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Food for Growth: Trends in Indonesia's Food Supply, 1880–1995

The interaction between economic development and changes in the average quantity of food consumed is likely to be strongest in economies that expand from low standards of living. In such cases, the income elasticity of demand for food is high and, consequently, small changes in average income will generate significant improvements in diet. Hence, in the absence of conventional, or undisputed, indications of economic development, changes in food supply may provide a useful alternative yardstick to measure changes in welfare.

Judging from the size of its population, Indonesia has long been one of the biggest relatively undeveloped countries in the world. Despite the availability of various indicators of long-term economic growth since the late nineteenth century, there is no unanimity among economic historians of Indonesia about the pace of long-term economic change. Some scholars casually assert that whatever growth occurred did not benefit the majority of the population, the ethnic Indonesians, but rather the Dutch colonial overlords or the ethnic Chinese middle class. This article uses long-term changes in per capita food supply in the Indonesian core island of Java from 1880 to 1952 and in Indonesia as a whole from 1953 to 1995 to shed new light on this issue.

Estimates of the available quantity of rice per capita have been used as an indication of changes in Indonesia's standard of living. Rice is a major food crop in the country, but it was only one of the items in the average diet. If consumers had a general preference for rice in Indonesia, a change in the quantity of rice available per capita can at least inform us about the extent to which Indonesians managed to fulfill their preferences, though not necessarily their food requirements.

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FOOD BALANCE AS AN INDICATOR OF LIVING STANDARD The food balance sheet was conceived by the Food and Agriculture Organization (FAO) in the late 1940s to assess global food requirements. It presents a comprehensive description of a country's food supply during a certain period, measuring total production of food stuffs, augmented by net imports and corrected for stock changes during the period involved. The definition of utilization distinguishes between the quantities used for exports, feed to livestock, seed, non-food, losses during storage and transport, and the amount available for human consumption. Per capita net supply of each food item is obtained by dividing total net supply by the population in the area concerned. The per capita available items are mostly aggregated by using caloric values and protein content.[1]

Comparisons of household surveys indicate that the amount of food actually consumed may differ from net supply according to the food-balance sheet. Differences may be caused by the loss of food during storage and cooking, the use of it to feed domestic animals and pets, or the discard of it as kitchen waste and leftovers. Moreover, since the production of some food items is not statistically reported, these items are excluded from the food balance. Statistical reporting of production can also be deficient, especially in sparsely populated developing countries. Furthermore, the food-balance sheet cannot indicate the socioeconomic or geographical distribution of food supply. These flaws reduce the value of food-balance sheets for the purpose of assessing broad changes in welfare.[2]

Still, several publications have used cross-sectional international data sets to establish the statistically significant positive correlation between gross domestic product (GDP) per capita and per capita food supply, thus confirming Engel's Law for households and national economies alike. Several studies have used time series to assess the historical relation between food supply and the

1 Colin Clark and Margaret Haswell, *The Economics of Subsistence Agriculture* (London, 1967) 1–23; FAO web pages, http://www.fao.org/waicent/faostat/agricult/fbs-e.htm (accessed 3 January 1999).

2 Concerning the shortcomings of the food balance, see, for example, Helen. C. Farnsworth "Defects and Abuses of National Food Supply and Consumption Data," *Food Research Institute Studies,* II (1961), 179–201; Thomas T. Poleman, "Quantifying the Nutrition Situation in Developing Countries," *Food Research Institute Studies,* XVIII (1981), 1–58; Elizabeth A. Dowler and Young Ok Seo, "Assessment of Energy Intake: Estimates of Food Supply *v* Measurement of Food Consumption," *Food Policy,* X (1985), 278–288.

general standard of living, for example, in France (1789–1964), Japan (1878–1964), and Belgium (1831–1939). The relationship between GDP per capita and per capita food supply is generally semilogarithmic, suggesting that the income elasticity of demand for food falls with increasing GDP per capita, largely because there are physical limits to how much food people can consume on average. Until the mid-1970s, the income elasticity of the Indonesian demand for food in general, and rice in particular, was estimated to be 0.5 to 0.7. Hence, a positive correlation between average income and average food supply can be expected, and, provided it is adequately measured, per capita food supply may be taken as a broad indicator of economic change in Indonesia.[3]

ESTIMATES OF FOOD SUPPLY IN INDONESIA Statistical reporting on food production in Indonesia improved significantly only after World War I, when the Dutch colonial government became increasingly concerned about food supply in the core island of Java. In 1930, population density in Java was close to 350 people per km^2. In fact, volcanos forced people to live in mountain valleys and coastal plains, where the population density exceeded 800 people per km^2. The concern was that Java would soon no longer be able to feed itself. Food production used to be monitored with data collected for tax purposes, but this system harbored inaccuracies. A new system to gauge food production closely was instituted c. 1920, permitting the first estimates of per capita food supply. This reporting system was gradually improved; reporting on food production has become fairly accurate in Java.[4]

3 Harry T. Oshima, "Food Consumption, Nutrition, and Economic Development in Asian Countries," *Economic Development and Cultural Change,* XV (1966/67), 385–395; Pedro Belli, "The Economic Implications of Malnutrition: The Dismal Science Revisited," *Economic Development and Cultural Change,* XX (1971/72), 1–23; Walton T. Wilford, "Nutritional Levels and Economic Growth: Some Empirical Measures," *Journal of Economic Issues,* VII (1973), 437–458. These studies drew attention to the role of food supply in explaining differences in economic performance between nations by stressing the economic effects of malnutrition. Jean Toutain, "La Consommation alimentaire en France de 1789 à 1964," *Économies et Sociétés,* X (1971), 1909–2049; Hiromitsu Kaneda, "Long-Term Changes in Food Consumption Patterns in Japan," in Bruce F. Johnston et al. (eds.), *Agriculture and Economic Growth: Japan's Experience* (Princeton, 1970), 398–431; Patricia van den Eeckhout and Peter Scholliers, "De Hoofdelijke Voedselconsumptie in België, 1831–1939," *Tijdschrift voor Sociale Geschiedenis,* IX (1983), 273–301; Tumari Jatileksono, *Equity Achievement in the Indonesian Rice Economy* (Yogyakarta, 1987), 73; Mubyarto, *Pengantar Ekonomi Pertanian* (Jakarta, 1987), 126–128.

4 The first estimate of per capita food supply was Marin G. van Heel, "Plantaardige Voedingsmiddelen op Java en Madoera," *Koloniale Studiën,* II (1917/18), 270–284. A more

In the underpopulated Outer Islands, where food supply was considered to be less precarious than in Java, many farmers still practiced "slash and burn," or swidden, agriculture. Swidden farmers tended to use part of food production as a buffer against adversity. Many of them also produced cash crops, such as rubber and copra, which allowed them to purchase imported food. Since there was no immediate urge to extend statistical reporting on food production to the Outer Islands, the first estimates of food production there did not occur until 1951. It took several years before the results were considered reliable.[5]

The first postwar food balance for Indonesia as a whole in 1956 stimulated a succession of calculated time series of per capita food supply on the basis of reported food production. In 1968, an elaborate food-balance sheet was prepared on the basis of special dietary surveys conducted for an extensive FAO review of the food and nutrition situation in the country. The Indonesian Central Bureau of Statistics (BPS) has continued the recommendations of this project and has since published more complete annual food balances according to guidelines from the FAO.[6]

