PART 5
Cash Income from Agriculture

Matthew Allen, R. Michael Bourke and Andrew McGregor

5.1 Rural villagers’ cash income ..........................................................284
5.2 Cash cropping in Papua New Guinea: an overview .................................292
5.3 Domestically marketed food ..........................................................300
5.4 Coffee ..................................................................................306
5.5 Cocoa ..................................................................................315
5.6 Copra and copra oil ..................................................................323
5.7 Oil palm ...............................................................................331
5.8 Forest products ........................................................................340
5.9 Marine resources .......................................................................349
5.10 Sugar .......................................................................................355
5.11 Rubber ..................................................................................360
5.12 Tea ......................................................................................367
5.13 Balsa ...................................................................................371
5.14 Vanilla ..................................................................................374
5.15 Spices and flavourings ...............................................................379
5.16 Pyrethrum ..............................................................................385
5.17 Other income from plants .........................................................389
5.18 Income from animals ..................................................................401
5.19 Purchased inputs for agricultural production ..................................408
5.20 Fluctuations in village cash crop production ..................................411
5.21 Marketing agricultural exports ..................................................420
5.1 Rural villagers’ cash income

Most rural Papua New Guineans earn cash from agriculture and closely associated activities such as selling firewood, fish or animals. This section presents estimates of the amounts of cash earned, how it is earned and the numbers of people who earn it. Rural villagers derive cash income from a number of sources, with sale of agricultural produce the most significant in both total income and the number of people who receive it. The amounts of cash earned are generally low, but there are exceptions. For example, some oil palm producers, people growing betel nut west of Port Moresby, and people in the Markham Valley who sell betel nut and fresh food to highland traders have relatively high incomes.

Agricultural activities

The best available data on cash income for rural villagers comes from surveys conducted as part of the Mapping Agricultural Systems of PNG Project (MASP; see Section 1.15).

During the MASP surveys the importance of various cash-earning agricultural activities was estimated using a four-point scale, from absent to very significant. After completion of fieldwork a cash value was assigned to each rating based on detailed studies of cash income in particular villages. The rating ‘absent’ was allocated a cash income of K0–10 per household per year, ‘minor’ was allocated K11–50, ‘significant’ was allocated K51–250 and ‘very significant’ more than K250 per household per year. Based on the allocated average cash income for each agricultural activity and the rural village population in each agricultural system, the total cash income for each agricultural activity was calculated at the level of agricultural system, province and nation.

The estimates from the MASP database at provincial and national level were then compared with data from industry sources for coffee and cocoa, two commodities for which reliable export income exists. The MASP estimates of income earned by the rural population from cocoa and coffee were close to industry data and increase the confidence in the accuracy of estimates for commodities sold in the informal sector, such as fresh food, betel nut and firewood.¹

Since 1990–1995 when the MASP fieldwork was conducted, changes have occurred in the value of the PNG currency relative to the United States dollar, with consequent impacts on prices and income in kina terms (Figures 4.1.1, 4.2.1). World prices for most export commodities have changed, as have some PNG production patterns. Within PNG significant changes have occurred in vanilla and copra production over the past decade, and are continuing in oil palm production. It is probable that a significant increase has occurred in the volume of

¹ The MASP estimates for rubber and oil palm were also similar to industry sources, but the MASP data overestimated incomes for copra. See Allen et al. (2001: Figure 5) for a comparison of estimated cash income for coffee and cocoa using MASP, Coffee Industry Corporation and Cocoa Board data.
fresh food sold within PNG since 1995. The MASP database does not include income from sale of sugar by outgrowers to Ramu Agri-Industries Ltd or that from sale of chickens to processing facilities near Lae.

Nevertheless, the broad patterns identified by the MASP surveys remain valid 10–15 years after the data were recorded. More recent information is available for the export cash crops and is presented in the sections that follow. However, the MASP database provides the only reliable estimates of the value of commodities sold in the informal economy.

The estimated cash income to rural villagers from sale of agricultural produce for the period 1990–1995 was about K200 million per year (about the same in US dollars at that time). Arabica coffee generated more income than any other commodity, providing 33% of all income from agricultural activities. This was followed by income from sales of fresh food (22%), cocoa (11%), betel nut and betel pepper (10%), copra (8%), oil palm (3%), firewood (3%) and fresh fish and shellfish (2%) (Figure 5.1.1, Table 5.1.1).

Sales of fresh food provided cash income to more households than any other activity. More than 90% of rural villagers lived in households where income was derived from the sale of fresh food (including Irish potato). This was followed by Arabica and Robusta coffee (53% of rural villagers), betel nut and betel pepper (35%), cocoa (27%), firewood (23%), tobacco (19%), copra (17%), fish and shellfish (13%) and cattle (13%) (Figure 5.1.2, Table 5.1.1).

Sales of oil palm or Arabica coffee gave the greatest returns per person (K47/person/year), followed by copra (K31), cocoa (K26), betel nut and betel pepper (K18) and fresh food (K15). Although kina returns

---

2 Cash income from sales of Irish potato was recorded separately from other fresh food in the MASP project (see tables), but has been included here with other fresh food.

3 The population data refers to the number of villagers living in MASP agricultural systems (see Section 1.15). So it is accurate to state that X% of rural villagers live in households in locations where income is derived from the sale of a certain commodity.
Rural villagers’ cash income generated more than K1 million per year income in rural areas, six are part of the informal economy. These are fresh food, betel nut, firewood, fish, tobacco and cattle. The other products (Arabica and Robusta coffee, cocoa, copra and oil palm) are exported and appear in official statistics.

Per household are now generally higher than they were in the mid 1990s, the overall patterns have not altered greatly since then.

