quantitative evidence for this assumption is hard to provide, because little is known about the formation and development of domestic markets in Java, and about the development of indigenous trade and informal transport services. What we do know is that between 1900 and 1920 railway transport boomed : both passenger and freight transport per kilometre of railway track increased during this period on average by 5 percent per year, which suggests the enormous advance in the mobility of people and goods.[4)]

In addition, it is likely that the period 1900–1929 was one of sustained economic expansion, which increased average real incomes. For instance, the volume of exports increased by 5.7 percent per year during 1900–1929 [Van Ark 1988 : 116–117]. There also

4) Calculated from Boomgaard and Van Zanden [1990 : Table 12]. Although relatively small to total production, railway transport of cassava increased rapidly in line with the growth of cassava production : 1913 159 tons, 1920 113,189 tons and 1924 86,727 tons [Van Ginkel 1926 : Vol. 1, 280].

Table 5 Indicators of Economic Change in Indonesia, 1880–1940

Indicator	1880	1900	1913	1929	1940
Children at primary schools (per 100,000 people)	334	407	1,406	2,713	3,352
Haji (per 100,000 muslims)	201	282	426	608	464
Bicycles and motor cycles (per 100,000 people)	0	7	272	1,004	994
Postal items (per 100 people)	18	43	87	145	155
Credit (1929 guilders, per 1,000 people)	—	9[a]	1,384	4,287	2,533
Imported textiles (tons per 100,000 people)	66	103	188	271	174
Domestic boat passengers (per 100,000 people)	309	454	1,336	2,180	736
Railway passengers (per 100 people)	9	87	215	245	133
Registered motor vehicles (per 100,000 people)	—	—	3	117	81

Sources: Calculated from *Koloniaal Verslag* (1880–1921), *Statistisch Jaaroverzicht van Nederlandsch-Indië* (1922–30), *Indisch Verslag* (1931–40), *Statistiek van den Handel, de Scheepvaart en de In- en Uitvoerrechten van Nederlandsch-Indië* (1880–1923), continued as *Jaaroverzicht van de In- en Uitvoer van Nederlandsch-Indië* (1924–41). Population from Van der Eng [1996: Appendix 3]. Retail price index from Van der Eng [1992: 361]. Textile price from CKS [1938].

Notes: *Haji* are muslims who have been on a pilgrimage to Mecca. About 85–90 percent of Indonesia's population were muslims. The stock of *haji* after 1893 was estimated by adding annual arrivals in Jeddah to the stock in the previous year, assuming a 4 percent mortality rate. The stock of bicycles and motor cycles was calculated as the cumulative number of imported bicycles and motor cycles only, assuming a working life of 20 years. For 1900–1914 the quantity of imported bicycles was estimates with the total value of imported bicycles and the 1915 unit price of bicycles. Credit refers to loans from government controlled village banks and pawnshops, deflated with an index of retail prices. For 1880–1914 the quantity of imported textiles was estimated with the value of textile imports and the 1915 unit price, linked for 1880–1914 to the price of *madapolam* and *calicot* from the Netherlands. Domestic boat passengers are passengers on KPM liners.

[a]. 1902

was a substantial increase in the imported quantity of various small consumer articles. This suggests that, increasingly, imported kerosene lamps replaced wickets floating in cups of coconut or peanut oil, matches replaced tinder boxes, china cups and glasses replaced coconut cups, earthenware plates and cutlery replaced banana leaves and eating with fingers. Mirrors and bicycles appeared in the indigenous households. Table 5 contains some indicators of the development of prosperity. All variables indicate an increase during 1900–1929. Moreover, the increase in the number of railway trips per person confirms the increasing mobility of people in Java, where most railways were situated.

It thus seems likely that average real income increased during 1900–1929. This increase occurred from low levels of living, which implies that the income elasticity of demand for food must have been high. This means that increasing incomes generated a significant increase in the demand for food. Apart from the economic impediments which prevented farm households from increasing their marketable surplus of rice to meet this demand, there was no seed-fertiliser technology available in Indonesia with which the production of rice could have been increased at short notice [Van der Eng 1994]. Rice imports increased to meet the growing demand, but they only helped to keep per capita supply broadly at level. It is therefore likely that the increasing demand for food products was satisfied with cassava products. Unlike rice, cassava production could increase rapidly by bringing new upland fields under permanent cultivation.