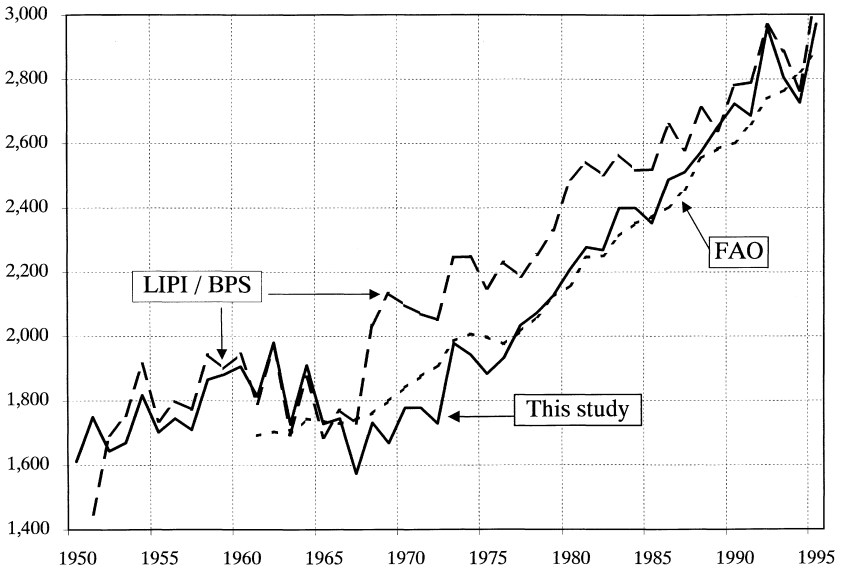
Figure 1 compares estimates used in this study with food-supply data from other sources. The chart indicates that the trends are roughly similar and that my estimates are congruent with the

elaborate study was X. F. Crince le Roy, "Raming der voor het Verbruik op Java en Madoera Beschikbare Hoeveelheden der Voornaamste Plantaardige Voedingsmiddelen in de Jaren 1921 tot en met 1930," *Landbouw,* VII (1931/32), 160–194. The results of these studies differed, because population data were inaccurate and calorie-conversion factors changed with later results of new research into food technology.

5 See, for example, M. B. Smits, *De Voornaamste Middelen van Bestaan van de Inlandsche Bevolking der Buitengewesten* (Buitenzorg, 1928); Anne M. P. A. Scheltema, "De Voeding van de Inlandsche Bevolking van Nederlandsch-Indië," *Kolaniale Studiën,* XIV (1930), 368–394. One estimate suggests that about 460 gm of rice per capita was consumed per day in the Outer Islands, and 260 gm in Java. Chris Lulofs, *De Voedselvoorziening van Nederlandsch-Indië* (Batavia, 1918), 114–136. Estimates of food consumption in the regular National Socio-Economic Surveys (*Susenas*) since 1964 confirm that calorie consumption in the Outer Islands has been significantly higher than in Java.

6 David M. Blankhart, "Food Balance Sheet (Preliminary Report), Persoalan Kebutuhan Makanan di Indonesia," in M. Sardjito (ed.), *Laporan Ilmu Kongres Pengetahuan Nasional No. 1, Malang 5–9 Augustus 1958* (Jakarta, 1958), 349–364; B. Napitupulu and Sunardjo, "Perkembangan Persediaan Bahan Makanan di Indonesia dalam Djangka Waktu 1951–1959," *Medan Ilmu Pengetahuan,* III (1962), 379–421; Leon A. Mears and Saleh Affif, "Carbohydrate Foods in Indonesian Diet," *Ekonomi dan Keuangan Indonesia,* XVI (1963), 19–46; A. G. van Veen, "Report to the Government of Indonesia on Food and Nutrition Policy in Relation to the Food Needs," *FAO Nutrition Consultants Reports Series No. 14* (Rome, 1970).

Fig. 1 Per Capita Net Food Supply in Indonesia, 1950–1995 (kcal/Day)



NOTE The Indonesian Institute of Sciences (LIPI) estimates for 1951–1952 are too low, because they are based on underestimated food production data for the Outer Islands.

SOURCES For 1951–1967: Indonesian Institute of Sciences (LIPI) figures in Robert Orr Whyte, *Rural Nutrition in Monsoon Asia* (Kuala Lumpur, 1974), 164; for 1968–1995: Indonesian Central Bureau of Statistics (BPS) figures in *Neraca Bahan Makanan di Indonesia;* for 1961–1995: Food and Agriculture Organization (FAO) figures from http://apps.fao.org/cgi-bin/nph-db.pl?subset=agriculture (accessed 3 January 1999); for 1950–1995: See Table 6 for the five-year averages of author's complete series.

latest FAO data from 1961 to 1995. However, my estimates are lower than the official BPS data since the mid-1960s for three reasons: (1) differences in the deduction rates for feed, seed, etc.; (2) slightly lower estimates of rice production for the sake of consistency in the long-term time series; and, most important (3), incomplete coverage of food production. This study includes only those foods for which data are available and for which estimates can be made for the period between 1880 and 1995—rice, maize, cassava, sweet potatoes, peanuts, soybeans, pork, lamb and beef—as well as approximations for the consumption of fish, sugar, copra, palm oil, and imported wheat. The main omissions are fruit, vegetables, poultry, and dairy products, which altogether

formed about 5 percent of total calorie supply in 1990. My estimates should therefore be increased by about 100 kcal to include these omitted food items.[7]

Since Figure 1 shows that the postwar trend is determined by the food products included in my estimates, it is likely that the trend shown in Figure 2 for the entire period from 1880 to 1995 is, in broad terms, adequate. But several points require further clarification. First, the chart shows that rice alone has determined the trend only during the last twenty-five years, whereas other staple crops clearly determined the changes from 1905 to 1970. Second, the chart shows that food-supply levels were significantly lower from 1880 to 1905 and from 1943 to 1970 than from 1905 to 1943 and from 1970 to 1995. Third, the chart reveals that even though the 1920s were a period of economic expansion, nothing in the food-supply data reflects this condition. Finally, the period 1970 to 1995 saw unprecedented economic gain, growth rates of GDP per capita averaging 3.5 percent per year. It is likely that income growth from low standards of living has been the main cause of the rise in food consumption.[8]

7 In previous publications, I have sought to correct the available data on population, food production, and foreign trade of food crops for inconsistencies in definition and coverage (see Appendix). Together with other data on, for example, inter-island trade and food stocks held by the state food logistical agency, and certain assumptions, it has been possible to construct estimates of food supply for Java from 1880 to 1952 and for Indonesia as a whole from 1953 to 1995, as explained in the Appendix. It is not possible to distinguish Java from the Outer Islands in the latter period, because published data on rice imports and exports and stocks held by the state food logistic agency pertain to the country as a whole. Moreover, annual data on inter-island shipments of food are not available after World War II. The results of any food balance depend on the reliability of the basic data concerning population, production, foreign trade, and stock changes. They also depend on assumptions about the deduction rates (seed use; feed; losses during milling, transport, and processing; and offal share), slaughter rates, and slaughter weights, as well as conversion factors.

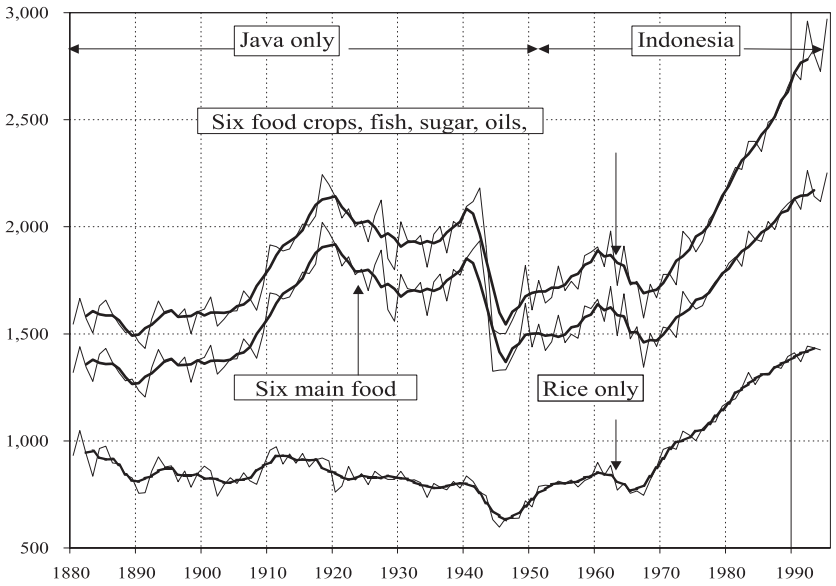
A rough approximation of daily per capita consumption of food products not covered:

	GRAMS	KCAL	PROTEIN (G)
Vegetables	120	35	2.0
Fruits	45	20	0.5
Fresh Fish	13	15	2.0
Chicken/eggs	12	40	2.0
Total		110	6.5

Cf. G. J. A. Terra, "De Voeding der Bevolking en de Erfcultuur," *Koloniale Studiën,* XVI (1932), 552–593; G. C. W. Chr. Tergast, "Indonesië's Inheemsche Landbouw," *Indonesië,* V (1951), 73–92.

