Subsistence Agriculture and Nutrition in Papua New Guinea: A research review

G.T. Harris

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<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>The Survey of Indigenous Agriculture 1961/62 (SIA)</td>
<td>3</td>
</tr>
<tr>
<td>Nutritional Intake Studies</td>
<td>6</td>
</tr>
<tr>
<td>Anthropometric Studies</td>
<td>13</td>
</tr>
<tr>
<td>The Causes of Malnutrition</td>
<td>15</td>
</tr>
<tr>
<td>Forces Weakening Subsistence Agriculture</td>
<td>18</td>
</tr>
<tr>
<td>(a) Population Pressure</td>
<td>18</td>
</tr>
<tr>
<td>(b) Export Cropping</td>
<td>22</td>
</tr>
<tr>
<td>(c) Absenteeism</td>
<td>24</td>
</tr>
<tr>
<td>Conclusions and Policy Considerations</td>
<td>25</td>
</tr>
<tr>
<td>Appendix 1</td>
<td>28</td>
</tr>
<tr>
<td>Appendix 2</td>
<td>29</td>
</tr>
<tr>
<td>References</td>
<td>31</td>
</tr>
</tbody>
</table>
ACKNOWLEDGEMENTS

This paper was first drafted in late 1980 but has been considerably strengthened as a result of discussions with Philip Harvey and Paul Wohlt, the insights gained whilst the author was a Visiting Research Fellow with IASER (attached to the Simbu Land Use Programme) in January and February 1981, and the comments of Michael Bourke, David Lea, and two anonymous referees. The fellowship was made possible by funds provided by the Office of Environment and Conservation.
Introduction

There are two major reasons why a government will want to act to improve nutrition. The first is the welfare and happiness of its citizens, with the related issue that some people, for reasons of age, sex, or location, may be particularly vulnerable to malnutrition. The second relates to the costs of malnutrition, which impinge on the individual, the family, the community, and the nation. In particular, malnutrition in early childhood is likely to reduce an individual's future productivity, which in turn may result in malnutrition amongst the young children for whom that person is responsible when he or she reaches adulthood. As Myrdal (1968:1603) has remarked:

The main cause of undernourishment and malnutrition in South Asia is, of course, poverty and, in particular, the low productivity of man and land in agriculture. The remedy is development, but the way will not be easy, partly because the dietary deficiencies themselves have reduced people's ability to work. On the other hand, as nutritional deficiencies tend to lower labour input and efficiency and to decrease vitality in general, they themselves constitute one of the obstacles standing in the way of development, particularly in agriculture.

There have been a number of studies on the links between nutrition and labour productivity (Maturu 1979) and these incidentally provide data from which benefit/cost evaluations of measures to counter malnutrition can be made (Selowsky and Taylor 1973). For example, if a given increase in calories per day results in a certain increase in output per day, then the benefits (increased output) may be compared with the costs of increasing calorie intake. A second major cost occurs because malnutrition increases susceptibility to disease, and therefore the need to call upon health services.

This paper concentrates on nutrition in the rural villages of Papua New Guinea, where some 80 per cent of the population live. It is important to note that a distinct "subsistence sector" cannot be easily identified. Rural villages are undergoing a transition as villagers increasingly supplement production for their own consumption with production for the market. Hence the National Accounts (Bureau of Statistics 1974) distinguish between "market" and "nonmarket" activities within rural villages. It is the nonmarket activity in rural villages that is the focus of this paper. This is defined in the National Accounts
as "the production of output by rural village households for (final) consumption in the rural villages and their production of fixed assets for use in producing for their own consumption".\(^1\) In addition almost all emphasis in the paper will be on villages outside daily commuting distance from a major urban area.

The relative importance of nonmarket activity in gross domestic product has declined since 1961, when national accounts estimates were first made. This decline is the result of the rapid development of the market sector, especially in the early 1970s, and more rapid price increases in that sector.\(^2\) The decline is illustrated in Table 1.

Despite this reduction in relative importance, it has been estimated that nonmarket activity in rural villages meets about 85 per cent of the food and shelter needs of about 85 per cent of the population (Harris 1978a). In terms of total food consumption, the nonmarket component provided almost two-thirds in 1972 and probably has fallen only marginally since then.

The major aim of this paper is to draw together and interpret the research that has been carried out on nonmarket activity in rural villages in Papua New Guinea.\(^3\) This will facilitate comparison of past with present, and provide a reference point from which future change can be monitored. Whilst this paper is concerned only with subsistence agriculture, it is acknowledged that hunting, fishing, and gathering of wild plants make substantial contributions to subsistence in many settings outside the densely settled highland valleys.

\(^1\) Bureau of Statistics (1974:15). This includes the value of traditional food produced for own consumption, the value of firewood collected, the value of the services of owner-occupied houses, the value of expansion of food gardens used for own consumption, and the value of equipment for use in production for own consumption (e.g., canoes).

\(^2\) For example, if constant (1972/73) prices are used, the share of the nonmarket component in GDP falls to 20.5 per cent by 1978, rather than 14.7 per cent if current prices are used.

\(^3\) For descriptions of subsistence agricultural practices based on research in particular localities, see Hipsley and Clements (1950), Brookfield and Brown (1963), Lea (1964), Rappaport (1968), Waddell (1968), Clarke (1971), Bourke (1976), Mitchell (1976), and Howlett et al. (1978). For more general treatments, see Brookfield and Hart (1971), Lea (1972), Harris (1978a), MacEwan (1978), and Bruyn et al. (1980).
Table 1
Nonmarket Component of Gross Domestic Product (GDP)
(kina: current purchasers' values)

<table>
<thead>
<tr>
<th>Year ended</th>
<th>Gross domestic product</th>
<th>Nonmarket component of GDP</th>
<th>Nonmarket as proportion of GDP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961</td>
<td>210.5</td>
<td>71.8</td>
<td>34.1</td>
</tr>
<tr>
<td>1967</td>
<td>375.7</td>
<td>105.8</td>
<td>28.2</td>
</tr>
<tr>
<td>1973</td>
<td>784.3</td>
<td>162.6</td>
<td>20.7</td>
</tr>
<tr>
<td>1977</td>
<td>1217.7</td>
<td>184.8</td>
<td>15.1</td>
</tr>
<tr>
<td>1978&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1334.0</td>
<td>196.2</td>
<td>14.7</td>
</tr>
<tr>
<td>1980&lt;sup&gt;2&lt;/sup&gt;</td>
<td>1393</td>
<td>195.5</td>
<td>14.0</td>
</tr>
<tr>
<td>1983&lt;sup&gt;2&lt;/sup&gt;</td>
<td>1502</td>
<td>203.2</td>
<td>13.5</td>
</tr>
</tbody>
</table>

<sup>1</sup> provisional, 1978 calendar year
<sup>2</sup> projected, 1980 and 1983 calendar years

Sources: Bureau of Statistics (1974; 1979), National Planning Office (1979)

The Survey of Indigenous Agriculture 1961/62 (SIA)

Benchmark data on subsistence agriculture are available for 1961/62 (Bureau of Statistics 1963). Results from this survey were subsequently used to estimate the contribution of subsistence agriculture to national income. The survey covered 84 per cent of the country's population.<sup>1</sup> Data were collected primarily on subsistence crops from 100 villages selected from a geographically stratified sample. Within each selected village, a representative sample of families was chosen and crop data collected from these families. Data were collected between December 1960 and June 1962. The "survey year" was centred approximately on the period April 1961 to March 1962.