The significance of the informal sector is commonly overlooked in economic analyses of the PNG economy. Of the 11 sources listed in Table 5.1.1 that

Table 5.1.1 Estimated annual cash income of the rural population from agricultural activities, 1990–1995[a]

<table>
<thead>
<tr>
<th>Product</th>
<th>Income (kina/year)[b]</th>
<th>Proportion of total income (%)</th>
<th>Rural population[k]</th>
<th>Proportion of total rural population (%)</th>
<th>Average cash income (kina/person/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arabica coffee</td>
<td>66,937,782</td>
<td>32.9</td>
<td>1,416,000</td>
<td>44.5</td>
<td>47</td>
</tr>
<tr>
<td>Fresh food</td>
<td>44,136,734</td>
<td>21.7</td>
<td>2,991,000</td>
<td>94.0</td>
<td>15</td>
</tr>
<tr>
<td>Cocoa</td>
<td>22,237,432</td>
<td>10.9</td>
<td>850,000</td>
<td>26.7</td>
<td>26</td>
</tr>
<tr>
<td>Betel nut and betel pepper</td>
<td>20,216,030</td>
<td>9.9</td>
<td>1,121,000</td>
<td>35.2</td>
<td>18</td>
</tr>
<tr>
<td>Copra</td>
<td>16,460,230</td>
<td>8.1</td>
<td>527,000</td>
<td>16.6</td>
<td>31</td>
</tr>
<tr>
<td>Oil palm</td>
<td>6,147,153</td>
<td>3.0</td>
<td>130,000</td>
<td>4.1</td>
<td>47</td>
</tr>
<tr>
<td>Firewood</td>
<td>5,029,200</td>
<td>2.5</td>
<td>741,000</td>
<td>23.3</td>
<td>7</td>
</tr>
<tr>
<td>Fish and shellfish</td>
<td>3,812,507</td>
<td>1.9</td>
<td>412,000</td>
<td>13.0</td>
<td>9</td>
</tr>
<tr>
<td>Irish potato</td>
<td>3,593,202</td>
<td>1.8</td>
<td>536,000</td>
<td>16.8</td>
<td>7</td>
</tr>
<tr>
<td>Tobacco</td>
<td>3,547,451</td>
<td>1.7</td>
<td>591,000</td>
<td>18.6</td>
<td>6</td>
</tr>
<tr>
<td>All other products</td>
<td>2,814,518</td>
<td>1.4</td>
<td>409,000</td>
<td>12.9</td>
<td>7</td>
</tr>
<tr>
<td>Cattle</td>
<td>2,417,596</td>
<td>1.2</td>
<td>403,000</td>
<td>12.7</td>
<td>6</td>
</tr>
<tr>
<td>Robusta coffee</td>
<td>2,318,227</td>
<td>1.1</td>
<td>270,000</td>
<td>8.5</td>
<td>9</td>
</tr>
<tr>
<td>Pels and plumes</td>
<td>959,931</td>
<td>0.5</td>
<td>160,000</td>
<td>5.0</td>
<td>6</td>
</tr>
<tr>
<td>Crocodiles</td>
<td>950,192</td>
<td>0.5</td>
<td>131,000</td>
<td>4.1</td>
<td>7</td>
</tr>
<tr>
<td>Pyrethrum</td>
<td>748,667</td>
<td>0.4</td>
<td>125,000</td>
<td>3.9</td>
<td>6</td>
</tr>
<tr>
<td>Rubber</td>
<td>619,633</td>
<td>0.3</td>
<td>64,000</td>
<td>2.0</td>
<td>10</td>
</tr>
<tr>
<td>Chilli</td>
<td>173,207</td>
<td>0.1</td>
<td>29,000</td>
<td>0.9</td>
<td>6</td>
</tr>
<tr>
<td>Cardamom</td>
<td>148,367</td>
<td>0.1</td>
<td>25,000</td>
<td>0.8</td>
<td>6</td>
</tr>
<tr>
<td>Rice</td>
<td>39,705</td>
<td>0.0</td>
<td>7,000</td>
<td>0.2</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>203,307,762</td>
<td>100.0</td>
<td>14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[a] This table is derived from data generated by MASP (Bourke et al. 1998; Allen et al. 2001). These estimates differ somewhat from those in Allen et al. (2001: Table 9) due to the use of a different population growth rate to derive the 1990 populations. There are also different assumptions regarding mean income for each class in the MASP database.

[b] These estimates are for income received by villagers. Total revenue from the sale of export crops was greater than this, but some of the total revenue goes to buyers and processors and pays for transport, insurance, levies and other expenses. Hence the income that villagers receive is less than the total export revenue.

[c] This is the population of rural villagers who live in agricultural systems where income is derived from each activity. Villagers may have more than one major source of cash income from agriculture. Hence the population total is greater than the actual rural population. Similarly, the total proportion of the population is greater than 100%.
In reality, most villagers earn cash income from a number of different agricultural activities. People have the highest cash income where they sell a number of commodities into the export and domestic markets, and where the volumes sold are larger. Cash incomes are lowest where people sell only small quantities of one or two commodities.

**Distribution of agricultural income**

It is not surprising in such a physically diverse nation as PNG where agricultural activities differ widely between locations that the amounts of income generated also vary. The national spatial pattern of income distribution for the most important sources of cash income are given in maps in the sections that follow.4

---

4 The distribution of cash income from agricultural activities within provinces is presented as maps in Hanson et al. (2001).

Arabica coffee production is confined to the central highlands and some mountainous locations in Morobe and Madang provinces (Figures 5.1.3, 5.4.2, Table A5.1.1). High levels of fresh food sales are more widely distributed, being significant in many locations in the highlands and lowlands (Figure 5.3.1). Cocoa production is concentrated in East New Britain, Bougainville, East Sepik, Madang and New Ireland provinces (Figure 5.5.4).

Two large markets exist for betel nut – the entire highlands region, and urban areas, particularly Port Moresby and Lae. This determines the pattern of income from betel nut, with sales higher in locations in Central and Gulf provinces west of Port Moresby; in Morobe, Madang and East Sepik provinces; and in areas readily accessible to urban centres in the Islands Region (Figure 5.17.1). Copra production is greatest in East New Britain, Madang, New Ireland, Bougainville and West New Britain provinces (Figure 5.6.3). Oil palm is concentrated in West New Britain and Oro provinces. Estates in Milne Bay and New Ireland provinces involve a small number of smallholders (Figure 5.7.1).
More than a third of the rural population lived in locations where the average cash income from agricultural activities was less than K20/person/year in 1990–1995 (Table 5.1.2). Of these people, 29% live in Southern Highlands Province, 12% in Morobe Province and 10% in Sandaun Province (Figure 5.1.4). People in Sandaun and Southern Highlands provinces had the lowest cash income from agricultural activities, with 92% and 86% respectively of the rural population earning less than K20/person/year. Other provinces with a substantial proportion of the rural population earning low cash incomes were Morobe (53%), Western (48%), West New Britain (45%) and Madang (40%) (Table A5.1.2).