8 This study's estimates of available rice per capita are lower than the estimates of, for example, Scheltema, *The Food Consumption of the Native Inhabitants of Java and Madura* (Batavia, 1936), and Leon A. Mears, "Rice and Food Self-Sufficiency in Indonesia," *Bulletin of Indonesian Economic Studies,* XX (1984), 126. Unlike the others, this study deducted seed use

Fig. 2 Net Food Supply in Indonesia Per Capita, 1880–1995 (kcal/Day, Annual and Five-Year Moving Averages)



NOTE Estimates for 1880–1952 refer to Java only, for 1953–1995 to the whole of Indonesia.

SOURCE See Table 6 for the five-year averages of author's complete series.

UNCERTAINTY IN THE DATA, 1880 TO 1920 Several factors explain why an estimate of 1,600 to 1,700 kcal per capita per day on average from 1880 to 1905 is plausible. For the period 1880 to 1920, the production of cassava and sweet potatoes had to be estimated by interpolating production data for 1880, 1903, and 1920. A comparison of per capita calorie supply with other estimates in Table 1 indicates that my estimates for 1880 to 1920 are significantly lower. It is not possible to identify the exact reasons for the different results, but it seems that the other estimates shown in Table 1 did not take account of foreign trade, losses, and seed and feed use. Moreover, the calorie conversion rates for the other

per harvested hectare. It was not possible to correct all years for crop failures and estimate seed use per planted hectare. Scheltema made no deductions. Mears deducted only a fixed percentage of production. Another reason for the differences is that different population estimates were used.

Table 1 Estimates of Per Capita Calorie Supply in Java, 1815–1941 (kcal)

	RICE	6 STAPLE CROPS	TOTAL
Intake			
1815	1,350	2,050	2,150
1841–45	1,050	1,500	1,600
1873–75	1,100	1,875	1,950
Production			
1815	1,256	1,654	1,917
1880	1,237	1,926	2,288
1900	933	1,739	—
1921–25	857	1,980	—
1936–40	867	2,111	2,408
Net supply			
1880–85	941	1,355	1,690
1900–05	818	1,371	1,706
1921–25	826	1,791	2,017
1937–41	802	1,795	2,133

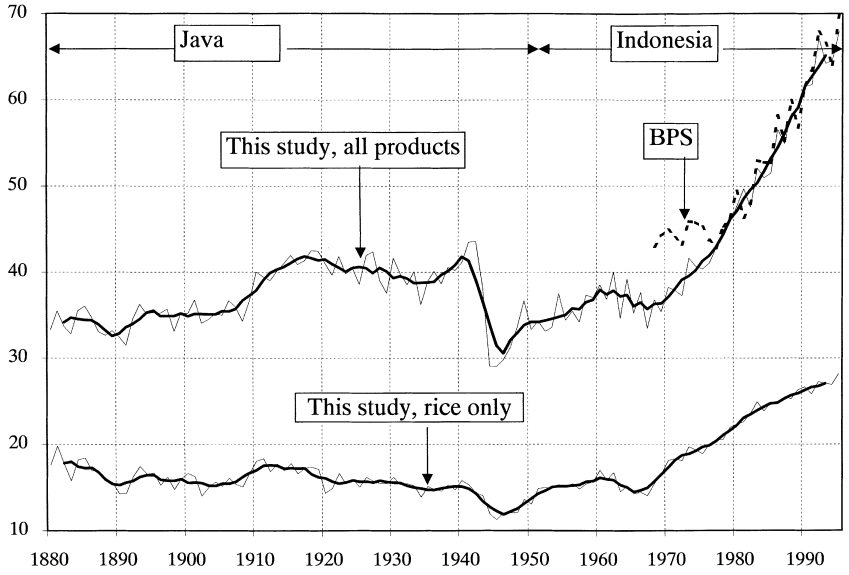
SOURCES "Intake" from Peter Boomgaard, "Java's Agricultural Production, 1775–1875," in Angus Maddison and Gé Prince (eds.), *Economic Growth in Indonesia 1820–1940* (Dordrecht, 1989), 114; "production" from Boomgaard and Jan-Luiten van Zanden, *Changing Economy in Indonesia: Food Crops and Arable Lands, Java 1815–1942* (Amsterdam, 1990), 50–51, 132; "net supply" from Table 6.

estimates are unclear, and they appear to be based on underestimated population data, which yield a significant upward bias before the 1920s.

A few other points recommend my estimates. First, the increase in calorie supply from 1905 to 1920 was due primarily to greater production of maize, sweet potatoes, and especially cassava. These crops tend to be grown on upland fields. Their rising production coincides with the fact that indigenous nonirrigated farmland multiplied quickly between 1905 and 1920 from 2.7 to 4.0 million hectares and that the total area harvested with major crops, except irrigated rice, increased from 2.7 to 4.4 million hectares. Since the assessment of arable land was separate from that of harvested area, there must have been a substantial increase in non-rice food production on upland fields during those years.

Second, the per capita supply of protein from 1880 to 1905 is broadly comparable to that prevailing from 1950 to 1970 (see Figure 3). Rather than calories, protein, together with vitamins and minerals, is important for physical and mental development.

Fig. 3 Net Supply of Protein Per Capita, 1880–1995 (g/Day, Annual and Five-Year Moving Averages)



SOURCES For 1968–1995: Indonesian Central Bureau of Statistics (BPS) figures in *Neraca Bahan Makanan di Indonesia;* for 1880–1995: See Table 6 for the five-year averages of author's complete series.

If survival at low levels of protein supply was possible from 1950 to 1970, it must have been possible earlier as well, albeit with more risks to health. The difference in trends between figures 2 and 3 is that the increase in protein supply from 1905 to 1920 was smaller than the increase in available calories. The extra protein came mainly from an abundance of peanuts and soybeans, which often reached consumers' meals in processed form as side dishes. However, the growth in peanut and soybean production was exceeded by the increased production of protein-poor but carbohydrate-rich cassava, which was the main force behind the expansion of per capita calorie supply.

THE AMBIGUITY OF CASSAVA Because consumption of cassava has been widely considered a sign of poverty, the simultaneous increase in calorie supply (which suggests a rise in average income), and in cassava consumption would seem contradictory.

The problem is that cassava is a versatile food crop, capable of many uses.[9]

Cassava was introduced into Java in the mid-nineteenth century, but its cultivation thrived only in the regions of Banten, Jepara, and Semarang, where it was produced as a cash crop for the manufacturing of tapioca (starch) for export. After tapioca factories had been established in Bandung and Garut, cassava production spread to Prianggan. Between 1900 and 1910, export of Cassava products escalated from 30,000 tons to 330,000 tons (calculated as fresh root equivalents). During the 1920s, it jumped again from 375,000 tons in 1920 to an extraordinary 2.4 million tons in 1928.