<sup>1</sup> The excluded areas were those not fully under Administration control, areas affected by the disease kuru, and the Port Moresby urban area.
Table 2 summarizes the overall results of the survey, although the data are presented in a different form than in the original results. The main point to be drawn from the table is the very adequate production of calories (4,356 per person per day) and protein (51.3 g per person per day). These may be compared with the daily nutrient requirements recommended by the Food and Agriculture Organization and the World Health Organization presented in Appendix 1.

The survey results are, however, subject to substantial error. The measurement of food production was made by measuring the area under different crops and applying representative yield figures to these areas. This grossly over-represented the consumption capabilities of subsistence producers, because they plant more than is needed as insurance against crop failure and to provide food for pigs. As a result, the amount harvested is typically well below that produced. In addition some of the harvested crop is retained as seed for the following period or fed to pigs.

There are a number of problems with yield studies in a land-surplus, multicrop situation. The yield figures used in the survey were based upon yield trials carried out by the Department of Agriculture, Stock and Fisheries. Unfortunately, village gardens are not arranged in such a way as to facilitate accurate yield measurement. The yields of two adjacent gardens of similar size can vary for one or more reasons: the existence of intercropping; the amount and intensity of labour effort applied; the age of the garden; the species and varieties of the staple crop; the length of fallowing since its previous use; aspect and soil quality, slope, altitude. Therefore, it is desirable to regard yield figures as convenient rules of thumb rather than as accurate measures.

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1 In this paper, "calories" refers to kilogram calories and is abbreviated as "kcal"; one kcal = 4,186 joules.

2 For example, in the early 1960s the Tsembaga consumed only 55 per cent of the energy value of their crops and fed the balance to their pigs (Rappaport 1968; 1971).

3 These last three were subsequently used to distinguish areas giving different crop yields in the Intensive Agricultural Survey of 1962/63 (Territory of Papua New Guinea 1967a, 1967b, 1967c), but as can be seen, they are only three of a large number of possible influences. For a discussion of the difficulties encountered in measuring yields on Bougainville, see Mitchell (1976).
Table 2
Value of Food Crop Production, 1961/62

<table>
<thead>
<tr>
<th>Crop</th>
<th>Production ('000 tonnes)</th>
<th>Grams/person/day</th>
<th>Proportion normally consumed</th>
<th>Calories/person/day</th>
<th>Protein grams/person/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bananas</td>
<td>620</td>
<td>1014</td>
<td>0.70</td>
<td>824</td>
<td>7.1</td>
</tr>
<tr>
<td>Sugar cane</td>
<td>312</td>
<td>493</td>
<td>0.30</td>
<td>89</td>
<td>0</td>
</tr>
<tr>
<td>Taro Colocasia</td>
<td>317</td>
<td>521</td>
<td>0.75</td>
<td>442</td>
<td>7.8</td>
</tr>
<tr>
<td>Taro Xanthosoma</td>
<td>148</td>
<td>239</td>
<td>0.65</td>
<td>175</td>
<td>3.1</td>
</tr>
<tr>
<td>Yams</td>
<td>237</td>
<td>384</td>
<td>0.75</td>
<td>300</td>
<td>5.8</td>
</tr>
<tr>
<td>Tapioca</td>
<td>53</td>
<td>66</td>
<td>0.80</td>
<td>104</td>
<td>0.5</td>
</tr>
<tr>
<td>Pineapple</td>
<td>5</td>
<td>8</td>
<td>0.85</td>
<td>4</td>
<td>0.1</td>
</tr>
<tr>
<td>Maize</td>
<td>62</td>
<td>100</td>
<td>0.29</td>
<td>105</td>
<td>2.9</td>
</tr>
<tr>
<td>Sweet potato</td>
<td>1220</td>
<td>1970</td>
<td>0.75</td>
<td>1684</td>
<td>22.2</td>
</tr>
<tr>
<td>Rice</td>
<td>3</td>
<td>5</td>
<td>1.00</td>
<td>17</td>
<td>0.4</td>
</tr>
<tr>
<td>Peanuts</td>
<td>3</td>
<td>5</td>
<td>0.85</td>
<td>14</td>
<td>0.6</td>
</tr>
<tr>
<td>Sago</td>
<td>117</td>
<td>189</td>
<td>0.90</td>
<td>598</td>
<td>0.9</td>
</tr>
</tbody>
</table>

| Total                 | 4357                     |                  |                               |                    | 51.3                     |

1 Bureau of Statistics (1963:11)

2 Based on population figures presented by Bureau of Statistics (1963:13)

3 Based on Fergie (1975:table 1)

4 Food values taken from Platt (1962)

As an alternative, the Bureau of Statistics examined a number of microstudies of food intake with the aim of determining total food consumption by the indigenous population. From the estimated total consumption was subtracted an estimate of nontraditional (imported) foodstuffs consumed by Papua New Guineans, thus providing a figure for the
intake of the indigenous population for consumption of subsistence foodstuffs. The next section examines these microstudies as a means of determining nutritional status.

Nutritional intake studies

Assessment of nutritional status can be made in a number of ways. First, a clinical examination can be made of the characteristics of hair, eyes, lips, teeth, and skin. Second, biochemical tests can be carried out (for example, of serum albumin concentrations). Third, anthropometrical measurements may be made of height and weight at certain ages, skinfold thickness at the biceps, or arm circumference (Jelliffe 1966). Fourth, morphological changes may be studied (particularly hair structure). In contrast to all these techniques, which measure the outcome of nutrition in the individual, other techniques focus directly on food intake. This method has been most often used in Papua New Guinea.

Dietary intake studies ideally involve the precise weighing of all food consumed by each individual concerned, followed by a chemical analysis of replicate diets. For reasons of time and expense, these are not often carried out in entirety, and many nutritionists prefer anthropometric measurements.