To the extent that surplus cassava production was marketed, cassava products must, in the main, have become an addition to the traditional diet in Java, rather than a substitute for rice. This interpretation is difficult to substantiate in the absence of representative inquiries into household budgets and consumprtion. There were areas in Java, discussed below, where people relied to a large extent on cassava for food. But it is very likely that cassava products were consumed widely. Indeed, throughout the late-nineteenth and twentieth centuries numerous suggestions can be found which indicate that cassava was widely consumed in many different forms, mostly as a side-dish or snack, even today.[5] It was eaten as dried or fried slices and chips (*gaplek*), fried processed chips (*kerupuk*), baked dough (*bulu emprit*), steamed balls with salt and grated coconut (*getuk*), salty snacks (*golak*), roasted flat dough (*opak*), steamed in banana leaf (*opak budin*), et cetera.

Was a diet to which cassava products were added, or dominated by cassava products, necessarily inferior to a rice-based diet? Table 6 shows that fresh cassava tubers contain less calories and less proteins than a comparable quantity of milled rice, because they contain a lot of water. But rice is not consumed raw, and not all cassava is consumed fresh. When comparing *gaplek* or processed tapioca with cooked rice, the difference concerning calories is already much less. However, the relative lack of protein remains.

Investigations have indicated that cassava consumers in rural areas were well aware of the nutritional shortcomings of cassava [Dixon 1981/82 : 369]. They consciously sought to compensate for this with foodstuffs with a high protein content, such as fish, meat, eggs and vegetables. It is not possible to establish long-term trends in the consumption of such foods in Java, or establish a positive correlation with the consumption of cassava-based products. The average consumption of meat and eggs was very low in Java, because they were relatively expensive. The addition of protein may therefore have come from fish and vegetables.[6] There are also indications that the leaves of the cassava plant were widely used as a vegetable condiment long before World War II and

5) Van Swieten [1875 : 267], Van Gorkom [1890 : Vol. 3, 275], De Bie [1900 : 281–286], Blokzeijl [1916 : 23], Department of Finance [1923 : 10], Dixon [1979 : 93–94].

6) Jansen and Donath [1924 : 46] noted that the population in the cassava region Trenggalek (East Java) deliberately consumed the protein-rich leaves of the *walu* plant as a vegetable. Onwueme [1978 : 152] remarked that in Africa the consumption of cassava leaves and tender young shoots is widespread. Van Veen [1938a ; 1941] provided an inventory of products which were usually considered to be worthless, but which could still be a valuable source of protein to the diet, such as processed press cakes of fatty pulses and less-known cereals like millet.

Table 6 Nutritive Values of Some Food Products (per 100 gram of product)

Food Product	Calories (kcal)	Proteins (gram)	Vitamine A (IV)	Vitamine B 1 (mg.)	Vitamine C (mg.)	Water (gram)
Milled raw rice	360	6.8	0	0.12	0	13.0
Cooked rice	178	2.1	0	0.02	0	57.0
Fresh cassava	146	1.2	0	0.06	30	62.5
Gaplek	338	1.5	0	0.04	0	14.5
Gaplek flour	363	1.1	0	0.04	0	9.1
Fried tapioca dough	350	0.6	0	0	0	12.0
Cassava leaves	60	6.9	10,000	0.20	20	n. a.
Beans	35	2.4	630	0.08	19	88.9
Cabbage	24	1.4	80	0.06	50	92.4

Sources : [*Daftar Komposisi Bahan Makanan* 1967 ; Onwueme 1978 : 152 ; Dixon 1984 : 64]

even today [Terra 1964].7) Table 6 shows that the leaves contain a considerable amount of protein, even more than better known vegetables such as beans and cabbage. Hence, it may be clear that cassava can be a good addition to the traditional diet and that, especially if eaten in combination with protein foods as a side-dish next to rice, a cassava-based diet does not necessarily have to be inferior to a rice-based diet [Van Veen 1938a ; Cock 1985 : 24–28].

A Cheap Addition to the Average Diet

It should be noted that cassava products were a source of cheap additional calories. Table 7 is based on retail prices at a wide range of rural bazaars in Java, where many producers marketed their crops. The table shows the ratio of the price of a quantity of calories from non-rice or non-cassava food crops and the price of the same quantity of calories from rice or cassava. It indicates that during the interwar years the price of calories from cassava fluctuated between 25 and 35 percent of the price of the same quantity of calories from rice. Cassava calories were also the cheapest, with calories from sweet potatoes costing between 35–45 percent of the price of calories from rice, maize between 35–50 percent, peanuts between 80–95 percent and soybeans between 90–110 percent.