Within thirty years farmers throughout Java became familiar with the crop. They must have noticed that it required less work and water than rice. It could be grown on infertile land, on steep slopes, and on the bunds of irrigated land. Moreover, it could remain in the ground for an extensive period, to be harvested almost at will. Java became the leading exporter of cassava products in the world, but, except for 1928/29, only a maximum of 15 percent of Java's cassava production was exported. Most of it stayed in Indonesia; home consumption is likely to have expanded parallel to export production.

From 1920 to 1970, average net supply of cassava remained broadly constant at about 100 kg/capita per year. The role of cassava in the average diet started to decrease only in the 1970s, when government policies guaranteed an increase in the supply of relatively cheap rice. Until then, per capita rice consumption barely fluctuated, as shown in Figure 2. Cassava was probably an addition to the traditional rice-dominated indigenous diet and not a substitute for rice; it was often a side dish or snack. Only in some poor regions of central Java, such as Bojonegoro and Gunungkidul, did cassava replace rice, particularly during the lean period prior to the main rice harvest. In these areas, increasing reliance on cassava led to deficiency ailments and edema. These isolated cases, however, do not reflect the general situation in Java or even Indonesia. In other major cassava-producing areas of Java, such as Prianggan, those problems did not exist.

9 This paragraph is based on van der Eng, "Cassava in Indonesia: A Historical Re-Appraisal of an Enigmatic Food Crop," *Southeast Asian Studies,* XXXVI (1998), 3–31.

If average calorie count suggests an improvement in the standard of living, why did the increasing demand for food not meet with increasing rice production? Until the 1920s, the preference of Indonesian consumers for rice was satisfied by rice production that increased at roughly the same rate as population growth. The expansion of the foreign-owned sugar industry on Java may have impeded the increase of rice production and forced the rural population to subsist on non-rice crops, in particular cassava. Fields used to grow cane did not produce rice. However, at its zenith c. 1930, the sugar industry harvested cane from only 6 percent of all irrigated land.[10]

The main constraints on the expansion of rice production in Java were technological. Irrigated land available for rice production was limited. It increased from 2.9 million hectares in 1905 to 3.3 million hectares in 1930, or 14 percent, whereas total arable land increased from 6.4 to 8.5 million hectares, or 33 percent. Expansion of the rice crop had to depend on three methods: (1) multiple cropping of irrigated land through the construction of irrigation works; (2) development and adoption of superior seeds and yield-increasing techniques, such as the application of fertilizers; and (3) the cultivation of upland fields.[11]

The irrigation works constructed by the colonial government served to keep per capita rice production in Java roughly constant. These works changed marginal rain-fed irrigated areas to permanently irrigated ones with higher crop yields. They also contributed to the prevention of serious crop failures and generated a significant increase of the cropping ratio of irrigated fields, from an average of 1.1 in 1905 to 1.5 in 1940. Modern high-yielding fertilizer-responsive rice varieties did not exist in colonial Indonesia. Despite systematic research after 1905, such varieties were not available in significant quantities until the 1930s. Moreover, chemical fertilizer was too expensive for most farmers who generally applied organic fertilizer only on cash crops, not on rice.

The expansion of upland rice production was neither economically feasible nor advantageous. On upland fields cassava easily yielded more calories per hectare, required lower labor

10 Paul Alexander and Jennifer Alexander, "Sugar, Rice and Irrigation in Colonial Java," *Ethnohistory,* XXV (1978), 207–233.

11 This paragraph is based on several chapters in van der Eng, *Agricultural Growth in Indonesia: Productivity Change and Policy Impact since 1880* (Basingstoke, 1996).

input, and returned a higher net profit per hectare. Cassava also was better able to endure unfavorable conditions than upland paddy, or maize. The time that farm households saved by producing cassava could be devoted to cash crops or income opportunities off farm.

Another sign that intensive production of cassava was not necessarily an indication of impoverishment was that in its processed forms, cassava enjoyed a positive income elasticity of demand. In combination with protein-rich fish or vegetables, it could be a valuable addition to the rice-based diet. In fact, the leaves of the cassava plant, which are eaten in Indonesia as a vegetable or condiment, are a good source of protein.[12]

In short, there are plausible reasons on both the supply side and the demand side to explain why farmers increased the production of cassava. That the food supply in toto and the cassava supply increased concurrently from 1905 to 1920 intimates no inherent contradiction; the situation is compatible with economic expansion.

STAGNATION OF FOOD SUPPLY DURING ECONOMIC BOOM AND BUST, 1920–1942 The next puzzle that needs clarification is the fact that the expansion of per capita food supply stopped after World War I, a period of ostensible economic expansion, and slightly declined until the mid-1930s, a period characterized by economic depression, before reaching a new peak in 1942. The fall in per capita food supply during the 1920s was, to some extent, caused by extraordinarily high levels of food production from 1918 to 1921. In 1918, a shortage of shipping space disrupted foreign trade. Processed cassava for export may have been stockpiled, but no data on stocks are available to illustrate this assertion. This disruption of international trade caused a hike in world food prices, which may have encouraged Indonesian farmers to increase food production. Colonial officials were concerned about rice supply in rice-deficit areas. From 1918 to 1920, the government took several measures to enlarge the food supply, such as obliging farmers and foreign-owned estates to grow food crops. Another

12 Unfortunately, indicators of trends in the consumption of fish or vegetables are insufficient to determine that increased consumption of cassava was accompanied by an increase in the consumption of these foods.

factor is that death rates from an influenza epidemic in 1918/19 caused population numbers to fall relative to food supply.[13]

Figure 2 indicates that the erratic changes in total per capita food supply during the interwar years were not caused by changes in the per capita supply of rice, but by fluctuations in the export of cassava products due to international prices. Farmers harvested cassava when prices were right; otherwise they would leave it in the ground until prices recovered, as in 1928, when no less than 40 percent of the total cassava harvest was exported in response to a price upswing.

The irregularity would not explain the stagnation of per capita food supply, given that the 1970 to 1995 data indicate that potential demand may not have been met. Arguments advanced by Komlos to explain the "early industrial growth puzzle" in Europe during the late eighteenth and early nineteenth centuries, when economic growth accompanied a decline in the "biological standard of living" (measured by food intake and human stature), may be applicable. The most plausible explanation is that average incomes continued to rise as the price of food products relative to manufactures increased. Consumers may have delegated part of their usual food expenditure to purchase other goods. Despite the absence of statistical data about industry, most of these products must have been produced domestically. However, low-priced manufactures from Japan started to flood the Indonesian market after World War I. For instance, during the 1920s, the number of bicycles imported into Java doubled, and the imported quantity of textiles increased five times.[14]

The situation reversed during the 1930s, when Indonesia's exports and export prices plummeted. Japan devalued its currency in 1931; colonial Indonesia did not devalue until 1936. Consequently, imports of Japanese products continued to increase. Moreover, after 1931, land that had previously been planted with sugarcane became available for rice production. Yet, the per capita

13 van der Eng, "The Real Domestic Product of Indonesia, 1880–1989," *Explorations in Economic History,* XXVIII (1992), 343–373.

14 John Komlos, "Shrinking in A Growing Economy? The Mystery of Physical Stature during the Industrial Revolution," *The Journal of Economic History,* LVIII (1998), 779–802. This use of usual food expenditure for other purchases implies that the macroeconomic confirmation of Engel's Law takes the shape of an inverse double logarithmic curve, meaning that after a specific level of GDP per capita is reached, the curve slopes downward. Oshima, "Food Consumption," 387, made this observation for Japan during the period 1950–1963.

rice supply in Java did not increase in the early 1930s, even though rice prices fell faster than the prices of other commodities, as rice farmers in mainland Southeast Asia increased production for export in order to maintain their cash incomes. In 1933, the colonial government argued that these falling rice prices endangered the supply of food in Indonesia, reducing the incentive for farmers to produce a surplus. The government curtailed rice imports and subsidized inter-island shipments of rice from Java. After 1933, Indonesia's dependence on imported rice decreased, in spite of the fact that domestic rice prices were higher than international prices. In addition, the government's 1934 restrictions on imported manufactures to spur domestic industry increased the price of manufactures relative to food products, probably lessening demand for them.