A number of issues related to measurement in food intake studies should be discussed. First, the calorie and protein intakes assumed necessary to maintain good health that have been applied to Papua New Guinea appear to have been excessive, as well as varying between studies. Second, the use of averages can obscure substantial variation between individuals. For example, it is well documented that some groups (especially infants and lactating mothers) are particularly vulnerable to malnourishment, and this may be concentrated at particular times of

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1 The Bureau of Statistics was concerned to estimate the value of traditional food produced for own consumption by rural villages, in order to estimate the "production for own consumption" element in National Accounts purposes. Therefore, the calorific intake was broken up into various food components and valued. Other estimates were made of the value of maintenance and construction of village houses, consumption of heating and firewood, expansion of gardens, and canoe construction.
of the year (e.g., Whiteman 1965a; Venkatachalam 1962; Hipsley and Clements
1950; Harrison 1976). There is also evidence to indicate that within
small areas and within villages there may be a maldistribution of food
available for consumption (e.g., Hipsley and Clements 1950; Buchbinder
1973, 1977; Jeffries 1978). The same may be true of distribution within
households (Ferro-Luzzi et al. n.d.). Third, the nutritional values accorded
to the same foods vary between studies and may account for apparently large
differences in intakes between groups. Fourth, studies vary considerably
in technique, statistical reliability, and the time involved in their
execution. Given this formidable list of problems, it is easy to agree
with a recent critic of food intake studies that:

"... Surveying food consumption often seems deceptively easy... but the figures are only as good as the methods used to collect and interpret them.... By whichever means the figures are obtained they must be correlated with clinical, biochemical, and anthropometric data that assess nutritional status."
(MacArthur 1977:125-126)

With all these limitations in mind, we now turn to the results of
a number of studies on food intake, presented in Table 3. Table 3
indicates a wide variation in intakes, some of which is no doubt due
to variation in the quality of different studies. Those of Hipsley and
Kirk (1965), Whiteman (1965a), Morgan et al. (1974), and Ferro-Luzzi
et al. (1975) are probably the most reliable.

Another source of the variation in intakes reported in Table 3
may be seasonal differences. Studies in two localities (Jobakogi in
Simbu and Saragum in East Sepik) provide data that point to such seasonal
variation. The extent of the variation casts some doubt on studies of
the food intake data. Unless we have an idea of how far the data are
representative of food intake during the year, how can we judge its
adequacy? Another aspect of seasonal variation concerns the demand
for food at different times of the year. If labour effort is concentrated
at particular times, food intake requirements will be greater at those
times. Periodic food shortages (taim hangri) are common in Papua New
Guinea (Lambert 1976; Harrison 1976; Hide 1980), for reasons that suggest
problems of planning by villagers rather than environmental limitations.
### Food Intake Data from Village Nutrition Studies

<table>
<thead>
<tr>
<th>Village</th>
<th>Province</th>
<th>Energy intake (kcal per adult per day)</th>
<th>Protein intake (grams per adult per day)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowland</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kaporaka²</td>
<td>Central (coastal)</td>
<td>M 1640±98</td>
<td>31.1</td>
<td>Hipsley and Kirk (1965)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F, n 1300±70</td>
<td>21.7</td>
<td></td>
</tr>
<tr>
<td>Kavatara³</td>
<td>Milne Bay (coastal)</td>
<td>M 2042</td>
<td>32.7</td>
<td>Hipsley and Clements (1950)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F, a 1716</td>
<td>32.7</td>
<td></td>
</tr>
<tr>
<td>Busama³</td>
<td>Morobe (coastal)</td>
<td>M 1680</td>
<td>13.5</td>
<td>Hipsley and Clements (1950)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F, a 1411</td>
<td>13.5</td>
<td></td>
</tr>
<tr>
<td>Kaisapit³</td>
<td>Morobe (300 m)</td>
<td>M 2195</td>
<td>18.8</td>
<td>Hipsley and Clements (1950)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F, a 1844</td>
<td>18.8</td>
<td></td>
</tr>
<tr>
<td>Saragum⁴, ⁵, ⁶</td>
<td>East Sepik</td>
<td>M i 2971-2896</td>
<td>41.8-51.1</td>
<td>Whiteman (1965a)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M ii 2390-2902</td>
<td>39.5-41.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>F, n i 1217-1225</td>
<td>21.7-28.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ii 1258-1267</td>
<td>21.5-23.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>f, l i 2022-2035</td>
<td>35.9-40.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ii 115/-1302</td>
<td>22.1-24.1</td>
<td></td>
</tr>
<tr>
<td>Yareno</td>
<td>East Sepik</td>
<td>U 2234</td>
<td>15.3</td>
<td>Townsend (1969)</td>
</tr>
<tr>
<td>Tambanum</td>
<td>East Sepik</td>
<td>U 1395</td>
<td>19</td>
<td>Oumou and Malcolm (1958)</td>
</tr>
<tr>
<td>Lumi</td>
<td>West Sepik</td>
<td>M 1600</td>
<td>22.4</td>
<td>Wookey (1973)</td>
</tr>
<tr>
<td>Kaul⁹</td>
<td>Madang (coastal)</td>
<td>M 1940</td>
<td>36.9</td>
<td>Norgan et al. (1974)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F, l 1420</td>
<td>24.5</td>
<td>Ferro-Luzzi et al. (1975)</td>
</tr>
<tr>
<td>Highland</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patep No. 2³</td>
<td>Morobe (1200 m)</td>
<td>M 2250</td>
<td>18.4</td>
<td>Hipsley and Clements (1950)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F, l 2142</td>
<td>18.4</td>
<td></td>
</tr>
<tr>
<td>Tsembaga</td>
<td>Madang</td>
<td>U 2400</td>
<td>35</td>
<td>Rappaport (1968)</td>
</tr>
</tbody>
</table>
Table 3 (Cont'd)

<table>
<thead>
<tr>
<th>Location</th>
<th>Sex, Age</th>
<th>Year</th>
<th>Weight (g)</th>
<th>Weight (g)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuguma</td>
<td>M</td>
<td>1956</td>
<td>2311±493</td>
<td>34.6±13.0</td>
<td>Buchbinder (1977)</td>
</tr>
<tr>
<td></td>
<td>F, a</td>
<td></td>
<td>2259±595</td>
<td>41.2±17.3</td>
<td>Buchbinder (1977)</td>
</tr>
<tr>
<td>Gunts</td>
<td>M</td>
<td>1956</td>
<td>2860</td>
<td>66.7</td>
<td>Buchbinder (1977)</td>
</tr>
<tr>
<td></td>
<td>T, a</td>
<td></td>
<td>2650</td>
<td>52.0</td>
<td>Buchbinder (1977)</td>
</tr>
<tr>
<td>Bundikra</td>
<td>M (1000 m)</td>
<td>1956</td>
<td>1945</td>
<td>20.0</td>
<td>Wookey (1973)</td>
</tr>
<tr>
<td>Pari</td>
<td>M (Eastern Highlands)</td>
<td>1956</td>
<td>2360±185</td>
<td>19.9</td>
<td>Hipsley and Kirk (1965)</td>
</tr>
<tr>
<td></td>
<td>F, n</td>
<td></td>
<td>1605±107</td>
<td>16.9</td>
<td></td>
</tr>
<tr>
<td>Lufa</td>
<td>M (Eastern Highlands)</td>
<td>1956</td>
<td>2520</td>
<td>47.1</td>
<td>Norgan et al. (1974)</td>
</tr>
<tr>
<td></td>
<td>F, a</td>
<td></td>
<td>2105</td>
<td>43.2</td>
<td>Ferro-Luzzi et al. (1975)</td>
</tr>
<tr>
<td></td>
<td>U</td>
<td></td>
<td>1830</td>
<td>25</td>
<td>Hamilton (1956)</td>
</tr>
<tr>
<td></td>
<td>1956 (?)</td>
<td></td>
<td>3200</td>
<td>22</td>
<td>Venkatachalam (1962)</td>
</tr>
<tr>
<td></td>
<td>F, n</td>
<td></td>
<td>1940</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1956</td>
<td></td>
<td>2485</td>
<td>30.0</td>
<td>Lambert (1976)</td>
</tr>
<tr>
<td></td>
<td>F, a</td>
<td></td>
<td>1739</td>
<td>20.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1975</td>
<td></td>
<td>1448</td>
<td>19.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F, a</td>
<td></td>
<td>1058</td>
<td>14.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M</td>
<td></td>
<td>3261</td>
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<td></td>
<td>3150</td>
<td>34</td>
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</tr>
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<td></td>
<td>M</td>
<td></td>
<td>2813</td>
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<td></td>
<td>F, l</td>
<td></td>
<td>2150</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Gumine</td>
<td>Simbu</td>
<td></td>
<td>2200</td>
<td>30.0</td>
<td>Wookey (1973)</td>
</tr>
<tr>
<td>Modopa</td>
<td>Enga May</td>
<td></td>
<td>2364</td>
<td>29.5</td>
<td>Waddell (1972)</td>
</tr>
<tr>
<td></td>
<td>Dec.-Jan.</td>
<td></td>
<td>2415</td>
<td>34.7</td>
<td></td>
</tr>
<tr>
<td>Tukisenta/Murapin</td>
<td>Enga</td>
<td></td>
<td>2300</td>
<td>25</td>
<td>Sinnett (1974;1977)</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td></td>
<td>2300</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F</td>
<td></td>
<td>1770</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F, l</td>
<td></td>
<td>1997</td>
<td>23.6</td>
<td></td>
</tr>
</tbody>
</table>