At the other end of the scale, 18% of the rural population lived in locations where average cash income from agricultural activities was greater than K150/person/year in 1990–1995 (Table 5.1.2). Provinces with a higher proportion of the rural population earning relatively large incomes from agriculture were Western Highlands (31% of those earning more than K150 per year), Eastern Highlands (26%) and East New Britain (15%).

Even in a province such as East New Britain, where most rural people earned relatively high incomes from agriculture, a fifth of the population, most of whom lived in Pomio District, earned less than K20/person/year. This illustrates how low-income populations can occur in pockets within a province and that a province is a crude unit with which to examine rural income distribution. The places where rural cash incomes are low are characterised by poor agricultural environments, with excessive rainfall, steep slopes, areas of inundation and soils of low fertility. Road access is also poor or non-existent and access to markets and services is poor. A number of health and education indicators also tend to be greatly below the national average in these locations.5

5 These issues are discussed in detail at provincial and district levels by Hanson et al. (2001). See also Section 6.10 in this volume on rural poverty, particularly Figure 6.10.4.
Non-agricultural income sources

Sources of rural cash income other than agriculture include:

- Small retail businesses, particularly small retail stores (‘trade stores’) that sell basic items, especially imported food.
- Transport businesses, including vehicles licensed to carry paying passengers.
- Sales of manufactured foods, including bread and other foods made from flour.
- Trading, as middlemen, of betel nut, betel pepper and lime.
- Paid labour for other villagers, plantations, logging operations and local businesses.
- Remittances of money from relatives working in urban locations or elsewhere in PNG.
- Royalties, compensation and other payments from mines and oil fields.
- Other small businesses, including carpentry, coffin construction and vehicle repairs.

The major mines and oil fields can be sources of large sums of money for nearby villagers. However, payments go to a relatively small number of people. Large mines are located at Ok Tedi in Western Province, at Porgera in Enga Province and on Lihir Island in New Ireland Province. There are smaller gold mines at Tolukuma in Central Province, near Kainantu in Eastern Highlands Province, on Simberi Island in New Ireland Province and at Sinivit in the Baining Mountains of East New Britain Province. A number of new mines are planned, including a large nickel mine in Madang Province. Oil and gas fields are located in the Lake Kutubu area of Southern Highlands Province. Payments are made to villagers who own land in the fields and along a Kutubu–Kikori pipeline. Amounts received vary greatly between groups of villagers, often over relatively short distances. Some individuals, mostly men, receive payments of up to K30 000 per year, but only a few hundred people receive such levels, and most villagers receive much less.

An estimated 60 000 to possibly 100 000 people mine alluvial gold. Alluvial gold mining takes place in all provinces, but the main centres of small-scale mining are the Wau and Bulolo areas of Morobe Province, the Maprik area in East Sepik Province, the
5.1 Rural villagers’ cash income

are in well-paid employment elsewhere in PNG. Remittances are also relatively high to villagers on the Trobriand Islands in Milne Bay Province. The coastal part of Central Province is a third region where remittances from urban-based workers to their rural relatives are relatively high. Transfers commonly occur as gifts when urban people visit their home village for holidays, particularly at Christmas time. They also occur as the payment of school or other education fees for the children of rural-based relatives and purchases of expensive items such as outboard motors for boats.

Royalty payments from logging can be significant. However, discussions with villagers indicate that amounts received are often much less than what is written into logging agreements. Payments to a community tend to be short-term as the logging operations move elsewhere after one or two years. In contrast, payments from mining operations continue over many years and the agreements are better adhered to. Income from casual labour can be moderately high for some rural people in the highlands during the coffee harvest season, particularly when prices are high.

Little numerical data exist on remittances of money from urban areas or enclave developments (mines, oil fields and logging camps). Remittances are particularly large to people in Manus Province, as many well-educated people from that province are in well-paid employment elsewhere in PNG.

Mount Kare and Porgera areas in Enga Province and the Kainantu area of Eastern Highlands Province. In 2002 production was four tonnes of gold valued at K100 million.

This occurs because of the unique social system in the Trobriand Islands, associated with food exchange systems.
Sources


5.2 Cash cropping in Papua New Guinea: an overview

In PNG the production and sale of cash crops is an important source of income at both the national and household level. At the national level, products from the renewable resource sectors of agriculture, forestry and fisheries contribute around a quarter of the total value of exports. However, this figure hides the importance of agricultural products as a source of income for rural villagers, who comprise 81% of PNG’s population. The sale of agricultural commodities is the most significant source of income for rural people in PNG, in terms of both total income and the number of people who receive it (see Section 5.1).

This section examines the role of cash crops in the export and domestic sectors of the economy, historical trends in cash crop production levels, and future prospects for cash crop production in PNG.

The export sector

PNG’s export economy is presently dominated by minerals (gold and copper) and oil (Figure 5.2.1). These three commodities account for 77% of the total value of exports. However, the contribution of agricultural exports is significant at around 17%, with the remainder from forestry (5%) and marine resources (1%).

In order of importance by value, PNG’s agricultural exports are palm oil, coffee, cocoa, copra and copra oil, vanilla, tea and rubber (Figure 5.2.2). These commodities, and other minor agricultural exports, are discussed in the following sections.

The domestic sector

The domestic cash crop economy consists of food (and other commodities such as betel nut) that is sold through PNG’s thriving fresh produce markets, sugar produced by Ramu Agri-Industries Ltd (most of which is sold within PNG), and minor quantities of tea and other products. Domestically marketed food was the second most important source of cash for rural villagers after Arabica coffee in the mid 1990s (see Section 5.3). A number of animal products are also sold, including chickens, pigs, fish and cattle (see Section 5.18).