After the devaluation in 1936, domestic rice prices were again in line with international prices. However, the colonial government intensified its commitment to stimulate domestic rice production. Initially, the aim had been to protect domestic rice producers, but in 1939, it was to secure domestic food supply in anticipation of the war. A logistical food board defended floor prices, and farmers started planting superior (in terms of taste, yielding capacity, and duration of growth) varieties of rice. In 1941, Indonesia became self-sufficient in rice.

THE DECREASE IN FOOD SUPPLY, 1943 TO 1970 Several factors explain the reduction in per capita food supply from 1943 to 1970. During the 1940s, it reflected the Japanese occupation and the war of independence, when Japanese, Indonesian, and Dutch authorities all tried to organize the rice-marketing system through rigorous controls, leaving farmers few incentives to produce a surplus. During World War II, imports were impossible, and during the late 1940s, an international rice shortage limited Indonesian imports.[15]

Government intervention in the domestic rice market continued after Indonesia's independence, while export production stagnated because of policy measures that discriminated against

15 van der Eng, *Food Supply in Java during War and Decolonisation, 1940–1950* (Hull, 1994); *idem,* "Regulation and Control: Explaining the Decline of Food Production in Java, 1940–46," in Paul H. Kratoska (ed.), *The Economic Impact of the Japanese Occupation on Southeast Asia* (Basingstoke, 1998), 187–207.

plantation agriculture and a foreign-exchange regime that exacted heavy taxation on exporters. Foreign-exchange shortages induced the government to promote domestic rice production, but results did not meet expectations during the 1950s and early 1960s. The government's plans to increase rice production through intensified land use were generally inadequate and underfinanced. Food policies focused almost exclusively on rice at the expense of other crops. Market intervention was, in principle, meant to guarantee a floor price in rice-producing areas and a ceiling in rice-deficit areas, but by the late 1950s, the rice stock of the logistical agency was largely distributed to civil servants, as part of their salaries. Although the agency purchased no more than 10 percent of the rice production, the dense regulation of that market and the decreasing real purchase prices of rice combined to discourage farmers from producing a surplus. The production of non-rice food crops suffered the consequences of a deteriorating transport infrastructure. Rather than moving toward self-sufficiency, the country increased its dependence on imported rice at a time when export revenues were falling. An acute shortage of foreign exchange forced the government to cut rice imports from 1964 to 1966, years marred by considerable problems in the country's food supply (see Figure 2).

The effort to enhance rice production and regain self-sufficiency was also hampered by an unprecedented increase in birth rates immediately after Indonesia's independence, and a sustained fall in mortality, particularly infant mortality. Annual average population growth in Java rose to approximately 1.9 percent from 1950 to 1970; it was 1.1 percent before World War II. Population growth in the Outer Islands was even higher, about 2.2 percent. Combined with the impact of the Japanese occupation and the Indonesian war of independence, this population growth implied a significant change in the age–sex distribution of the Indonesian population and therefore in the average food requirements. Table 2 indicates that the increased share of young children and women implied a slight decrease in the average food requirements.

THE ERA OF RAPID GROWTH, 1970 TO 1995 The years after the 1960s were characterized by almost continuous and unprecedented economic expansion; growth rates of GDP per capita aver-

Table 2 Average per Capita Daily Food Requirements in Indonesia, 1930–1990

	KCAL			PROTEIN (GRAMS)		
	MEN	WOMEN	ALL	MEN	WOMEN	ALL
1930[a]	2,135	1,725	1,933	43	36	40
1940[a]	2,124	1,720	1,925	43	36	39
1950[a]	2,174	1,744	1,962	44	37	40
1961	2,082	1,701	1,889	43	36	39
1971	2,089	1,721	1,902	42	36	39
1980	2,120	1,731	1,925	43	36	39
1990	2,168	1,751	1,959	44	37	40

[a] Java only.

NOTE The estimates take account of differences in the age–sex distribution of the Indonesian population but assume no changes over time in average height and weight.

SOURCES 1930, 1940, and 1950: Widjojo Nitisastro, *Population Trends in Indonesia* (Ithaca, 1970), 160; 1961: *Sensus Penduduk 1961 Republik Indonesia: Angka² Sementara Hasil Pengolahan 1% Sample Diperluas;* 1971: Nathan Keyfitz, "The Youth Cohort and Indonesian History," *Masyarakat Indonesia,* XIII (1986), 1; 1980 and 1990: *Sensus Penduduk Seri S, 1980* and *Sensus Penduduk Seri S, 1990*. Food requirements from Djumadias Abunain et al., "Kecukupan Kalori, Protein dan Zat Gizi yang Dianjurkan untuk Indonesia," in Tubagus Bachtiar Rifai (ed.), *Widya Karya Nasional Pangan dan Gizi: Buku II, Kumpulan Kertas Kerja Utama* (Jakarta, 1979), 88.

aged 3.8 percent per year, even though annual population growth continued to average 2.2 percent. Figures 1 and 2 clearly indicate that per capita food supply increased significantly during these years and that the trend was determined largely by the growth of rice production. Apparently, Indonesia managed to escape the decline in the biological standard of living that stunted Western Europe and North America during the late eighteenth and early nineteenth centuries. Several factors help to explain this difference.

The first is Indonesia's dramatic windfall from high international petroleum prices during the years 1974 to 1986. Indonesia's oil exports had already grown rapidly during the late 1960s, but its export revenues increased even faster after OPEC decided to curtail production. The concentration of oil and gas resources in the hands of one state-owned company dramatically expanded the funds available to the central government, a major share of which went to support the agricultural sector. Public investment in the construction of irrigation works and roads and in the development and dissemination of high-yield crops, as well as the heavy subsidization of current farm inputs and the protection of Indonesian

rice farmers from price fluctuations on the international market, contributed substantially to the productivity and profitability of rice production relative to other food crops.

The rapid growth of rice production was fuelled by a rapid growth in the demand for rice that occurred for three reasons. The first was high population growth, and the second was rapid economic growth, which increased average incomes at a time when the income elasticity of demand for rice was still about 0.7. The third reason involves the extent to which Indonesia's rapid growth was broad-based, even though it had been spurred by oil revenues. For instance, support for farm agriculture prevented an exodus from rural to urban areas, relieving a potential strain on the capacity of cities to absorb more people. The promotion of broad-based growth in both urban and rural areas helps to account for the fall in poverty rates and the balance in income distribution. The growth of incomes across the board meant that all consumers were able to increase food consumption. Consumers in the middle- and high-income strata substituted premium quality rice for low-quality rice. More important, the much larger group in the low-income strata was able to substitute calories from low-quality rice for cheap cassava-based calories. This effect was enhanced by a major decrease in the price of calories from rice relative to calories from other staple food crops. These income and substitution effects significantly increased the demand for rice.[16]

Occasional late harvests and crop failures made the importation of unprecedented quantities of rice necessary. Unlike during the 1960s, increased export revenues allowed the state food logistical agency to purchase rice abroad as necessary to meet production shortfalls during the 1970s and early 1980s. Favorable harvests and input subsidies that boosted the effective rate of protection reduced Indonesia's dependence on imported rice. The country achieved self-sufficiency in 1985, and maintained it to a great degree until 1995.

16 Hal Hill, *The Indonesian Economy since 1966: Southeast Asia's Emerging Giant* (Cambridge, 1996), 191–199; Van der Eng, "Cassava in Indonesia," 19. Unfortunately, the exact magnitude and relative importance of the income-and-substitution effects are impossible to trace. Although results of the triannual national surveys of household consumption and expenditure in Indonesia since 1964 are theoretically apropos, these data grossly underestimate food consumption, particularly of non-rice food crops, making the substitution effect particularly difficult to trace. See, for example, Ahmad Suryana, "Consumption and Demand for Selected Food in Indonesia," *Indonesian Agricultural Research and Development Journal,* X (1988), 1–8.