1 F, u - nonpregnant, nonlactating adult female  
2 F, l - lactating adult female  
3 f, a - all adult females  
4 M - adult males  
5 U - unspecified; probably refers to mean community intakes
Table 3 (Cont'd)

2 Figures preceded by plus and minus signs are standard errors.

3 The 1947 Survey provides nutrition data on a per capita basis, not per adult. The figures in the table were derived by adjusting the "suggested dietary allowances" by the percentage of this allowance estimated to have been met by the households of each village. One important implied assumption in this procedure is that all members of the household secured the same percentage of suggested dietary allowances.

4 i refers to November-January inclusive

   ii refers to March-July inclusive

5 The first figure in each range is based on food consumption as used by the 1947 Survey; the second is those of Peters (1958).

6 Hipsley and Kirk (1965) also provide data on pregnant and lactating adult women but their intakes were not significantly different from nonpregnant, nonlactating women.

7 1956 calorie figures are based on recalculations (by Lambert) to ensure comparability between 1956 and 1975. Protein figures, on the other hand, are 1956 figures adjusted by reference to Lambert's (1976) comments as to percentage changes since 1956.

8 Cited by Bailey and Whiteman (1963: 383-4). They also cite Venkatachalam as measuring the intake of females (state of pregnancy or lactation not specified) at 1,900 calories and 21 g of protein, and adult males at 3,200 calories and 30 g; and Oomen and Malcolm at 2,150 calories and 28 g, for adult males and 1,500 calories and 20 g for pregnant or lactating females.

9 There were no differences between nonpregnant/nonlactating and pregnant/lactating females.

Whether such shortages are serious depends on the ability of the body to store nutrients. Children in critical periods of growth may be affected more seriously than adults. It is also possible that variation in food intakes may derive from the existence of genetically different human types with different nutrient requirements.

Apart from food consumption, there is the question of demand for food (i.e., the expenditure of energy) which varies between individuals. For example, there are differences in age, sex, and body weight within the same locality, and with temperature between localities. The precise measurement of energy used is more difficult than measuring food intake.
Two dietary studies in Papua New Guinea also measured energy expenditure. For one village in the Eastern Highlands and one in Central Province, Hipsley and Kirk (1965) reported that estimated mean daily expenditure significantly exceeded mean food intake, except for Eastern Highland men. Similar results were found on Karkar Island and at Lufa in the Eastern Highlands' as shown in Table 4.

Table 4

<table>
<thead>
<tr>
<th>Village</th>
<th>Energy expenditure (kcal/day)</th>
<th>Energy intake (kcal/day)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>Females</td>
<td>Males</td>
</tr>
<tr>
<td>Pari (EHP)</td>
<td>2221+65</td>
<td>1973+65</td>
<td>2360+185</td>
</tr>
<tr>
<td>Kaporaka (Central)</td>
<td>2130+156</td>
<td>1707+66</td>
<td>1640+98</td>
</tr>
<tr>
<td>Lufa (EHP)</td>
<td>2570</td>
<td>2245</td>
<td>2520</td>
</tr>
<tr>
<td>Kaul (Madang)</td>
<td>2350</td>
<td>1830</td>
<td>1940</td>
</tr>
</tbody>
</table>

It is possible that energy expenditure was overestimated for various activities, especially sleep, rest, and sitting, during which over half the energy expenditure occurred (Hipsley and Kirk 1965a: 108). Both studies indicated that the coastal men and women studied consumed about 20 per cent less energy than the highland men and women. The major explanation of this difference was the colder highland climate; a much greater expenditure of energy by highlanders in walking to and from their gardens was also noted.
An earlier review of the literature (Oomen 1971) concluded that the average energy intake in the highlands (based on 14 surveys) was 1,880 calories per adult per day; in the lower regions, 11 surveys indicated an average of 1470 calories. Protein intake in the highlands typically ranged between 20 and 30 grams per day, depending chiefly on the variety of sweet potato consumed. These estimates are broadly consistent with the data presented in Table 3.

A number of other studies have measured the labour time involved in various tasks. Some of these studies have been discussed by Gini (1978). The consistent finding of these studies is the modest labour input of adult males (about 20 hours per week), and to a lesser extent adult females, into subsistence food production. As noted above, Whiteman's (1965a) study of activities in the East Sepik caused her to classify village people as sedentary (with lower food intake requirements) rather than as agriculturalists. She commented (1965:68) that it would be difficult to say whether 'this slow pace of life for an agricultural community is the result of a low intake of calories and other nutrients or whether the people simply have nothing else to do'. Alternatively, the situation in a neighbouring village was assessed as follows:

It is...wrong to...conceive the low labour input per day as leisure 'preference'.... The very nature of subsistence agriculture means that the subsistence farmer can only spend a little time each day in food-producing activities because he must be his own doctor, house-builder, manufacturer, landlord, priest, and so on (Lea 1970: 125).

The dietary intakes reported in Table 3 are well below recommended standards (see Appendix 1). Must it be concluded that Papua New Guineans have a severe nutritional problem? In Lufa and on Karkar, two areas with dietary intakes below recommended levels, there is little evidence of protein-energy malnutrition as measured by clinical, anthropometric, or biochemical testing (Ferro-Luzzi et al. 1978). This suggests that no one measurement or index is sufficient to estimate nutritional status. Small body sizes may represent a successful adaptation to the nutritional and health environment (in particular modest food intake) which allows many other nutritional indicators to be essentially normal.
Anthropometric studies

Given the drawbacks of food intake studies, anthropometric studies have gained favour as a more direct measure of nutritional status, in particular the method of weighing children of a known age and assessing this weight in the light of the Harvard Scale. If a child is below 80 per cent of the recommended weight for his age, he is classified as malnourished; and if below 50 per cent, he is classified as severely malnourished. This method is much easier to carry out than food intake studies, and a number of studies have been done at the provincial level (Sinclair 1979). The method is not, however, without its critics, particularly if the children are weighed only once rather than followed during growth.