1 Palm oil is the main economic product derived from the fruit of the oil palm. The other products are palm kernel oil, refined palm oil and palm kernel expellent (see Section 5.7).
5.2 Cash cropping in Papua New Guinea: an overview

Significant changes have occurred in the relative importance of different export cash crops since the late 1800s, when the commercial production of copra commenced in the Gazelle Peninsula of East New Britain Province. There was also a decline in the relative contribution of agricultural commodities to the export economy in the 1970s, following the development of a number of large mines. Other important changes have been the decline of the plantation sector and the expansion of the smallholder sector.

In the late 1800s and early 1900s copra was PNG’s most important export commodity, accounting for around 90% of all exports in 1921–22. Most copra was produced on plantations that were established throughout the Islands Region in the early 1900s. In 1950 copra still accounted for almost 70% of all exports, but by the mid 1970s its export share had declined to only 5%. This decline was primarily due to development of the coffee, cocoa and mineral industries between 1950 and 1980, and the collapse of the international copra market (Figures 5.2.3, 5.2.4).

A feature that is common to several cash crops is a change in production over time. The relationship between production levels and time tends to produce a characteristic S-shaped curve. The production of coffee in PNG over the past 60 years is a good example of this relationship (Figure 5.2.5). The S-shape of the curve is indicative of a process in which growth initially occurs at a slow rate and then at a rapid rate before slowing down and eventually plateauing. It would appear that each of PNG’s main cash crops is at a different stage in this process. Coffee and cocoa are both at an end stage, having experienced periods of rapid expansion (early 1960s to mid 1970s in the case of cocoa and early 1960s to early 1980s for coffee). Oil palm, on the other hand, is still in the rapid growth phase (Figure 5.7.4). It is likely that oil palm production will slow in coming years due to environmental limits on further expansion.

Another characteristic that is common to most export cash crops in PNG is the historical decline of plantation-based production and expansion in smallholder production. The plantation sector has been in decline for all export tree crops over the past 30 years, with the exception of oil palm and tea (Table 5.2.1). On the other hand, smallholder production of oil palm, cocoa, coffee and rubber has been expanding.

Figure 5.2.1 Value of major exports, 2004–2006 (annual mean). Source: Bank of PNG.

Figure 5.2.2 Contribution by value of the main cash crops to agricultural exports, 2004–2006 (annual mean). Source: Bank of PNG.
Figure 5.2.3 Contribution by value of the main cash crops to agricultural exports, by decade, 1951–2006.
Sources: Bank of PNG and various industry sources.
Figure 5.2.4 Export values of main cash crops, 1947–2006. Note: The values presented have not been adjusted for changes in the buying power of the kina. This makes the increase in values nearer the present seem greater than they really are. Sources: Bank of PNG and various industry sources.

The gross annual growth rate data presented in Table 5.2.2 hide this change. For example, in the case of cocoa, overall production grew at 1.3% per year over the period 1986 to 2005, but smallholder production actually increased by 2.7% per year over that period and plantation production declined by 4.1% per year (Table 5.2.1, Figure 5.5.2).

Some of the reasons for the decline in plantation cash crop production are specific to particular crops, such as the age of trees and palms in the cocoa and copra industries. Other factors have affected the plantation sector more broadly. These include the rising costs of inputs, particularly fuel and labour, partly as a consequence of the devaluation of the kina; the declining state of infrastructure, particularly roads and bridges; extreme fluctuations in world market prices; and uncertainties concerning land ownership, particularly around the time of Independence in 1975, when village groups made claims to land that had been previously alienated to the colonial state and was being leased to plantation owners.

The expansion in smallholder production for all of the main cash crops has also occurred for a variety of reasons. In some cases, such as the expansion of smallholder coffee production in the 1960s, government extension and promotion initiatives had a positive effect. However, in many other instances, villagers in PNG have readily adopted cash crops.

---

Table 5.2.1  Annual growth rates of volume of oil palm, cocoa, coffee and rubber from the smallholder and plantation sectors, 1986–2005

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Annual growth rate (%)&lt;sup&gt;[a]&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Smallholder</td>
</tr>
<tr>
<td>Oil palm (fresh fruit bunch)</td>
<td>4.3</td>
</tr>
<tr>
<td>Cocoa</td>
<td>2.7</td>
</tr>
<tr>
<td>Coffee</td>
<td>2.0</td>
</tr>
<tr>
<td>Rubber</td>
<td>3.2</td>
</tr>
</tbody>
</table>

<sup>[a]</sup> Calculations are based on the growth rate from 1986 to 2005. The 1986 figure is a mean for the three-year period 1985–1987; likewise, the 2005 figure is a mean for the period 2004–2006. For rubber, the period is 1986–2000 (1999–2001).

Sources: Calculated from data in relevant sections in this book.

---

Table 5.2.2  Production volume and annual growth rates of export tree crop commodities, 1975–2005

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Production (tonnes)&lt;sup&gt;[a]&lt;/sup&gt;</th>
<th>Annual growth rate (%)&lt;sup&gt;[a]&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palm oil</td>
<td>18,145</td>
<td>332,167</td>
</tr>
<tr>
<td>Copra oil</td>
<td>26,093</td>
<td>47,000</td>
</tr>
<tr>
<td>Coffee</td>
<td>35,141</td>
<td>61,992</td>
</tr>
<tr>
<td>Tea</td>
<td>4,772</td>
<td>7,181</td>
</tr>
<tr>
<td>Cocoa</td>
<td>31,557</td>
<td>45,857</td>
</tr>
<tr>
<td>Rubber</td>
<td>5,526</td>
<td>4,722</td>
</tr>
<tr>
<td>Copra</td>
<td>87,320</td>
<td>18,067</td>
</tr>
</tbody>
</table>

<sup>[a]</sup> The 1975 figure is a mean for the three-year period 1974–1976; likewise, the 2005 figure is a mean for the period 2004–2006.

Sources: Calculated from export data in relevant sections in this book.
without any advice or assistance from government. Moreover, contrary to the predictions of some academics and policy makers, the customary land tenure arrangements existing in PNG appear not to have inhibited this expansion.

**Future prospects**

A number of the long-term trends discussed above can be expected to continue into the foreseeable future. It seems likely that the plantation sector will continue to decline, while the smallholder sector will continue to expand. With the exception of oil palm, smallholders now dominate production of the export tree crops. Prospects for the continued growth of these exports are good, so long as smallholders continue to receive reasonable cash returns (see Section 5.20). However, past experience suggests that a number of factors will influence levels of production in the short term, including international market prices, currency fluctuations and the price of imported inputs, particularly fuel.