During the 1950s the ratio of the price of fresh cassava and rice calories rose well

7) De Bie [1901–02 : 112] reported already early this century that the leaves of two popular cassava varieties were eaten as vegetables. Donath [1938 : 1131] and Van Veen [1938b] drew attention to the nutritive value of cassava leaves and the fact that the cassava leaves were eaten in areas where cassava was the main food crop. Both noted that the actual knowledge of supplements in cassava-based diets was limited. Dixon [1981/82 : 369] also mentioned consumption of cassava leaves, while Roche [1983 : 55–57] specified that cassava leaves were a common vegetable in Garut (West Java), where a lot of cassava was produced for starch production, and in Gunungkidul, where cassava was produced for home consumption.

Table 7 Ratios of the Price of Calories from the Main Non-Rice Food Crops and Rice in Rural Java, 1920–1994 (five-year annual averages)

Period	Maize	Cassava	Sweet Potatoes	Peanuts	Soybeans
1920/24	49	33	40	95	110
1925/29	44	34	42	87	100
1930/34	36	27	37	82	96
1935/39	44	33	41	90	89
1950/54	47	42	54	112	119
1955/59	55	36	45	118	124
1960/64	51	39	49	121	114
1965/69	49	43	55	125	120
1970/74	51	47	62	178	150
1975/79	51	44	59	182	150
1980/84	50	50	65	189	155
1985/89	54	49	69	222	187
1990/94	53	50	74	207	173

Sources : Calculated from *Statistisch Jaaroverzicht voor Nederlandsch-Indië* (1922–30), *Indisch Verslag* (1931–40), *Statistical Pocketbook of Indonesia* and *Statistik Indonesia—Statistical Yearbook* (1941–84), BPS [1995]; calorie conversion rates from *Daftar Komposisi Bahan Makanan* [1967].

Notes : Ratios calculated from rural price data referring to first quality produce, up to 1983 to pounded rice (*bulu*) and since then to milled IR 36 rice (*cereh*), shelled maize, fresh cassava and sweet potato tubers, shelled peanuts and white soybeans. A value less than 100 indicates that calories from the respective non-rice food crop are cheaper than calories from rice. A figure higher than 100 indicates that calories from rice are cheaper than calories from the respective non-rice food crop.

above prewar levels. This also occurred with the other crops, indicating that rice calories became cheaper. However, cassava calories remained the cheapest, while the increase of the ratio of cassava and rice calories from the late 1930s to the late 1960s was moderate compared to the ratios of the other crops and rice. The same applies to the increase from the late 1960s to the late 1980s.

The relative fall of the price of rice calories in the 1950s and 1960s, compared to the 1930s was partly due to the consumer-oriented rice policies implemented by the Indonesian government. Until the 1970s the aim of these policies was to keep the consumer price of rice low in order to depress inflation. This policy encouraged demand to the extent that Indonesia was forced to import up to two million tons of rice annually in the early 1960s. During the 1970s rice policies became more producer-oriented, which facilitated the increasing adoption of high-yielding rice varieties. Rice production increased tremendously, but much of the growing rice surplus concerned low-quality rice which fetched lower prices than the traditional rice varieties preferred by consumers.

A lot of cassava may have been sold as *gaplek*, because the marketing of fresh cassava required good transport facilities, while the production of tapioca required investments in processing facilities. The fresh cassava equivalent price of *gaplek* may have been 30 percent higher than the actual price of fresh cassava (the difference being the processing and marketing margin). It is therefore likely that *gaplek* competed in a segment of the food market in which consumers had the choice between *gaplek* and low-quality rice, which may have been 30 percent cheaper than the price of first-quality rice used to compile Table 7. In that case the price of calories from *gaplek* would in the 1970s have been around 85 percent of the price of the same quantity of calories from rice, instead of around 45 percent as indicated in Table 7. Consequently, it is very likely that an accumulating number of low-income consumers could substitute calories from cheap rice for calories from *gaplek* after the 1960s.

Characteristics of Cassava-Producing Areas

Farm households producing cassava most likely consumed more cassava than those producing rice. Does that mean that there was an increasing number of people in Java

Table 8 Districts in Java with More than 13 Percent of Arable Land Harvested with Cassava, 1920