The use of weight-to-age ratios to determine nutritional status may be misleading. A study of Enga children (Harvey 1979) provides evidence that the majority of these children classified as malnourished were so classified because they were stunted (i.e., had a low length/height-to-age ratio), not because they were wasted (i.e., had a low weight-to-length/height ratio). Bailey (1974) explains this growth retardation as principally due to the late introduction of supplementary feeding of infants. A similar conclusion was reached for 1,180 children under 14 years from Kaul (Madang) and Lufa (Eastern Highlands). Stunting was present in about half of the children but wasting in only 1 to 3 per cent (Ferro-Luzzi et al. 1978). Thus weight-for-age and height-for-age deficits were common, but weight-to-height deficits were not. Heywood (1979) suggests that much of the weight-for-age deficit in Papua New Guinea results from a height-for-age deficit and notes that children in developing countries do not grow at the same rate as in developed countries, from which weight-for-age standards are derived.

Attention has been drawn to the need to separate two ways (both legitimate) in which these figures may be used (Heywood 1979): first, as a general index of health status (which summarises what has happened to the child up to the point at which nutritional status is assessed) and second, as an index of nutritional status per se with implications for the future. If emphasis is given to the first, it leads to a position where control of infectious disease is seen as the solution to malnutrition (e.g., Malcolm 1974). If, on the other hand
(as in this paper), childhood malnutrition is seen as an important indicator of the risk of future ill health, then programmes to improve nutritional status are of obvious importance. What then becomes important is that specific target groups are identified and that specific nutritional objectives are set for those groups (Heywood 1979).

A national anthropometric survey was carried out between December 1977 and March 1978 on 115,000 children under five years of age attending Community Health Clinics to determine the proportion who were malnourished (i.e., below 80 per cent of the standard weight for age). The results (Lambert 1978) were compared with a similar survey on 66,000 children carried out in 1975 in order to evaluate existing nutrition programmes and identify problem areas.

A significant reduction, from 43 per cent to 38 per cent, was noted in the mean percentage of children who were identified as malnourished. The positions of five provinces (three in Papua) worsened and of twelve improved. However, well over one-third of the sample were found to be malnourished, and this was particularly marked in the inland parts of the coastal provinces of the mainland.

These two surveys have some severe methodological limitations. First, only the nutritional status of children attending clinics was recorded. Second, there were large variations in sample numbers between districts, and within districts between the two surveys. A related point is that the 1975 figures for some districts are not comparable with the 1978 figures because they are derived from different areas within the same district. One indication of the possible inaccuracy involved in comparing the two surveys concerns the Southern Highlands, which showed a significant increase in malnutrition between 1975 and 1978. A study of weight for age by Clarke and Coghill (1980) between 1974/75 and 1978 found no significant change in the proportion of children below 80 per cent weight for age, although it did find an apparent increase in more severe malnourishment, that is, below 60 per cent weight for age. Third, there is likely to have been variation in the weighing and recording procedures carried out by the many clinic staff involved.

In an attempt to improve the methodology of nutrition surveys, trial surveys were carried out in Milne Bay in 1979 and 1980 (Nutrition
Monitoring Group 1980). Two interesting results emerged: first, there were substantial differences in the extent of malnutrition reported by the weight-for-age method using returns for clinics, and a similar weight-for-age and anthropometric survey carried out by a research team which carried out its own measurements. Second, different environmental zones had very different nutritional levels: areas between 600 and 1,200 metres, which were more isolated and had lower income earning opportunities, had significantly more malnutrition than areas below 600 metres.

The causes of malnutrition

Thus far, we have examined evidence as to the extent of malnutrition in Papua New Guinea. Despite the methodological problems associated with measuring the extent of malnutrition with any great precision, the anthropometric studies leave little doubt that there is a severe nutritional problem in Papua New Guinea.

Given the costs of poor nutrition to individuals, communities, and society, it is important to know the causal factors involved in malnutrition so that appropriate research and extension activities may be undertaken. At the same time it is vital to note that there is no one cause of malnutrition applicable to all areas of Papua New Guinea.¹ What is of prime importance in one area may be incidental in another. As Oomen and Malcolm (1958:3) put it, 'the kaleidoscopic qualities of Papuan society do not yet permit the making of general statements on diet and nutrition'. Villages in close proximity, and adjacent households in the same village, may have quite different nutritional patterns. Wookey (1973a:96) comments in similar vein: 'the results (of nutrition surveys) have shown as wide a variety of problems and food patterns as there are surveys'.

Despite this variation, the determination of causes is important because only then may appropriate strategies be introduced. What the

¹ A study of malnutrition cases reported by health centres and hospitals in 1971 (Wookey 1973a) gave eleven different factors reported as the major cause. The results of this study (see Appendix 2) were not statistically reliable but the two most important factors were lack of knowledge and restriction on foods given to young children.
variation means is that separate studies need to be made of each area where a nutrition problem is recognised to determine the cause or set of causes relevant to that area. It also means that attempts to discern the cause of malnutrition at the provincial level (e.g., by relating malnutrition to cash crop income per head, population densities, and the like) are not likely to be helpful.

The fundamental cause of malnutrition, as reported by a number of researchers (e.g., Hipsley and Clements 1950; Venkatachalam 1962; Bailey 1965; Hipsley and Kirk 1965; Korte 1976) is inadequate intake of protein and calories, especially by infants and pregnant/lactating females. Inadequate protein intake is more common in the highlands, whereas low calorie intake is more prevalent in the lowlands. A number of reasons have been suggested in explanation of this inadequate consumption. These reasons can be classified into those resulting from inadequate production, and other reasons.

Inadequate production may occur for a number of reasons:

1. Involvement in export cropping may divert land and labour away from food production. The earnings from the sale of export crops may not be used to sufficiently compensate for reduced food production (e.g., Grossman 1980).

2. Absenteeism, particularly of young adult males, may mean that those remaining are not able to perform some necessary tasks, and food production per capita of remaining population may fall in consequence (e.g., Bourke and Allen 1979).

3. High population pressure may mean that food crop yields fall because gardens are not given sufficient fallows between uses (e.g., Allen et al. 1978; Bourke and D'Souza 1980; Wood 1980a, 1980b).

4. Food supplies may be short at particular times of the year, either because of weather or because other demands on labour time have meant inadequate plantings, or because of poor planning (Bourke and Allen 1976). Allen et al. (1978) suggest that women on the Nembi Plateau are 'stretched to their physical limits' to maintain food production while men lead a more leisurely existence.
5. Finally, where wage employment is possible for males, their contribution to subsistence may decline with implications for total output. Harrison (1976:52) remarks:

The tasks that were traditionally shared...have almost entirely fallen on the shoulders of the women. Subsistence is the province of women, obtaining cash that of men, and school or play that of children. As a consequence...some subsistence activities have been curtailed.