Future prospects for cash crops are discussed in the sections on individual crops that follow. Forecasts by the World Bank for future prices for selected commodities are given in Figure 5.2.6, although it is difficult to predict future prices with accuracy.

The domestic cash crop economy – particularly the marketing of fresh produce – has expanded over the past 30 years and is likely to continue to do so. This expansion is being driven in part by the devaluation of the kina, which has seen a significant increase in the price of imported food. Consumers in both urban and rural areas have responded by purchasing less imported food and more local produce.

A common perception of the agricultural economy in PNG is that it has not kept pace with population growth and that export cash crop production has actually been in decline since Independence. The data presented in Tables 5.2.1 and 5.2.2 show that these perspectives are wrong. The official annual population growth rate over the period 1980–2000 was 2.7%. The average annual growth of oil palm production of around 10% has significantly outstripped population growth. While the growth of all other export cash crops has not quite kept pace with population growth, growth rates in the smallholder sector of most cash crops have more or less kept pace with population growth.

Another common perception is that smallholder producers are not responsive to market opportunities and conditions. The rapid expansion of vanilla production since 1998 (see Section 5.14), the steady expansion of fresh food and betel nut production over the past 30 years, and the adoption and expansion of a range of export tree crops over the past 60 years all indicate that smallholders are responsive to market opportunities.

**Constraints**

New market opportunities are appearing and more will appear in the future, including such things as the sale of organically certified produce. Smallholders will respond to these market opportunities, but certain constraints need to be removed or reduced to allow them to do so. Constraints that inhibit expansion of export agricultural production in PNG include:

- Poorly maintained transport infrastructure, particularly roads and bridges.
- Inadequate access to credit and working capital for middlemen and traders.
- The poor export quality of some commodities, particularly vanilla and coffee.
- Insufficient knowledge by producers of market requirements.
- Inadequate security for traders and producers, who are vulnerable to robbery and assaults.
- Poor dissemination of information and planting material.
- Limited areas of land that do not have major climatic or physical limitations for high productivity, especially for large-scale production of cocoa and coffee.

---

2 A different group of factors constrain further expansion of domestically marketed food (see Section 5.3).
Continuing population growth is placing increasing pressure on land resources. Eventually population pressure and environmental limitations of steep topography, very high rainfall and inundation will constrain the expansion of land under agriculture. Future growth in the value of both food and cash crop production will have to come from greater productivity of land that is already used for cropping and from higher quality produce. These challenges are common to agriculture in most of the world. There are many reasons to expect that PNG producers will meet these challenges as they have met challenges in the past.

**Figure 5.2.6** World Bank real price forecasts for selected commodities. **Note:** Data for 2006 are actual prices and data for 2007–2015 are price forecasts. Real prices are the projected prices in today’s spending power, that is, ignoring inflation. Source: World Bank (2007).
5.2 Cash cropping in Papua New Guinea: an overview

Sources


5.3 Domestically marketed food

Fresh food grown and sold within PNG is known as ‘domestically marketed food’. Sales of fresh food have grown over the past 40 years from a small base, with particularly rapid expansion since 1998 following devaluation of the PNG currency. The term ‘fresh food sector’ in PNG often refers to introduced temperate-climate vegetables such as Irish potato, broccoli, carrot, tomato and capsicum. However, these vegetables form only a small part of domestically marketed foods that include staple food crops such as sweet potato, banana, sago, taro and yam.

**History of marketed fresh food**

Prior to colonisation, food was exchanged and bartered in parts of what is now PNG. Bartering was common where significant environmental differences occurred over short distances. For example, people along the Sepik River exchanged fish for sago with those who lived away from the river near sago swamps. This exchange continues on parts of the Sepik River today. Food was also given in competitive exchanges, the most significant being pigs or pig meat in the highlands and yams in parts of the Sepik basin and islands of Milne Bay Province.

Elsewhere, coastal villagers traded coconut, betel nut and marine foods with inland people, who provided taro, yam, banana, green vegetables and other garden produce. This occurred on the Gazelle Peninsula of East New Britain Province; among the Mekeo, Motuan and Koiari people of the Port Moresby area; and on the north coast of the Huon Peninsula, Morobe Province. People on very small islands had limited capacity to grow food because of environmental constraints and pressure on land caused by high population densities. They exchanged marine foods for fresh foods with people on nearby larger islands. A number of pre-colonial trade relationships persist (see Box 5.3), but some have disappeared with the building of roads and long distance travel.

The exchange of fresh food for manufactured goods began as soon as outsiders arrived in PNG. Missions bought food from surrounding areas to feed staff and school children. Marketplaces quickly appeared in new colonial towns. There was a marketplace in Rabaul before 1920, and marketplaces were established in the main highland centres in the 1950s. In the 1970s a number of food marketing schemes were instigated, commencing with the Fresh Food Project in 1973, but most failed after some years.

Intermediate traders or middlemen have been slow to appear in PNG fresh food markets, but numbers are increasing. Middlemen operate at local levels, buying in a main town market and selling within the same town, or moving produce longer distances to mines or to Port Moresby. The growth in the number of middlemen is a sign of a maturing economy and indicates increasing efficiency in the marketing chain.
Box 5.3 Some rural locations where a significant proportion of food comes from trade

- Mid Sepik River and Chambri Lakes, East Sepik Province. Fish is exchanged for sago. About two-thirds to three-quarters of sago consumed is imported from nearby areas.

- Near the mouth of the Sepik River, East Sepik Province. There is no agriculture in this area and sago is imported from surrounding areas in exchange for fish and woven bags.

- Boisa Island, north-west of Manam Island, Madang Province. *Galip* nut, an important seasonal food, is exchanged for sago and yam from the mainland. Sago is the main food during the drier part of the year (May to October) and all sago is obtained from trade.

- Sialum area, north coast of the Huon Peninsula, Morobe Province. Coconut, fish and marine foods are exchanged for banana and root crops from inland locations, particularly during seasonally dry periods.