FOOD FOR GROWTH: FOOD SUPPLY AS AN INPUT Indonesia's official food balances indicate that the production and consumption of nonstaple foods (such as meat, poultry, fruits, and vegetables) and of processed foods (such as dairy products and products based on imported wheat) started to increase significantly only after the mid-1980s. The implication is that long-term changes in the quantity of per capita food supply have been determined by changes in the supply of carbohydrates from the six main food crops cited herein. The failure of the phases 1880 to 1905 and 1943 to 1970 to achieve the average requirements shown in Table 2 suggests that these periods could have suffered a significant shortfall in food supply. Were hunger and malnutrition rampant during these periods? Were the registered levels of per capita supply sufficient for subsistence?

There are three theoretical explanations for the gap between per capita supply and requirements. First, average requirements may actually have been lower during the two periods in question, because earlier years of high population growth generated a relatively large proportion of children and adolescents, who require less food than adults. Unfortunately, the age distribution of the Indonesian population is available only for the years indicated in Table 2, 1930, 1940 and 1950 being only approximations. Until 1961, the census data distinguished only between "non-adults" and "adults." According to Wertheim, Indonesians considered girls aged fourteen to fifteen and boys sixteen to seventeen, or, on average, children fifteen years or younger to be non-adults. Table 3 shows that the share of children may have been greater in Java from 1890 to 1905, compared to earlier and later years. If these figures are correct, the 1890 to 1905 birth cohorts were overrepresented at later stages. They added extra demand for food when they started to reach adulthood from 1905 to 1920, after which the effect may have disappeared. Nonetheless, the biggest postwar change in the share of non-adults, as shown by Table 3, is between 1950 and 1971. The difference in average calorie requirements between 1950 and 1971 in Table 2 suggests that the larger share of children did not drastically decrease average food requirements.[17]

17 Willem F. Wertheim, "La Population de l'Indonésie et Le Test des 40%," *Population,* IX (1954), 655–674, developed this "forty percent test" to approximate the birth rate for Indonesia during the 1930s on the basis of the observation that in most developing countries, the share of people aged fifteen years and younger is around 40 percent. One major problem with the

Table 3 Proportion of Non-Adults in Total Population, 1860–1990 (Percentages)

	JAVA		JAVA	INDONESIA
1860	44.4	1930	40.9	40.8
1870	43.9	1940	40.9	NA
1890	45.8	1950	37.0	NA
1895	46.0	1961	41.1	42.1
1900	45.5	1971	43.1	43.9
1905	44.8	1980	39.8	40.9
1920	41.0	1990	34.4	36.6

NOTES NA means not available. Non-adults means younger than fifteen for 1940–1990.
SOURCES 1860–1930: *Volkstelling 1930, Deel VIII: Overzicht voor Nederlandsch-Indië* (Batavia, 1936), 84; 1940–1950: Widjojo Nitisastro, *Population Trends in Indonesia* (Ithaca, 1970), 160; 1961: *Sensus Penduduk 1961 Republik Indonesia: Angka² Sementara Hasil Pengolahan 1% Sample Diperluas;* 1971: Nathan Keyfitz, "The Youth Cohort and Indonesian History," *Masyarakat Indonesia,* XIII (1986), 1; 1980 and 1990: *Sensus Penduduk Seri S, 1980* and *Sensus Penduduk Seri S, 1990*.

Second, subsistence at such low levels might well be possible. Table 4 surveys a wide range of detailed investigations into the diets of Indonesian people by year and region. It covers all consumed products, whereas the estimates in Figure 2 cover only the major portion of total consumption. The data are fragmented, revealing a considerable variation in food consumption. This variation is caused, to some extent, by differences in the age–sex distribution and body size of the populations in the samples. Indonesians evince substantial differences in height and weight in different parts of the country. Dietary research during the 1930s in West Java discovered that an average man weighed 50.5 kg and was 159 cm tall, and that a woman weighed 43.5 kg and was 148 cm tall. But in deprived areas of central Java, average body weights were lower: 44.5 to 47.0 kg for men, and 39.5 to 42.0 kg for women. The average family member (including children and elderly people) in Java was estimated to weigh between 33 and 35 kg. Hence, it is difficult to apply one minimum standard of per capita food consumption to the entire population throughout the period under consideration. These observations underscore the impression from Table 4 that the average levels of

data in Table 1 is that until 1905, population statistics were used to assess the statute labor obligations of indigenous Indonesians. The age of boys was often given low to evade these regulations.

Table 4 Per Capita Daily Consumption according to Dietary Surveys in Indonesia

SOURCE	AREA	YEAR(S)	KCAL	PROTEIN (GRAMS)
(1)	Jakarta (male servants and students)	1893	2,512	73
(2)	Pulu Laut mines (male laborers)	1913	2,984	100
(3)	Kepanjen (Pasuruan)	1921	1,612	53
(3)	Purworejo (Pasuruan)	1921	1,683	52
(3)	Lumajang (estate workers)	1921	1,742	46
(4)	Kutawinangun (farmers)	1933/34	1,789	45
(4)	Kutawinangun (wage laborers)	1933/34	1,755	49
(5)	East Cirebon	1935/36	1,288	35
(5)	Blora	1935/36	1,675	44
(5)	Gresik	1937	1,401	37
(6)	Jakarta (coolies)	1937	1,563	37
(5)	Segalaherang (Kerawang)	1937/39	1,599	42
(5)	Pacet (Cianjur)	1937/39	2,141	52
(5)	Gunungkidul (Yogyakarta)	1938/41	1,265	18
(5)	Rengasdengklok (Kerawang)	1939	2,220	56
(7)	Bojonegoro (after crop failures)	1939	908	15
(5)	Pulosari (Pemalang, after crop failures)	1939/41	950	26
(8)	Waled (Cirebon)	1939	1,278	35
(9)	Seram (Maluku)	1939/40	1,650–2,000	16–26
(10)	Laborers living on estates	1940	1,964–2,132	52–57
(10)	Laborers living outside estates	1940	1,282–1,983	32–53
(10)	Farmers living near estates	1940	1,391	35
(11)	Lahabang and Rabu (Kalimantan)	1950	2,143	59
(12)	Toraja (Sulawesi, 20–25 year olds)	1950	1,899	49
(13)	West Timor (West Nusatenggara)	1951	1,296	37
(5)	Pati	1956/57	1,685	40
(11)	Semarang	1957	1,619	34
(14)	Jakarta (male laborers)	1957	1,591	45
(15)	Surabaya (male laborers)	1958	1,431	41
(16)	Gunungkidul (Yogyakarta)	1958/59	1,350	16
(11)	Purwakarta	1959	2,043	52
(17)	Bogor (male students)	1960	2,100	60
(17)	Bogor (female students)	1960	1,400	43
(18)	Ciwalen, Amasari (West Java, poor)	1961	1,638	41
(18)	Ciwalen, Amasari (West Java, well-off)	1961	1,824	47
(19)	Surabaya	1968	1,488	40
(20)	West Java (sample survey)	1969/70	1,620	33

1,600 kcal/day during the period 1880–1905 and of 1,750 kcal/day during 1950–1970 were not inconceivably low.[18]

Third, food requirements are determined not only by age, sex, and body size but also by physical activity. A person performing hard physical labor requires more energy than someone performing light work. It is difficult to establish how much physical

18 Simon Postmus and A. G. van Veen, "Dietary Surveys in Java and East-Indonesia," *Chronica Naturae,* CV (1949), 229; Maarten Timmer, *Child Mortality and Population Pressure in the D.I. Jogjakarta, Java, Indonesia: A Social-Medical Study* (Rotterdam, 1961), 396, 400.