The second group of causes operate even when production is adequate to meet villagers' needs, and are concerned with lack of knowledge of relevant nutritional facts, and the nutritional composition of traditional staples.

Villagers are generally not aware of nutritional facts such as the value of beans and nuts as sources of protein (e.g., Bailey 1965; Wookey 1973b; Lambert 1976; Bourke and Allen 1979; Shaw 1979) and the value of early introduction of solids into an infants diet (Malcolm 1969; Bailey 1974). Alternatively, they may know but be unwilling to make the necessary adjustments to their practices. Standard practice in the highlands is to commence feeding infants solid food only after their first teeth appear, normally about six months (Hipsley and Kirk 1965:136-42; Oomen and Malcolm 1958:61-76; Bailey 1965). When solid food is introduced, it is largely bulky sweet potato, which may cause young children in particular to stop eating before they receive sufficient protein (Bims 1976). In addition many, if not most, communities have taboos that restrict the provision of solid food to young children (Wookey 1973a:119; Whiteman 1962, 1965). As a consequence, intake of protein and fat by infants is often inadequate, at least until the child is sufficiently mobile to gather supplements for himself (Hipsley 1964). Even when children are able to participate in household meals, there is often no means to ensure that they get an adequate amount of food (Hipsley and Kirk 1965). This relates to the point noted earlier concerning the existence of malnutrition in households where aggregate food supplies are satisfactory.

A related issue is the frequency of feeding. Some researchers have argued that infants should have access to food frequently throughout the day and not be subject to long fasting periods (Hipsley 1964, 1973; Wookey 1973b). This will, however, be influenced by the work patterns of those caring for infants.
There are other factors that can be identified. Some result from short-term disruptions to food production, such as that due to war or the threat of war. Others are related to the family cycle: when there are large numbers of children and/or aged persons dependent upon a few producers, malnourishment is likely to be more prevalent. The potentially most important factor, which is receiving close study by the Simbu Land Use Programme team among others, is that of increasing population pressure on a fixed amount of land.

There is evidence to support all of these reasons, at different times and places, as causes of malnutrition. The more important determinants of inadequate production are discussed later in this paper, but to generalize, it appears that inadequate production is less important than lack of knowledge on nutritional matters, combined with the nature of traditional staples. The generally plentiful supply of land and equable climate means, as the Survey of Indigenous Agriculture indicated in the early 1960s, that food production is normally more than adequate for the needs of villagers. The effect of increasing population pressure on land is discussed later in this paper.

Forces weakening subsistence agriculture

I have examined this subject elsewhere (Harris 1978a) but it is considered briefly here because of the importance of identifying those factors that weaken the ability of subsistence agriculture to provide adequate nutrition for its people. The most important of these are increasing population pressure, export crop production, and absenteeism.

(a) Population pressure

Heavy population pressure may result in more frequent usage, and less falling, of garden land than is consistent with maintenance of fertility. Therefore yields may decline, as appears to be the case, for example, on the Nenbi Plateau of the Southern Highlands (Allen et al. 1978). Whilst overall population density in Papua New Guinea is low, there is substantial difference between and within communities, as is shown by Brown and Podolefsky (1976) highland data in Table 5.
<table>
<thead>
<tr>
<th>Group</th>
<th>Densities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dugum Deani</td>
<td>414</td>
</tr>
<tr>
<td>Chimbu</td>
<td>260</td>
</tr>
<tr>
<td>Mae Enga</td>
<td>120</td>
</tr>
<tr>
<td>Kapauka</td>
<td>104</td>
</tr>
<tr>
<td>Siane</td>
<td>80</td>
</tr>
<tr>
<td>Mt. Hagen</td>
<td>68</td>
</tr>
<tr>
<td>Maring</td>
<td>64</td>
</tr>
<tr>
<td>Gadsup</td>
<td>58</td>
</tr>
<tr>
<td>South Fore</td>
<td>33</td>
</tr>
<tr>
<td>Huli</td>
<td>20</td>
</tr>
</tbody>
</table>

Source: Brown and Podolefsky (1976); density figures based on field research.

In considering population densities, it is important to consider usable land, which may be substantially less than the total land area available to a group. Further sophistication can be introduced by considering the quality of the usable land, which will indicate its carrying capacity. Estimates of carrying capacity have been made from some areas and these provide useful bases from which to consider the impact of population growth. This paper examines two such studies, the Intensive Agricultural Surveys 1962–64 (hereafter IAS) (Territory of Papua and New Guinea 1967a; 1967b; 1967c) and the study in Naregu (Central Chimbu) by Brookfield and Brown (1963)—and some follow-up work (Harris :978b).
The IAS of 1962-64 were conducted in three high population density areas—Wabag, Chimbu, and Mapirik—in order to assess how serious actual or potential land shortages had become. The result of this work was a calculation of the number of people able to be supported by each community with allowances for pigs, cash crops, house sites, and so on. Population projections were made to determine when population would exceed carrying capacity of the land. The results were generally favourable for Wabag, the "worst" community was projected to reach its maximum population (assuming one pig per person) in the year 2037, although in Chimbu the two worst communities were to reach their maxima in 1978 and 1998 respectively. These predictions assume that carrying capacity, as measured, is a meaningful concept and that changes in land use do not take place.

A restudy of population in each village in the Wabag and Chimbu study areas was carried out using 1973 population data (Harris 1978b). This indicated that population growth had been much less rapid than had been projected (principally because of emigration) and that the move towards maximum carrying capacity was therefore slower.

Aggregate figures may hide important features at the local level. Hence we turn now to examine population growth in one community in Central Chimbu, Naregu, which was first studied in 1960 by Brookfield and Brown (1963). An 'index of occupation intensity' was calculated for each of the twelve groups (comprising four clans) within the Naregu tribe. Values for this index ranged from 0.22 to 0.97, with a mean of 0.64. That is, there was a substantial range of densities within a relatively small area of moderate population density.

Using more recent census data, we can recalculate Brookfield and Brown's intensity of occupation index for the twelve subclans of Naregu, and these are presented in Table 6.

The table shows that in June 1973, four of the groups had reached or surpassed the maximum population as calculated by Brookfield and Brown; by 1979, six groups had exceeded these levels. The fertility of the lands of these groups, and their agricultural systems, may be 'under pressure'. The main reason for the increase in the indexes appears to be return of large numbers of absentees. Absenteeism fell from
Table 6