District	% Arable Land under Cassava	Cassava Area per Capita (× 0.01 ha)	People per Ha. of Arable Land	Yield Irrigated Paddy (ton/ha)	Production Irrigated Rice per Capita	% Upland Area in Total Arable	% Irrigated Land for Sugar Cane
1 Semarang	36.1	2.28	15.9	2.01	42	36	0.1
2 Kulonprogo	31.5	3.75	8.4	2.19	58	58	0.0
3 Pamekasan	21.8	4.90	4.4	1.09	16	85	0.0
4 Boyalali	20.0	4.13	4.8	1.89	64	62	3.4
5 Grobogan	19.3	4.95	3.9	1.33	96	47	0.0
6 Purworejo	18.3	2.94	6.2	2.20	97	64	4.6
7 Magetan	18.1	3.51	5.2	1.62	68	52	8.0
8 Sampang	17.8	3.87	4.6	1.30	32	76	0.3
9 Gunungkidul	17.8	3.06	5.8	1.94	24	86	0.0
10 Bojonegoro	17.7	4.35	4.1	1.23	90	39	0.3
11 Surakarta	17.0	4.65	3.6	1.76	67	64	2.1
12 Berbek	17.0	3.07	5.5	2.22	109	41	12.0
13 Ngawi	15.0	3.66	4.1	2.03	150	41	2.4
14 Kebumen	15.0	2.17	6.9	2.10	111	55	4.6
15 Kediri	15.4	2.64	5.8	2.82	94	54	34.6
16 Pati	14.6	3.10	4.7	1.55	98	42	5.7
17 Bandung	14.4	2.45	5.9	2.65	105	56	0.1
18 Tulungagung	13.7	2.70	5.1	2.68	90	70	11.7
19 Salatiga	13.5	2.64	5.1	1.55	65	64	0.0
20 Bangil	13.5	2.37	5.7	2.35	98	50	15.5
21 Ponorogo	13.3	2.92	4.6	2.09	72	62	4.9
22 Blitar	13.1	2.97	4.4	2.56	74	72	10.8
Total Java	9.5	1.87	5.1	2.16	96	54	5.8

Sources: Calculated from Bagchus [1926] and *Uitkomsten der in de Maand November 1920 gehouden Volkstelling* [1923].

Note: The total number of districts is 80.

Table 9 Districts in Java with More than 13 Percent of Arable Land Harvested with Cassava, 1985

District	% Arable Land under Cassava	Cassava Area per Capita (× 0.01 ha)	People per Ha. Arable Land	Yield Irrigated Paddy (ton/ha)	Production Irrigated Rice per Capita	% Upland Area in Total Arable
1 Wonogiri	42.6	6.24	6.8	4.82	101	79
2 Gunungkidul	35.1	6.73	5.2	4.29	27	94
3 Ponorogo	28.3	3.18	8.9	5.23	168	61
4 Sampang	27.9	5.32	5.3	4.20	86	81
5 Pacitan	27.3	6.92	3.9	4.59	78	87
6 Trenggalek	24.2	2.49	9.7	4.99	79	79
7 Karanganyar	22.4	2.09	10.7	5.31	174	64
8 Sumenep	19.8	3.30	6.0	3.92	41	84
9 Pamekasan	17.1	2.11	8.1	4.10	36	81
10 Garut	17.1	1.43	12.0	4.28	127	59
11 Ngawi	15.9	1.76	9.0	5.27	284	40
12 Tasikmalaya	15.6	1.49	10.5	4.14	133	64
13 Blitar	15.3	1.47	10.4	4.98	111	69
14 Magetan	14.7	1.38	10.6	5.46	165	47
15 Banjarnegara	14.7	1.82	8.1	4.85	99	77
16 Boyolali	14.6	1.50	9.7	4.83	120	70
17 Ciamis	14.4	1.90	7.6	4.64	190	68
18 Kebumen	14.2	1.47	9.6	4.57	144	63
19 Sukoharjo	13.6	1.06	12.8	5.11	191	52
20 Wonosobo	13.6	1.59	8.5	4.16	90	72
21 Purworejo	13.3	1.79	7.5	4.85	181	67
22 Malang	13.3	1.03	12.9	5.34	71	77
Total Java	10.5	0.91	11.5	4.73	133	56

Sources: Calculated from BPS [1986a ; 1986b ; 1986c].
Note: The total number of districts is 83.

whose diet consisted mainly of cassava and cassava products ? What were the characteristics of cassava producing areas ? The Tables 8 and 9 provide some particulars of the districts (*kabupaten*) which stand out for the production of cassava in 1920 and 1985, these tables allow us to address some common perceptions.

Firstly, it has been argued that increased population pressure in Java necessitated the production of cassava, because the production of irrigated rice fell short [Napitupulu 1968 : 65]. The tables indicate that neither population pressure, nor per capita production of irrigated rice necessarily accompanied a high percentage of arable land under cassava. Some districts reveal a high percentage of area under cassava and a low per capita production of rice, in particular Pamekasan (Madura), Sampang (Madura) and Gunungkidul (Yogyakarta) in 1920, and Gunungkidul and Pamekasan in 1985. But population pressure in these areas was not high compared to other districts.