- Malai and Tuam islands, south of Umboi Island, Morobe Province. In the past, fish, dogs, pigs, wooden bowls and pandanus leaf mats were exchanged for sago, yam, banana and taro from nearby Umboi. This trade continues, but the terms of trade are now less favourable for those on the very small islands and quantities traded have declined.

- Coastal area opposite Daru and Saibai islands, Western Province. Agriculture in this area is limited and dugong, turtle, fish and shellfish are traded or sold to obtain sago. Purchased rice had become a more important source of food energy than traded sago, but the effects of price rises for rice are not known.

- Wari Island, Milne Bay Province. About a third of food needs are obtained from trade with people from Basilaki Island. Clay pots are sold for cash, which is used to purchase food from larger nearby islands.

- Amphlett Group, Milne Bay Province. Clay is obtained from nearby Fergusson Island to make clay pots, which are in turn exchanged with people on Fergusson for about one-third of food needs on the Amphlets.

- Wagifa Island, near Goodenough Island, Milne Bay Province. Wagifa people can only grow a limited amount of fresh food, mostly cassava. They sell fish and other marine foods at a small rural market on Goodenough Island and buy root crops, banana and other garden food. Food is also traded to other small islands in Milne Bay Province including Dobu Island, Brumer Islands, and those in the Engineer Group.

- Numerous islands north and south of Manus Island (Hareengan, Arowe, Sori, Andra, Hus, Oneta, Pityilu, Hawei, Ndrilo, Mbu ke, Johnston, Big Ndrova, Little Ndrova and Tili anu islands). Fish, crab, lobster, shellfish, octopus, lime, string bags and skirts are exchanged for sago, other vegetable foods, betel nut, tobacco and clay pots.

- Matsungan, Petats, Yame, Pororan and Hetau islands west of Buka in Bougainville Province. Capacity to grow food is limited because of population pressure and reduced soil fertility. Sweet potato, banana and other garden food is obtained from Buka Island in exchange for fish and other marine products. A local saying is: *Sapos yu no gat wanzelpa kanu bai yu no inap kaikai* – If you do not have a canoe you cannot eat (as you cannot trade for food).

Sources: Various MASP provincial working papers.
The devaluation of the PNG currency in 1994 had a positive effect on marketed food (see Section 4.1). The value of the kina fell from US$1.00 in the early 1990s to about US$0.85 in 1994. The kina further declined after 1997, from about US$0.70 to about US$0.32 by 2005 (Figure 4.1.1). Imported foods, including rice and wheat, became three times more expensive, which resulted in increased demand from both urban and rural dwellers for locally grown food. Rural producers responded by growing more food for sale, particularly in the highlands where low coffee prices had reduced incomes. Both the size and number of food markets in the main towns increased.

**Marketing fresh food**

Domestically marketed food is sold in the following ways in PNG:

- In small food markets that occur in villages, on roadsides, in small rural centres, at government and church stations, and at logging camps. Larger, permanent markets are present in all cities, towns and smaller urban areas.
- Through supermarkets, restaurants, fast food outlets (*kai* bars), hotels and hostels.
- Directly to institutions and companies that cater for large numbers of people, including to mine and oil field settlements (such as Ok Tedi, Porgera, Lihir and Kutubu), high schools, universities, prisons and defence force establishments.

Most food is sold in open food markets. However, wholesalers also buy fresh food from producers and sell it to retailers or other consumers. Wholesalers include Alele Fresh Farm Produce (Port Moresby, Mount Hagen, Goroka and Lae), Vegmark Fresh Produce (Mount Hagen) and Green Fresh Limited (Port Moresby). Alele and Vegmark also transport fresh food from the highlands to Lae and Port Moresby. Some growers market other people’s produce, as well as their own.

**Some features of food markets in PNG**

Food markets share some common features, despite a wide variety of food and non-food items being sold:

- Items are offered for sale in ‘heaps’ (or bundles) at a fixed price per heap rather than per unit weight; for example, K1 per heap rather than K1.70 per kilogram.
- The price is varied by adjusting the size of the heap, as well as the price of the heap.
- Considerable variation exists between sellers in the size of heaps on offer and hence the prices of items being sold.
- Premium prices are paid for size for some items, at least in the highlands. For example, the price per kilogram of a large cabbage is higher than that for a smaller one.
- There is little obvious competition between vendors. Sellers do not call out or try to attract buyers to their stall.
- Middlemen buy from vendors in one market and resell elsewhere, such as on a street near business offices, for slightly higher prices (smaller heaps).
- Imported goods, uncommon before 1970, are increasingly sold in markets.

**Significance of domestically marketed food**

People in PNG markets mainly sell fresh foods but, increasingly, cooked foods made from both locally produced and imported ingredients are being marketed. The most commonly marketed fresh foods are sweet potato, other root crops, corn, peanuts, green vegetables such as *aibika*, cabbage, beans and amaranthus, fruit including pawpaw, pineapple, mango and watermelon, and nuts such as *karuka* and *galip*. The most common cooked foods are made from flour.
Statistics on the volume and value of marketed fresh food in PNG are limited but it is clear that this part of the economy is large and is growing. About 83% of the food energy consumed in 2006 was grown within PNG (Figure 2.1.1), while the per person consumption of imported rice has declined since 1998 (Figure 2.7.2). The shortfall of imported food is being met by increased domestic food production and increased sales of fresh food, particularly the staple root crops, banana and sago.

It is not known what proportion of the estimated 4.5 million tonnes of staple foods produced in 2000 (see Section 2.2) was sold. If just 1% of this volume was sold, it would amount to around 45 000 tonnes of food being marketed. However, staple food crops are only a small proportion of all food sold, so the total volume of food moving through PNG markets each year is considerably greater than 45 000 tonnes.

The estimated annual income from food sales in 1990–1995 was K44 million (see Section 5.1). That was second only to income from sales of Arabica coffee (K67 million) (Figure 5.1.1, Table 5.1.1). Prices of fresh foods have risen in local markets, although not as much as the prices of imported foods (see Section 4.3). It is almost certain that income from fresh food sales has increased since 1996, but there is no reliable estimate.