Table 4 continued

SOURCE	AREA	YEAR(S)	KCAL	PROTEIN (GRAMS)
(20)	East Java (sample survey)	1969/70	1,760	43
(21)	Java (sample survey)	1972/73	1,404	38
(21)	Sumatra (sample survey)	1972/73	1,700	48
(21)	Bali/Nusatenggara (sample survey)	1972/73	1,693	43

NOTES Where a survey concerned several villages, an unweighted average was calculated. The outcomes of the surveys are not entirely comparable, because each of them employed different calorie-conversion factors.

SOURCES (1) Christiaan Eykman, "Bijdrage tot de Kennis van de Stofwisseling bij de Bewoners der Tropen," *Geneeskundig Tijdschrift voor Nederlandsch-Indië,* XXXIII (1893), 174; (2) Lambertus Leopold, *De Gezondheidstoestand der Arbeiders bij de Steenkolenmijnen van Poeloe Laoet* (Amsterdam, 1915), 17; (3) W.E.K. van Lynden and Anne M.P.A. Scheltema, *Het Voedselverbruik in Eenige Districten van de Residentie Pasoeroean* (Batavia, 1923), 59, 62, 79; (4) Jacob J. Ochse et al., *Geld- en Producten-Huishouding, Volksvoeding en -Gezondheid in Koetowingangoen* (Bogor, 1934), 112; (5) Tubagus Bachtiar Rifai, "Bentuk Milik Tanah dan Tingkat Kemakmuran: Penjelidikan Pedesaan Didaerah Pati, Djawa-Tengah," unpub. Ph.D. diss. (Universitas Indonesia, 1958), 181–182; (6) Willem F. Wertheim et al., *The Indonesian Town: Studies in Urban Sociology* (The Hague, 1958), 137; (7) Chris L. M. Penders, *Bojonegoro 1900–1942: A Story of Endemic Poverty in North-East Java, Indonesia* (Singapore, 1984), 133; (8) G. J. A. Terra, "Food Patterns in Indonesia," in *Tradition, Science and Practice: Proceedings of the 3rd International Congress of Dietetics* (London, 1962), 43; (9) Simon Postmus and A. G. van Veen, "Dietary Surveys in Java and East-Indonesia," *Chronica Naturae,* CV (1949), 318; (10) Luidolf H. Huizenga, *Het Koeliebudgetonderzoek op Java in 1939–1940* (Wageningen, 1959), 165; (11) B. Napitupulu, "Hunger in Indonesia," *Bulletin of Indonesian Economic Studies,* III (1968), No. 9, 64; (12) Jan F. de Wijn, "A Nutritional Survey of the Toradja Population," *Documenta de Medicina Geographica et Tropica,* IV (1952), 163–164; (13) Victor M. Oppers, "Nutrition, Tuberculosis and BCG-Vaccination in Timor," *Documenta de Medicina Geographica et Tropica,* IV (1952), 229; (14) Djumadia Abu Nain and Dradjat D. Prawiranegara, "A Report on a National Survey among Laborers in Jakarta 1957," in *Laporan Ilmu Kongres Pengetahuan Nasional No. 1. Malang 5–9 Augustus 1958* (Jakarta, 1958), 657; (15) "Penjelidikan Makanan Buruh-Buruh Dikota Surabaja," unpub. report (Surabaya, 1959); (16) Kenneth V. Bailey, "Rural Nutrition Studies in Indonesia: Background to Nutritional Problems in Cassava Areas," *Tropical and Geographical Medicine,* XIII (1961), 224; (17) "Penjelidikan Gizi Mahasiswa Bogor," unpub. report (Bogor, 1960); (18) Lauw Tjin Giok et al., "A Study of the Nutritional Status at Two Economic Levels in Tjiwalen and Aman Sari Villages of West Java," in M. Sardjito (ed.), *Laporan Kongres Ilmu Pengetahuan Nasional II. Djil.2-A1* (Jakarta, 1962), 123; (19) Yoshiaki Toda and Hoepoediono Soewndo, "Nutritional Survey of Inhabitants in Surabaja, Indonesia," *Kobe Journal of Medical Sciences,* XVI (1970), 132; (20) van Veen, Lie Goan Hong, and Oey Kam Nio, "Some Nutritional and Economic Considerations of Javanese Dietary Patterns," *Ecology of Food and Nutrition,* I (1971), 41; (21) Sajogyo, *Usaha Perbaikan Gizi Keluarga. ANP—Evaluation Study, 1973* (Bogor, 1973), 23.

work people do on average. Nutritionists prefer to use the basal metabolic rate (BMR) to determine calorie requirements. The BMR is the energy that the body requires to sustain itself without performing any action. The World Health Organisation (WHO) recommends a BMR value of 1,450 kcal/day for males aged eighteen to sixty with an average weight of 50 kg, and of 1,080 kcal/day for women aged eighteen to thirty with an average weight of 40 kg, and of 1,180 kcal/day for women aged thirty to sixty with the same average weight.[19]

19 WHO, *Energy and Protein Requirements* (Geneva, 1985), 133–135.

The calculation of average requirements in Table 2 assumes that men aged twenty to forty required 2,530 kcal/day and men aged forty to sixty 2,470 kcal/day, and that women aged twenty to forty required 1,880 kcal/day and women aged forty to sixty 1,740 kcal/day. These figures allow for an energy surplus to meet the requirements of physical activity, whatever it may have been. Table 5 shows the energy needed for several activities. For example, an average consumption of 2,530 kcal/day by a man weighing 50 kg leaves a surplus of 1,080 kcal/day for physical activity. If this man engages in hard work, requiring four times his BMR, his energy requirements are $(4 \times 1{,}450)/24$, or 242 kcal/hour. Hence, he would have been able to work 4.5 hours per day. This example helps to explain the differences in per capita food consumption shown in Table 4. For instance, men working in the Pulu Laut coal mines in 1913 would have consumed more energy than the average Indonesian male, because of intense physical demands.[20]

It is possible to speculate about the extent to which physical labor in the Indonesian economy may have varied over time. From 1880 to 1905, the average supply of the food products covered in Figure 1 was about 16 percent below the average requirements after 1930. Assuming that the age–sex distribution was the same before 1930, and that the relative shortage of food did not affect food allocation in the average household, the man in the example would have been able to work 3.8 hours per day during those years. The increase in food supply from 1905 to 1920 would have permitted the average person to work longer hours and/or perform more strenuous tasks, possibly to capture new income opportunities beyond the common subsistence requirements.

The 4.5 hours per day of work that the man in the example was able to do during the years in which average requirements were more than met—that is, 1910 to 1942 and 1973 to 1995—hardly seems long. But until 1995, more than 50 percent of the labor force was engaged in agriculture, which offered only seasonal

20 Energy intake and work output in terms of hours worked do not have to be positively correlated in the long run, because structurally low energy intake tends to cause stunted human growth rather than prolonged lethargy and low hours worked per year. A low energy intake at a low body weight may generate a relatively high number of hours worked. See Wade C. Edmundson and Pandurang V. Sukhatme, "Energy Intake and Human Productivity," in Edmundson, Sukhatme, and Stella A. Edmundson, *Diet, Disease and Development* (Delhi, 1992), 56–83.