Secondly, it has been argued that the sugar industry in Java commanded so much irrigated land for cane production, that people were forced to use upland fields to cultivate cassava for food. Table 8 shows that in 1920 the main cassava producing areas did not produce sugar, and that rice production per capita in the sugar producing areas was not necessarily below the average, necessitating cassava production.

Semarang in 1920 was a-typical. It contains the city of Semarang, which explains the high population density and the low per capita production of rice. In addition, colonial authorities had obliged farm households in Semarang, especially in the sub-district of Grobogan, to plant cassava as a buffer crop after disastrous rice crop failures in 1849/50 and again in 1901/02. This may be a reason why the city of Semarang had many tapioca factories before World War II, obtaining cassava from farmers in the vicinity. Many factories were destroyed during the 1940s and tapioca production did not recover in the area.

Attempts to correlate one of the first two variables in Tables 8 and 9 with the other variables failed to yield any statistically significant results for both 1920 and 1985. Hence, cassava production was generally not a consequence of population pressure, or a shortfall in rice production, or the presence of sugar industry. It is not possible to identify a general combination of factors which can explain why farm households in specific regencies produced relatively more cassava than elsewhere. Producers in different districts must have had different, possibly coinciding reasons to produce cassava.[8) Reasons may have included the presence of a tapioca factory in the area, the fact that the local officials of the agricultural extension service persuaded farmers to grow cassava as a cash crop, the organisation of a cooperative for the marketing of cassava, the availability of transport facilities to places where processing and marketing took place, the distance to urban centres, the profitability of cassava relative to other upland cash crops, et cetera. Such factors can only be identified through local historical research.

Clearly, areas with relatively high cassava production were not necessarily areas with high cassava consumption. Neither were such areas necessarily ridden by poverty and famine, as some have argued. This perception is largely based on the well-documented cases of the deprived and destitute areas of Bojonegoro (Rembang) and Gunungkidul during the 1930s, 1950s and 1960s.[9) In these areas abject poverty and malnutrition were associated with high per capita consumption of cassava. However, there is little evidence for the assumption that these cases reflect the food situation in other areas in Java. Nor did studies conducted in these regions during the 1930s and 1950s, prove that the poor nutritional status in these areas was caused by cassava as such. For one thing, Gunungkidul and Bojonegoro rank only 9 and 10 in Table 8 and there are no indications for widespread poverty in the first 8 districts.

8) A major difference could be the production of cassava for starch production in West and East Java, and for home consumption as *gaplek* in Central Java. But each province contains districts which disprove such a general characterisation.

9) See e. g. Van Veen [1939: 468–470], Postmus and Van Veen [1949], Bailey [1961: 289–300], Penders [1984: 126–137]. The problems in Gunungkidul continued well into the 1980s, despite the rapid growth in the average consumption of rice in Java as a whole [Sjahrir 1986: 50].

In Bojonegoro the problems were caused by a combination of crop failures due to pests and disadvantageous weather conditions in the late-1930s. The main harvests were a failure in both 1936/37 and 1937/38. In addition, the tobacco harvest failed in 1937, which made it impossible for many farm households to purchase food. In Gunungkidul the problems were endemic and caused by poor soil quality. Uncontrolled clearing of land and improper cultivation methods had led to major erosion problems in this remote, dry and sparsely populated area. These problems had little to do with the presence of Western enterprise or high population density. Bojonegoro and Gunungkidul were both isolated cases, which did not reflect the general situation throughout Java.

V Cassava : An Enigmatic Food Crop

The thesis that the increasing consumption of cassava is a proxy for a decline in the standard of living in Indonesia and in Java in particular rests largely on two assumptions : firstly, that Indonesian people have an innate preference for rice over other foods and, secondly, that the income elasticity of aggregated demand for cassava is negative, meaning that increasing average income leads to decreasing cassava consumption and vice versa.

The sections above have indicated that the way in which consumer demand for food products was satisfied in Java was obfuscated by at least three facts. Firstly, the elasticity of supply of rice was low until the late-1960s because the ceiling of technological change advanced only slowly, while the elasticity of supply of cassava remained high. This implies that the growth of domestically produced and imported rice could only keep per capita consumption at level. Thus, consumers had to find substitutes for rice to meet the additional demand for food. Cassava was an important substitute. Secondly, cassava was consumed in many different forms, which each may have had different income elasticities of demand. Thirdly, the price of cassava calories was quite low before World War II, while the price of rice calories decreased relative to cassava calories after the war. If rice and cassava products are substitutes, the cross-price elasticity of cassava products and rice would indicate the impact of this change on rice consumption after the ceiling of technological change in rice production was lifted.