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Kamaniambugo</td>
<td>0.97</td>
<td>1</td>
<td>1.07</td>
<td>3</td>
<td>1.21</td>
<td>3</td>
</tr>
<tr>
<td>Bindegu</td>
<td>0.91</td>
<td>2</td>
<td>1.14</td>
<td>1</td>
<td>1.35</td>
<td>2</td>
</tr>
<tr>
<td>Togl - Konda</td>
<td>0.82</td>
<td>3</td>
<td>1.00</td>
<td>4</td>
<td>1.11</td>
<td>4</td>
</tr>
<tr>
<td>Buruk-Maima, Damagu</td>
<td>0.80</td>
<td>4</td>
<td>0.89</td>
<td>5</td>
<td>1.04</td>
<td>6</td>
</tr>
<tr>
<td>Komu - Konda</td>
<td>0.79</td>
<td>5</td>
<td>1.11</td>
<td>2</td>
<td>1.46</td>
<td>1</td>
</tr>
<tr>
<td>Mondu - Ninga</td>
<td>0.77</td>
<td>6</td>
<td>0.87</td>
<td>6</td>
<td>1.08</td>
<td>5</td>
</tr>
<tr>
<td>Sunggwakani</td>
<td>0.66</td>
<td>7</td>
<td>0.66</td>
<td>8</td>
<td>0.76</td>
<td>8</td>
</tr>
<tr>
<td>Domkani</td>
<td>0.58</td>
<td>8</td>
<td>0.62</td>
<td>9</td>
<td>0.75</td>
<td>9</td>
</tr>
<tr>
<td>Bau - Aunduga</td>
<td>0.56</td>
<td>9</td>
<td>0.73</td>
<td>7</td>
<td>0.93</td>
<td>7</td>
</tr>
<tr>
<td>Kigun-Sumbai</td>
<td>0.49</td>
<td>10</td>
<td>0.61</td>
<td>10</td>
<td>0.61</td>
<td>11</td>
</tr>
<tr>
<td>Yonggomakani</td>
<td>0.40</td>
<td>11</td>
<td>0.45</td>
<td>11</td>
<td>0.63</td>
<td>10</td>
</tr>
<tr>
<td>Wugukani</td>
<td>0.22</td>
<td>12</td>
<td>0.26</td>
<td>12</td>
<td>0.26</td>
<td>12</td>
</tr>
<tr>
<td>Naregu total</td>
<td>0.64</td>
<td>12</td>
<td>0.75</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


29.9 per cent of total population in 1969 to 12.5 per cent in 1973, and to 9.1 per cent in 1979. This conclusion is consistent with the hypothesis that Chimbu people are tending to stay at home to protect land rights in a land shortage situation.
Studies of carrying capacity of land suffer from a number of important limitations. There is enormous variation between groups and between households in matters of food production and consumption which limits the value of the resulting average figures. There are also errors resulting from sampling and from the cumulative impact of numbers of assumptions that are common in most surveys.

More importantly for our purposes, whilst such a survey might produce reasonably accurate data relating to current land use intensities, it is not at all clear which of the number of possible responses might be made in response to increasing population pressure in the future. Some of these are agricultural, others are not. It is nonetheless probably true that population pressure is insufficient for almost all communities in Papua New Guinea to be the basic cause of any declining productivity in subsistence agriculture or of poor nutrition. As population pressure increases, there is considerable scope for intensification of agriculture. This initially occurs, as Brown and Podolefsky (1976) have shown, through shorter falls.

(b) Export cropping

Another general proposition of relevance to malnutrition is that export crop production, particularly during times of high prices, can result in an absolute fall in food production. First, land (particularly good quality land) may be permanently planted in export crops and, depending on population densities, may result in good gardens being used longer between falls, with consequent yield declines. Second, labour may be concentrated on export production to the extent that food production is neglected.

There is not a great deal of evidence, other than studies of a fairly conjectural nature, particularly Lambert (1979), linking export crop production and malnutrition, and that study has been sharply criticized by Hide (1980). It is, however, clear that where high population pressure and cash cropping are combined, strains are likely to occur. In Chimbu many villagers have planted coffee on good quality land which was formerly under food gardens (Paul Wohlt, pers. comm.). In some areas at least, this has resulted in lower yields as food crops have been planted on poorer quality land which may also be fallowed less often.
The links between increasing population pressure and cocoa production have been carefully studied at Biroi in the North Solomons Province (Mitchell 1976). In this study, it is emphasized that the growing of cocoa is a very inefficient use of land in terms of providing food for the household: 'There is no getting away from the cold fact that a plot of land which would support a model family with root crops for ten to twenty years...cannot even provide enough cash to buy imported foods for a single year' (Mitchell 1976:116). Even with plentiful land and heavy labour inputs, relying on cocoa to finance food purchases is a marginal proposition. Whilst land shortage was not, in the early 1970s, a problem at Biroi, it was for some neighbouring groups with similar population growth rates but much less land. Many Biroi households that have planted cocoa have had serious difficulty in getting enough land for food gardens. For married couples setting up households in the 1980s, Mitchell predicted that there would not be land on which to plant cocoa (1976:140). The relative inefficiency, in terms of land, of meeting nutritional needs by buying imported foods from the proceeds of export crop production has also been noted for other areas of Papua New Guinea (Shand and Straatmans 1970; Harris 1978a).

Another aspect of this problem is that money earned from export crop sales may not be spent on foodstuffs. There is evidence that high coffee prices of the late 1970s resulted in enormous increases in expenditure on prestige-enhancing goods, particularly beer and motor vehicles (Townsend 1977). However, there is also evidence, summarized in Harris (1980), of large increases in purchases of rice.

There is, indeed, little hard evidence to show that consumption of subsistence foods by village households fell during the coffee boom. However, there is some suggestion of a link between the coffee boom and increased malnutrition from the 1978 National Nutrition Survey. Taking the eight districts in the three major coffee producing provinces (Western Highlands, Eastern Highlands, Chimbu) for which there are data for both 1975 and 1978, five showed an increase in malnutrition and three a reduction. This compares with a reduction in eight of the nine districts in the two other highland provinces (Southern Highlands and Enga). The ninth district showed no change.

One study of an Eastern Highlands village during the coffee boom of the late 1970s (Grossman 1980) has identified severe competition between coffee and subsistence. He comments that:
[As] a result of the enthusiasm for cash-earning activities, subsistence affluence has been replaced by what I call subsistence malaise, a condition in which the previously strong commitment to subsistence production has declined because of a negative comparison to cash cropping.... [There has been] a resulting reduction in the productive level and resilience of the subsistence system (Grossman 1980:15).

This seems to be an extreme example, but indicates the likely direction of impact of high export crop prices on subsistence agriculture. It is not clear what will be the effect of a fall in export crop prices on the purchase of imported foods and on subsistence agriculture.

The second influence of export cropping on nutrition may occur on the labour side, by causing inadequate time to be devoted to food production. The evidence from a number of studies, reviewed by Gini (1978), is that the labour inputs (2 to 3 hours per adult male per week) into cash cropping is small relative to that put into subsistence (about 20 hours). One limitation of the data on which Gini worked was that it was usually confined to adult males whereas food production is much more the responsibility of females. If high export crop prices means that females switch labour towards export crop production, this could indicate a link between export cropping and malnutrition from the labour side. Another limitation is that the studies occurred at one point in time and do not indicate changes in time allocations that may result from, for example, a rise in export crop prices.

(c) Absenteeism

The fact that the absence of a large proportion of a village's population can have bad effects on those remaining has long been recognized. In Papua New Guinea as well as in other colonies, limits were set on the proportion of males who could seek wage employment on plantations.