Table 5 Energy Expenditure by Activity, Multiples of the Basal Metabolic Rate

	MALE	FEMALE		MALE	FEMALE
Sleeping	1.0	1.0	Digging holes for planting	—	4.3
Walking at normal pace	3.2	3.4	Planting	2.9	3.9
Walking with load	3.5	4.0	Sowing	—	4.0
Cleaning house	—	2.2	Collecting, spreading manure	5.2	—
Child care	—	2.2	Weeding	2.5–5.0	2.9
Washing clothes	—	3.0	Harvest cutting ears	2.1	—
Spinning cotton	—	1.4	Harvesting root crops	3.5	3.1
Weaving	2.1	—	Picking coffee	—	1.5
Office work at desk	1.3	—	Threshing	—	5.0
Carpentry	3.5	—	Winnowing	3.9	1.7
Bricklaying	3.3	—	Collecting coconuts	4.6	—
Clearing ground	2.9–7.9	3.8	Husking coconuts	6.3	—
Digging irrigation channels	5.5	—	Pedalling a loaded ricksaw	8.5	—
Hoeing	—	4.4	Pulling a cart with load	5.9	—

SOURCE WHO, *Energy and Protein Requirements* (Geneva, 1985), 186–191.

employment. This scarcity of income opportunities meant that since a considerable number of laborers worked less than eight hours per day throughout the year, the food supply may well have been sufficient. In short, earning additional income was not just a matter of deciding to burn more calories; the demand for the extra goods and services had to be great enough to justify making the effort.

Because the period 1905 to 1929 saw almost continuous economic expansion, income opportunities most likely improved from 1905 to 1920, although surely not to the same extent for everyone. The increasing commercialization of agriculture and the advances in transport services surely raised the need for physical labor. Moreover, most crops produced for export required higher inputs of physical labor than the indigenous food crops, except irrigated rice.[21]

The escalating consumption of cassava until 1920 is explained not only by the shortage of irrigated land but also by cassava's profile as an easy crop yielding a relatively large amount of energy per hectare and per hour worked. Cassava may be low in protein and other nutrients, but, as Figure 3 shows, increased production

21 Gerrit J. Vink, *De Grondslagen van het Indonesische Landbouwbedrijf* (Wageningen, 1941), 106.

of other crops enhanced the per capita supply of protein. This explanation of the increase in cassava consumption clarifies why attempts by the colonial government in the nineteenth century to introduce cassava as a staple crop in Java failed; there may not have been any need for additional calories from non-rice crops at that time.[22]

One reason for the decline of the per capita food supply after Indonesian independence is that net population growth accelerated to more than 2 percent on average. But it is also likely that a fall in additional income opportunities diminished the demand for consumable energy. During the economic stagnation of the 1950s and 1960s, the majority of new entrants into the labor market was absorbed in the agricultural sector. Unfortunately, the frontier of arable land had already been reached in Java. Work outside the agricultural sector was limited, mostly to the "informal economy" of wage laborers, petty traders, hawkers, and peddlers. The lack of gainful employment for which physical labor was required may help to explain the reduction in the food supply during the 1950s and 1960s. In contrast, the broad-based economic expansion since the 1960s seems to have created a wide range of income opportunities for physical labor.

Although a positive correlation between per capita food supply and per capita income is likely, this article finds that the relationship between food supply and the standard of living in Indonesia since 1880 has been much more complicated. At first glance, the relationship might seem to be a straightforward confirmation of the macroeconomic application of Engel's Law. This study, however, provides evidence against tenaciously held perceptions that a decline, or stagnation, of prosperity characterized the late colonial era. The decline in per capita rice supply, which others have used to substantiate the claim that prosperity decreased, is only marginal in relation to food supply as a whole, and irrelevant for an interpretation of changes in total food supply until the 1970s.

A closer look at long-term changes in the composition of food supply, and in the production and demand for food, reveals that several other factors have to be taken into account. On the supply side is Indonesia's inability to satisfy an increase in the demand for food with a higher supply of the main staple food

22 Van der Eng, "Cassava in Indonesia," 9.

crop, rice. From 1905 to 1920, cassava products met the additional demand for carbohydrates, while a greater output of soybeans and peanuts met the concomitant demand for protein. The demand for food probably grew with purchasing power, as well as with new opportunities for physical employment. During the interwar years, per capita food supply decreased slightly, mainly because demand shifted from staple foods to cheap manufactures.

The years 1943 to 1970 witnessed a drastic fall in food supply per capita not only because of an extraordinary acceleration in population growth but also because of government regulations imposed on food markets and the general demise of the Indonesian economy. Since the 1960s, the upward trend in per capita food supply was caused largely by dramatic increases in rice production, generated by the implicit and explicit support that the government extended to rice farmers. Higher incomes and broad-based economic development, with its new opportunities for labor, brought an increased demand for food. For the first time, low-income consumers could meet their growing need for food with inexpensive rice, rather than non-rice food products.

APPENDIX: CALCULATION OF PER CAPITA FOOD SUPPLY IN INDONESIA, 1880–1995

Table 6 shows the estimates of per capita food supply discussed in this article. The procedures used to obtain consistent time series on population, harvested area, and production of the main six staple food crops in Java and in Indonesia have been elaborated in van der Eng, *Growth and Productivity Change in Indonesian Agriculture, 1880–1985* (Groningen, 1990). These were slightly revised and updated to 1993 in *idem, Agricultural Growth in Indonesia: Productivity Change and Policy Impact since 1880* (Basingstoke, 1996), 271–279, 293–308. The non-rice food crops in Figure 2 are maize, sweet potatoes, cassava, peanuts, and soybeans. The procedures used to correct for the use of seed and feed and for losses of food crops are explained in *Growth and Productivity Change,* 79–82, and in *idem, Food Supply in Java during War and Decolonisation, 1940–1950* (Hull, 1994), 78. Imports, exports, inter-island trade of food products, and changes in the rice stock of the state food logistic agency are contained in *Growth and Productivity Change,* 62–64.

The other food products are buffalo, cattle, goats, sheep, pigs, fish, sugar, copra, palm oil, and imported wheat. Estimates of meat production are explained in *Growth and Productivity Change,* 65–71, and *Agricultural Growth,* 289–292. Official data on landed fish are available since 1951. An estimate for 1940 suggests a production of 6.5 kg per capita.

Table 6 Per Capita Food Supply in Indonesia, 1881–1995 (Five-Year Averages)

	CALORIES (KCAL)				PROTEINS (GRAMS)	
	RICE ONLY	6 STAPLE CROPS	OTHER PRODUCTS	TOTAL	RICE ONLY	TOTAL
1881–1885	952	1,380	226	1,606	18	35
1886–1890	843	1,298	226	1,524	16	33
1891–1895	861	1,344	227	1,571	16	35
1896–1900	836	1,358	226	1,583	16	35
1901–1905	806	1,374	225	1,598	15	35
1906–1910	860	1,500	224	1,724	16	37
1911–1915	928	1,707	224	1,932	18	40
1916–1920	876	1,904	224	2,128	17	42
1921–1925	826	1,791	225	2,017	16	40
1926–1930	838	1,733	237	1,970	16	41
1931–1935	795	1,697	224	1,920	15	39
1936–1940	797	1,772	228	2,000	15	40
1941–1945	709	1,637	209	1,846	13	37
1946–1950	666	1,453	173	1,626	13	33
1951–1955	797	1,496	221	1,716	15	35
1956–1960	829	1,577	244	1,822	16	37
1961–1965	810	1,587	245	1,832	15	37
1966–1970	833	1,471	229	1,699	16	36
1971–1975	1,001	1,594	269	1,863	19	40
1976–1980	1,116	1,736	339	2,075	21	44
1981–1985	1,268	1,906	433	2,339	24	50
1986–1990	1,360	2,065	525	2,590	26	58
1991–1995	1,433	2,171	659	2,830	27	65

I assumed a 15 percent offal rate and for 1880 to 1950, a per capita consumption of 5 kg per year. Sugar, copra, and palm oil consumption are estimated with data on production, imports, and exports, disregarding losses and non-food consumption. Sugar consumption was assumed to be 10 kg per capita per year from 1880 to 1939. Copra consumption was assumed to be 10 kg per capita per year from 1880 to 1953.

The procedures used to estimate population and food supply during the turbulent 1940s have been elaborated in *Food Supply in Java,* 72–82. All data have been updated to 1995 with official Indonesian statistical sources. All calorie and protein conversion rates are from Departemen Kesehatan, *Daftar Komposisi Bahan Makanan* (Jakarta, 1967).