Elasticities and Measurement Problems

Survei Sosio-Ekonomi Nasional (Susenas, Indonesia's regular socio-economic surveys) into household expenditure allow the calculation of expenditure elasticity as a proxy of income elasticity of demand for food products. Some estimates are included in Table 10, which indicate the extent to which an increase of household expenditure results in a change in the consumption of a product. In 1976 the expenditure elasticity of the demand for rice was generally higher than that of fresh cassava. The same holds for rice in rural

Table 10 Expenditure and Cross-Price Elasticities of Rice and Cassava, 1976 and 1978

Household Expenditure:		Low	Low-Middle	High-Middle	High	Average[a]
1976: *Expenditure elasticity:*						
Rice	-Urban	1.44	1.10	0.79	0.12	0.53
	-Rural	1.68	1.30	0.99	0.46	0.95
Cassava	-Urban	0.84	0.52	0.23	− 0.40	− 0.01
	-Rural	1.04	0.67	0.38	− 0.12	0.35
1978: *Expenditure elasticity:*						
Rice	-Urban	0.43	0.33	0.13	− 0.01	0.22
	-Rural	1.90	0.79	0.46	0.10	0.81
Cassava	-Urban	− 0.25	1.75	1.17	− 0.33	0.59
	-Rural	1.02	0.98	0.39	− 0.15	0.56
Gaplek	-Rural	− 0.67	− 0.76	− 2.44	− 1.20	− 1.27
1976: *Cross-price elasticity:*						
Cassava-rice		1.00	0.71	0.79	0.69	0.77
1978: *Cross-price elasticity:*						
Rice-cassava	-Urban	− 0.62	− 0.43	− 0.36	− 0.16	− 0.39
	-Rural	− 1.09	− 0.60	− 0.45	− 0.20	− 0.59
Cassava-rice	-Urban	− 0.08	− 0.07	− 0.04	− 0.06	− 0.06
	-Rural	0.04	0.00	0.02	0.03	0.03
Rice-*gaplek*	-Rural	1.50	1.59	3.80	6.09	3.25
Gaplek-rice	-Rural	− 0.13	0.03	0.08	− 0.03	− 0.01

Sources: [Alderman and Timmer 1980: 89; Monteverde 1987: 128–144]
Notes: Cassava refers to fresh cassava. The figures refer to Indonesia as a whole.
[a]. The 1976 averages are calculated with population weights, the 1978 averages with quartile weights.

areas in 1978, but not for urban areas. Moreover, it appears that fresh cassava in rural areas in 1976 and in urban and rural areas in 1978 had a positive expenditure elasticity, which suggests that consumption increased with income. On the other hand, *gaplek* had a very high negative expenditure elasticity, which makes it an inferior product. This conclusion confirms the importance of the form in which the cassava product is consumed, when assessing the extent to which changes in per capita cassava consumption reflect changes in average prosperity.

The cross-price elasticity indicates how the consumption of one product reacts to the change of the price of another product. For 1976 fresh cassava and rice appear to be substitutes, because an increase in the price of cassava led to an increase of the consumption of rice. But a more detailed view on the cross-price elasticity for 1978 indicates that the effect was less obvious that year. Only *gaplek* revealed the same reaction. In contrast, an increase in the price of rice led to a decrease in fresh cassava consumption, while an increase in the price of fresh cassava led to a decrease of rice consumption. Hence, rice and fresh cassava seem to be complementary goods across the spectre, both in urban and rural areas. This conclusion again emphasises the need to differentiate between the different ways in which cassava was consumed.

Similar estimates of expenditure and cross-price elasticities can be made for the other years during which Susenas was conducted (1963/64, 1969/70, 1976, 1978, 1980, 1984, 1987,

Table 11 Consumption of Cassava Products in Java, 1976 (kg. per capita)

		Expenditure of Households			Weighted Average
		Low	Middle	High	
Urban	–Fresh Roots	7.4	7.2	5.3	5
	–Tapioca	2.5	5.0	11.9	5
	–Total	9.9	12.2	17.2	12
Rural	–Fresh Roots	21.9	29.3	24.8	25
	–*Gaplek*	27.2	23.8	5.8	24
	–Tapioca	7.3	14.2	30.5	12
	–Total	56.4	67.3	61.1	61

Source : Calculated from Dixon [1984 : 78, 84–85].
Note : Fresh root equivalents. The group 'low expenditure' households concerns the first 50 percent of all households arranged according to expenditure, 'middle expenditure' concerns the next 40 percent and 'high income' the top 10 percent.