Although higher incomes are earned from coffee sales, more rural people earn an income from selling fresh food than from any other economic activity (Figure 5.1.2, Table 5.1.1). More than 90% of rural villagers live in areas where income is derived from selling fresh food.1

The volume and value of fresh food is greatest nearest to the largest towns and where road transport is good. Port Moresby, three times the size of the next largest city, Lae, has an extensive market influence that reaches into the highlands, even though it is not connected by road to the rest of PNG. Fresh food marketing is most important around Port Moresby, including the peri-urban areas and the Sogeri Plateau; in the Markham and Ramu valleys; the northern valleys of Eastern Highlands and Simbu provinces; the Wahgi Valley and other valleys in Western Highlands Province; the north-east lowlands of the Gazelle Peninsula in East New Britain; and near many of the smaller urban areas (Figure 5.3.1).

Marketing systems

The overwhelming characteristic of food marketing in PNG is the high level of individual grower involvement. In the case of the staples, virtually all marketing is undertaken by growers using public motor vehicles for transport. Farmers lack confidence in the marketing chain, have a perception that they can make more money by cutting out middlemen, and use their produce to fund visits to relatives in Port Moresby, Lae and Madang. The high level of farmer involvement in marketing has undesirable consequences. Marketing costs are higher, farmers earn less when all their costs are considered, produce quality is poorer, market development is limited, and consumer prices are increased. As well, production is reduced because producers are travelling and marketing, rather than growing more produce.

The number of food wholesalers is small and they are concentrated in the highlands. The fresh food industry could not have developed to the extent that it has without the tenacity of these few businesses. Wholesale enterprises require considerable support and assistance to offset the substantial constraints under which they operate. A lack of affordable finance is probably the major constraint to fresh produce marketing, both finance for investment in marketing infrastructure and working capital for traders to buy produce from farmers.

---

1 Similarly, in the 1980 and 2000 censuses, a high proportion of rural people reported that they lived in a household where income was derived from selling fresh food.
Future prospects

Much progress has been made in the marketing of fresh food over the past 40 years. In the past 10 years in particular the sector has expanded with large increases in the volume of food sold, in the range of foods on offer, in the quantity of cooked foods and in the quality of produce. Nevertheless, the considerable difference between rural and urban areas in per person consumption of the various staple foods suggests unmet demand for locally grown food staples in urban areas (Table 2.1.1) and thus potential for expansion in the marketed fresh food sector. The greatest potential is for further sales of the main staple foods, including sweet potato, banana and sago; temperate-climate vegetables from the highlands to lowland urban areas; and sales of sweet fruit, particularly mandarin, mango, rambutan and mangosteen, from coastal or mid-altitude locations to the major urban areas and to the highlands where sweet fruit do not grow (see Section 3.3).

Constraints

A number of major constraints limit expansion of the fresh food sector in PNG. The constraints differ by food. However, the following is a generalised list of problems that need to be addressed:

- Insufficient middlemen and excessive involvement of producers in selling relatively small amounts of food (for example, spending large amounts of time and money travelling), so that efficiencies of scale are not achieved.
- Inadequate market information (for example, on prices, demand and shipping availability).
- Poor communications between producers, middlemen, transporters and retailers.
- Poor marketing skills by producers.
- Lack of consistency in the volume and quality of produce offered for sale.

Figure 5.3.1 Locations where sales of fresh food provided income for rural villagers, 1990–1995. Source: MASP.
Expensive and infrequent sea, river and road transport; a lack of priority by airlines to carry fresh food; and poorly maintained rural roads that cause food to be damaged during transport.

Inadequate storage facilities at points of transport change; for example, from road to ship.

Production constraints, including not using the best available varieties; insufficient attention to soil fertility maintenance; production in a less than optimum climatic zone (for example, producing mandarin in the highlands when the best fruit is grown at 800–1400 m altitude); and failure to control major pests and diseases.

Lack of availability of agricultural inputs, including appropriate planting material, fertilisers and pesticides.

These constraints result in poor quality produce being offered for sale. Produce is handled roughly at every stage of the marketing process from harvesting to retailing; it is inappropriately packaged; is delayed during transport; and is held in unsuitable temperature and humidity conditions.

### Indigenous nuts

PNG does not have a competitive advantage in exports of fresh food or flowers (see Section 5.17). A very unfavourable fruit fly situation, poor transport infrastructure and inadequate airfreight links are the main causes. Indigenous nuts are an exception. Nuts with a large export potential include galip, pao and okari (see Section 3.4). These nuts could become for PNG what the Brazil nut is for the Amazon or the macadamia (a nut indigenous to Australia) is for Hawaii. However, despite their inherent qualities, these nuts are largely unknown outside Melanesia. To create a major export industry will require a substantial investment in product and market development. The Hawaiian macadamia nut industry required the injection of substantial equity and risk capital. Such capital has not been forthcoming for new agribusiness ventures in PNG. Until such investment occurs, opportunities exist for small-scale developments supplying local markets, where the nuts are known and are in demand.

### Sources


5.4 Coffee

Coffee is the most important source of village agricultural income (Table 5.1.1, Figure 5.1.1). It is particularly important for both villagers and urban-based businesses in the highlands where opportunities to earn cash income from other sources are limited. In the early to mid 1990s an estimated 1.7 million people (53% of the rural population) lived in households where cash income was earned from selling Arabica or Robusta coffee (Table 5.1.1, Figure 5.1.2). Coffee generated an average of K364 million per year in export income over the period 2004–2006, which was 26% of the value of agricultural exports in this period (Figure 5.2.2).

Two types of coffee are cultivated in PNG. Arabica coffee, the most important, is usually grown between 700 m and 2050 m altitude, but occasionally as low as 100 m and as high as 2400 m (Figure 1.13.3). Robusta coffee, considerably less important, is usually grown between sea level and 550 m. Both types of coffee are grown in environments where average rainfall is 1700–5000 mm per year.

The production of Arabica coffee is highly seasonal (see Box 5.4). The main season varies a little between years and between locations, but is generally in the period May to September and particularly in June, July and August. A study of Robusta coffee found no definite harvesting season in the Gazelle Peninsula area, East New Britain Province. However, in the Milne Bay area further from the equator, the main harvest occurs between May and August with the peak in June–July.