In relation to malnutrition, the argument is straightforward. Males and females have different customary tasks with respect to food production. If many males are away, then their tasks (e.g., clearing and fencing new gardens) may not be carried out as often or at all. Thus gardens may be used for longer periods than usual and crop yields may fall as a result. Unless this is compensated for in some way, the quantity of food available to a community is likely to fall and malnourishment will increase.
This is a difficult issue on which to secure hard data. Some prima facie evidence may be gleaned from the Rural Survey of 1974/74 (Conroy and Skeldon 1977) which included a question as to whether, in the opinion of the residents, more work was required of them because of the absence of emigrants. If villages are classified as those from districts with a high proportion of population absent, and other villages, there was a significantly greater affirmative answer to the question from the higher absentee villages.

A related issue concerns the consumption of the absentee compared with his potential production: if consumption by the absentee before his migration exceeded his production, then consumption per capita for those remaining will increase as a result of his absence. This impact will vary according to the involvement of absentees, prior to departure, in productive activities, and this varies substantially between communities.

High absenteeism was found to be a cause of malnutrition in Okapa in 1979 (Bourke and Allen 1979). Population densities were moderate, gardening systems were operating satisfactorily, and a wide variety of crops were grown. The authors identified high absenteeism (35 per cent of adult males and 3 per cent of adult females were away) and 'social causes' (ignorance, lack of planning, and laziness were mentioned) as the main causes of malnutrition. A follow-up study, however, did not reveal that absenteeism was a particularly significant factor in causing malnutrition in the area. Education programmes and an increase in coffee plantings to provide incomes to reduce the necessity of emigration were recommended.1

Conclusion and policy considerations

Before turning to discuss some policy implications, I will draw together the major points covered in this paper. First, nutritional intake studies report wide variation in food intake at different times and at different localities in Papua New Guinea, but these intakes are generally well below current FAO/WHO standards. Anthropometric studies, which seem to be less subject to methodological objections than food intake studies, report high proportions of children to be malnourished. Second, there is no one single cause of malnutrition; causes vary between time and place. However, lack of knowledge (or an unwillingness to use

1 The authors also posed the interesting hypothesis that younger, better educated parents are less likely to have malnourished children.
available knowledge) seems to be a more important factor than inadequate food supplies. Third, increasing population pressure, export crop production, and absenteeism are important factors in limiting the ability of subsistence agriculture to support its population.

It has not been the aim of this paper to draw policy conclusions regarding subsistence agriculture. However, the data presented earlier in this paper indicate several policy directions.

First, the returns to education and extension work appear to be high. If, for example, it was possible to incorporate materials on basic nutrition into primary school curricula, there could be more important changes in the patterns of feeding babies and infants in years to come. There already exists a large body of research findings to support such extension.

In those areas where population pressure is having a negative effect on yields, there is similar potential for education and extension, albeit of quite a different kind. The research base is less developed here, but some impressive results have been reported. For example, a study of intensification of subsistence agriculture in the Southern Highlands (Bourke and D'Souza 1980) has found that sweet potato yields responded significantly to composting, that coffee pulp was an effective fertilizer on mixed gardens, and that legumes, such as peanuts, grown in rotation with sweet potato helped maintain sweet potato yields, as well as providing valuable protein. For a nearby area, Wood (1980a, 1980b) has recommended a number of measures to help conserve topsoil, the erosion of which has accelerated with the intensification of subsistence agriculture. These include: the planting of trees as fallow crops and composting. These are important recommendations for areas where subsistence agriculture is 'under pressure'.

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1 For a comprehensive set of recommendations, see MacEwan (1978).

2 Some important issues remain to be resolved, in particular whether the nutritional problem in the highlands is one of protein deficiency (Korte 1975) or of energy (Ferro-Luzzi et al. 1975).

3 Trees allow a more rapid improvement in soil organic matter and in the nutrient storage capacity of soil than does grass fallow cover.
Second, it is important to understand the motivation of those involved in decisions concerning subsistence agriculture and nutritional matters. Of relevance here are the remarks of Scoiullar (1974) on attempts to change the eating habits of rural Papua New Guineans. The chances of causing such a change are significant, says Scoiullar, only when children are unhealthy and then only when three conditions are met:

1. The ailment being treated is identified as malnutrition (not as a disease resulting from malnourishment) and parents realize that malnutrition is the cause of the child's misery.

2. Hospital feeding programmes produce nutritionally adequate meals from locally grown produce.

3. Mothers practice preparing more nutritious meals during the child's period in hospital.

Change is more likely to occur if the new foods are more palatable than those previously consumed, especially from the men's point of view, and if little additional labour and no cash outlay are required to secure this increased palatability.

Finally, it is important to keep in mind that what may be relevant in one part of the country at one point of time may not be relevant elsewhere. The target group and what is being attempted with that target group (Heywood 1979) are likely to be quite different over space and time.
### APPENDIX 1

**FAO/WHO Recommended Daily Nutrient Requirements**

*for Different Degrees of Activity*

<table>
<thead>
<tr>
<th>Type of Occupation</th>
<th>Energy (kcal)</th>
<th>Protein (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reference man</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lightly active</td>
<td>2,700</td>
<td>37</td>
</tr>
<tr>
<td>Moderately active</td>
<td>3,000</td>
<td>37</td>
</tr>
<tr>
<td>Very active</td>
<td>3,500</td>
<td>37</td>
</tr>
<tr>
<td>Exceptionally active</td>
<td>4,000</td>
<td>37</td>
</tr>
<tr>
<td><strong>Reference woman</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lightly active</td>
<td>2,000</td>
<td>29</td>
</tr>
<tr>
<td>Moderately active</td>
<td>2,200</td>
<td>29</td>
</tr>
<tr>
<td>Very active</td>
<td>2,600</td>
<td>29</td>
</tr>
<tr>
<td>Exceptionally active</td>
<td>3,000</td>
<td>29</td>
</tr>
</tbody>
</table>

1. A reference man is defined as aged 20–39 years and weighing 65 kg; a reference woman is aged 20–39 years and weighing 55 kg. The recommended requirements are not minima but recommended averages for a community.

**Source:** FAO/WHO (1973)
APPENDIX 2

Major Factors Resulting in Malnutrition, as Reported by Health Centres and Hospitals in 1971

Number of reports made concerning each factor

a. Insufficient or inadequate food available from gardens (not available to many squatter settlers). Cyclone deprivation.
b. Restriction on food given to children/late introduction of solid foods. Taboos.
c. Lack of knowledge in families and poor choice of foods.
d. Economic problems and poor budgeting.
e. Not enough variety of food in some areas.
f. Insufficient breast milk in mothers on poor diet/old age/too many children.
g. Worm infestations and malaria/TB -- precipitated by such infestations and by infections. Gastro-intestinal infections -- poor environmental sanitation.
APPENDIX 2 (cont.)

h Lack of protein intake.

i Pregnancy/large numbers of children in family.

j Traditional methods of subsistence farming inadequate. No time for elaborate food preparation/great distance of house from garden.

k Social and cultural factors: (i) husband drawing regular wages and not giving money to the family; (ii) mother refusing to breast-feed babies because of a superstitious belief she has been poisoned; (iii) maternal death and adoption; (iv) parents not controlling food intake of children; (v) child left in care of grandmother while mother works.

Note: Results not statistically reliable

Source: Wockey (1973a:118)
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