1990, 1993) [e. g. Dixon 1984 : 78 ; Trewin and Tomich 1994 : 10–13]. However, each of the surveys only captures the *gaplek*, fresh cassava and raw tapioca used in household cooking. The data fail to capture other forms in which cassava products were consumed in the household, such as ready-made noodles, crackers and cakes containing tapioca and other starchy products such as wheat [Dixon 1982 : 249–250 ; Damardjati *et al.* 1993 : 23–25]. They also omit the consumption of prepared foods outside the house, often in the form of snacks. This is a reason why the estimates of daily per capita calorie consumption from Susenas (1,800–1,900 kcal during 1980–1993) are much lower than those of Indonesia's food balance sheets (2,500–2,900 kcal).[10] In fact, the consumption of rice and cassava products accounted for in Susenas during 1980–1993 captured on average 82 percent of rice production and only 26 percent of fresh cassava production in Indonesia.

Table 11 contains estimates of the consumption of all cassava products for different expenditure groups in 1976. Even these estimates are incomplete. When multiplied with population numbers, they account for less than half of cassava production in Java that year. Still, Table 10 indicates that, when the household budget increases, per capita consumption of fresh cassava remains the same, consumption of *gaplek* declines and consumption of tapioca increases considerably. The net effect for all rural households is that per capita cassava consumption increases with the household budget. Hence, tapioca-based products are not inferior goods. For instance, deep fried crackers (*kerupuk*) generally contain a lot of tapioca and have a high income elasticity of around 1.5 [Unnevehr 1982 : 28 ; Dixon 1984 : 79]. Hence, the form in which cassava is consumed determines whether per capita consumption of cassava can be accepted as an indicator of the standard of living.

10) Dixon [1982] and Suryana [1988] discussed the many reasons that can be given to explain this deficiency in the Susenas data, such as under-reporting, the quality of food, the hidden goods problem and own production as income.

Trends in Tapioca Production

This finding would allow us to shed further light on the trends observed in Fig. 3, if there were a way of differentiating the forms in which produced cassava has been consumed over time. In particular, trends in tapioca consumption would be revealing. Unfortunately, it is very difficult to approximate production and consumption of tapioca, even today.

The main reason is that there may have been few economies of scale in starch production. Various types of equipment can be used, but starch production does not necessarily require capital-intensive production techniques [Damarjati *et al.* 1993 : 17–21]. There may have been some economies of scale in the production of the prime quality starch which Java exported before World War II, but mainly because of the large scale production would guarantee consistency in product quality. The absence of scale economies is the main reason why cassava processing in Indonesia has always been dominated by small-scale ventures.

There are indeed many indications that most starch was produced in household and cottage industries during the colonial era [e. g. Hasselman 1914 : 133 ; Blink 1926 : 388]. Several sources indicate that this industry was very important in particular areas, but omit quantifying such statements.[11] The industry was so important that in 1938 the government established the Cassave Centrale (Cassava Board), which sought to improve the quality of *kampung* meal by propagating improved cultivation and processing procedures [Anonymous 1938]. It also tried to secure better returns to farmers by enhancing indigenous involvement in cassava trade.

Cottage production of starch continued after World War II. There are several descriptions of small processing plants, but little statistical evidence which allows generalisation [e. g. Holleman and Aten 1956 : 16–68]. Quantitative data on small-scale industries are available since the 1960s, but they appear to lump small-scale cassava processing ventures together with other food processing industries. Moreover, the reliability of these data is doubtful. The 1974–75 census of small-scale and cottage industries reveals a considerable capacity for processing cassava, but still seems to be incomplete.[12] Several local recent studies indicate that cottage production of starch still is a very important source of rural employment and income in several regions [Hardjono

11) For instance, the best prewar study of tapioca production suggested in the 1930s that 'perhaps' 25–30 percent of cassava is processed into flour [Wirtz 1937 : 517].

12) This census counted 4,342 household firms and 1,010 small companies which produced tapioca. The total capacity of all tapioca producing companies in 1975 was estimated to be 21–23 percent of domestic supply [Nelson 1982 : 81–82]. However, the average capacities of these household and cottage firms was only a rough guess. Nelson [1982 : 80–82] suggested that 17 percent of domestic cassava supply was in the form of starch, rising to 27 percent in 1979. Unnevehr [1982 : 14] combined the 1976 Susenas with the 1975–76 census, to suggest that fresh cassava, *gaplek* and starch each formed about one-third of domestic cassava supply, which indicates that two-thirds was consumed in forms with a positive income elasticity.

and Maspiyati 1990 ; Kawagoe *et al.* 1991].

Even the development of starch production in large-scale establishments is difficult to assess, because not all were registered. In the colonial era factories were registered only if they used machinery which had to meet safety standards. The number of tapioca factories with licensed machinery increased as follows : 1910 21, 1915 50, 1919 69, 1925 88, 1930 149, 1935 120, 1940 156 [Segers 1988 : 59–61]. The production figures from these factories are not reliable. They seem to be most complete for 1940, when production of 161,500 tons of tapioca was reported. On the whole, these factories processed 10 percent of all fresh cassava and marketed about 35 percent of their produce domestically. A more detailed survey in 1940 registered factories employing ten people or more and/or using mechanical production techniques. This survey counted 219 tapioca factories in Java, which may have processed at least 14 percent of all fresh cassava. This definition for registration seems to have been continued after World War II, when the number of tapioca factories increased from 139 in 1954 to 213 in 1958, processing 3–5 percent of tuber production in Java [Sudarto 1960 : 36]. In 1960 there were 230 large and medium scale factories, processing about 7 percent of tuber production in Java [BPS 1964 : 31].

Annual data on industrial production by large and medium-scale industries are available since 1969. They note 342 tapioca producing plants in 1970, 161 in 1975, 188 in 1985 and 148 in 1994. In 1985 these factories together produced 224,200 tons of tapioca and processed more than one million tons of fresh cassava, or 7 percent of the total production in Indonesia [BPS 1987]. A range of other factories, producing e. g. noodles, bakery products, crackers and cattle fodder, also reported using cassava as raw material.

This concise survey of the available historical data is that it is impossible to fathom changes over time in the degree to which produced cassava was processed into tapioca. It is therefore also not possible to indicate the changes in the degree to which produced cassava was consumed in the form of fresh tuber, starch or starch-based products (which had a positive income elasticity of demand) or *gaplek* (which had a negative income elasticity of demand). Thus, the role of cassava in historical changes in food supply in Indonesia remains an enigma.

VI Conclusion

This article has noted dramatic changes in cassava production and consumption in Java during more than 100 years. It argued that, on the supply side, the rapid growth of cassava production during 1900–1920 was caused by the shift of the frontier of arable land into the upland areas, where the returns from cassava in terms of calories and money may have made it more appealing than other food crops that could be grown without irrigation. On the demand side, the dramatic expansion of cassava consumption came at a time when per capita income in Java must have increased, while consumers found that the calories from cassava were much cheaper than the calories from rice.

The growing ability to produce cassava came at a time when the limits of the extension of irrigated land had been reached. Economic and technological reasons impeded an increase of yields in irrigated rice production at a time when economic growth fuelled the per capita demand for food. The increasing demand for food was therefore largely met through the expansion of cassava production on upland fields. This happened at a time when transport facilities improved rapidly, making the marketing of the perishable cassava tubers possible, and making the production of cassava for distant markets a viable option for farmers operating upland fields. The exact reasons for the growth of cassava production may have varied between districts. In some areas farm households may have been forced to rely more on cassava for food consumption, while in other parts farmers may have produced most cassava for processing into tapioca or *gaplek*, and marketing in distant markets.

The article also argued that, even though conclusive evidence is difficult to provide, cassava may not have replaced rice in the average diet. Rather, cassava may have provided additional foods in the form of cheap calories from cassava-based snacks, which must have had a high income elasticity of demand and were therefore appreciated at all income levels. The validity of suggestions that the growing consumption of cassava are a sign of impoverishment depend on changes over time in the degree to which cassava was not consumed as fresh tuber or as tapioca-based snacks. Unfortunately, no evidence for such changes could be provided. In that respect cassava remains an enigmatic food crop. Only comparative historical studies into the local role of cassava production and consumption in Java may shed light on this suggestion.

Suggestions that cassava is an inferior food crop are to some extent based on the observation that per capita cassava consumption has fallen significantly since the late-1960s, while the per capita consumption of rice has increased. However, the article has argued that these two trends can be explained as a consequence of a decrease of the price of rice calories relative to cassava calories, which led low-income earners to substitute low-quality rice for *gaplek*. Moreover, it should be noted that the decline in the consumption of cassava did not mirror the increase in rice consumption, which indicates that cassava products maintained a role in the average diet in Indonesia.

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