Adoption and history

Coffee was first introduced to PNG in 1873 (see History of agriculture) and was growing in the Rabaul Botanical Garden by 1890. Between about 1900 and 1940, several plantations were established in Central Province and around Wau in Morobe Province and by villagers in the Sangara area of Oro Province. However, coffee remained an insignificant cash crop until the early 1950s, when commercial production of Arabica coffee commenced on small expatriate-owned plantations and in villages in the central highlands. Before 1960, most of the Arabica coffee exported from PNG was grown in highland regions of Morobe Province, particularly in the Wau, Finschhafen, Kaiapit and Wasu areas, but during the early 1960s a rapid expansion of smallholder coffee production occurred in Western Highlands, Simbu and Eastern Highlands provinces. This expansion occurred as a result of extension activities, the absence of alternative cash-earning opportunities, high export prices for coffee, the construction of the Highlands Highway in the mid 1960s, and the example provided by the plantation developments.¹

¹ In 1954 the Australian Administration took steps to reduce the rate at which land was being alienated for commercial coffee plantation development. By 1961 new plantation development had effectively ceased.
Robusta coffee had been grown successfully in Oro and Milne Bay provinces, and in parts of Central, East New Britain, Madang and East Sepik provinces. However, production grew slowly in comparison to the rapid expansion that occurred in the highlands. Robusta coffee has always attracted significantly lower prices than Arabica.

The Australian Administration was forced to slow the rate of growth of coffee production in PNG to meet quotas imposed by the 1962 International Coffee Agreement. Measures taken included the prohibition of further estate development; a ban on planting coffee on new agricultural leases, including settlement schemes; and reduction of extension and promotional activities in the smallholder sector. Despite these measures, smallholder production continued to increase at an average rate of 28% per year between 1961 and 1968. Most of this expansion occurred in Eastern Highlands, Western Highlands and Simbu provinces, where it is known that many Australian agricultural extension officers chose to quietly ignore the bans on assisting villagers to plant coffee.

Following the abandonment of the quota requirements of the International Coffee Agreement in December 1972, the PNG Government attempted to reinvigorate coffee extension and promotion activities, particularly in the less developed areas of the country, such as Southern Highlands Province. It is possible that the renewed extension and promotion efforts resulted in the significant increase in smallholder production that occurred in the 1970s, although other factors, such as high export prices, were more important.

In the early 1980s the government sponsored the development of smallholder coffee blocks. These were parcels of land removed from customary tenure and owned and operated by families or groups of families, separate from village plantings. The blocks had from 5 ha to 29 ha under coffee and were often managed by a professional organisation. The Coffee Industry Corporation (CIC) (see Section 6.4) estimated that there were 636 coffee blocks in 2007. The current standard of management is highly variable, with many blocks producing poorly.

Figure 5.4.1 Coffee production by province, 2006 (by volume). Source: Coffee Industry Corporation Ltd.

Western Highlands and Eastern Highlands provinces continue to dominate coffee production in PNG, contributing about 82% of the total quantity of coffee produced in 2006 (Figures 5.4.1, 5.4.2, Table A5.4.1). Other provinces that contributed to coffee production in 2006 were Morobe, Simbu, Enga and Southern Highlands. Robusta production has traditionally been dominated by East Sepik Province, which increased its output steadily during the 1990s, mainly as a result of new plantings in the Wosera and Maprik areas. However, production in East Sepik Province has fallen significantly since 2002 as a result of increased cocoa and vanilla plantings. Historically, Arabica coffee has accounted for about 95% of production, with Robusta the remaining 5%, but Robusta production has declined in recent years to less than 1% of total production.

There is little current information concerning the area of land planted to coffee in PNG. According to a 1999 estimate, approximately 70 000 ha were planted to coffee, of which 57 000 ha were smallholder plantings, with the remainder in the plantation and block sectors. In 2007, according to CIC figures, 2

---

2 The Coffee Industry Corporation defines a block as a holding with 5–29 ha under coffee and a plantation as having 30 ha or more planted with coffee.
Figure 5.4.2 Locations where coffee sales provided income for rural villagers, 1990–1995. Source: MASP.
plantations had 4400 ha under coffee and the blocks an estimated 12 000 ha. Based on production from 2004 to 2006 and average yields (see below), it is estimated there is 70 000–85 000 ha of smallholder coffee and 12 000–15 000 ha of plantation and block coffee.

Levels of production

Coffee production, measured by the quantity exported, increased rapidly between 1960 and 1980, but the rate of increase has slowed since 1980 (Figures 5.2.5, 5.4.3, Table A5.4.2). There has been virtually no new coffee plantation development since 1961 and the plantation sector has declined since the mid 1980s. There were 107 coffee plantations operating in 1977, but only 33 in 2007. Hence the significant increase in production over the past 40 years has come entirely from the smallholder sector. Between 1985 and 2005 smallholder production doubled and its contribution to overall production increased from 65% to 85% (Figure 5.4.4, Table A5.4.3). Conversely, production from plantations and blocks halved over this period and their combined contribution decreased from 35% to 15%.

Since 1978 the total annual production of coffee has exceeded 40 000 tonnes. Production peaked at 84 000 tonnes in 1989 and again in 1998. The variation in annual production that has occurred since 1980 is mostly explained by fluctuations in the export price and annual rainfall. Smallholder producers are very sensitive to returns on their labour and so are highly responsive to changes in price (see Section 5.20). Growth in production has been limited since 2000 by low prices (until 2004), high rainfall (in 2005 which resulted in a poor harvest in 2006) and deteriorating road access to many producing areas.

Survey data from village smallholders and plantations allows yields per hectare to be estimated (Table 5.4.1). For the period 1960 to 1995, the average yield of smallholder Arabica coffee was about 950 kg/ha of green bean, while average plantation yields were almost twice this at 1650 kg/ha. There are significant differences between the highest and lowest reported yields (data not presented in Table 5.4.1), and where the same producers have been surveyed over a number of years, yields may vary considerably between years. On plantations, most of the variation can be attributed to differences in weather conditions between years, rather than greater or lesser attention to harvesting, as is probably the case with smallholders. However, yields on plantations appear to have decreased significantly in recent years; over the period 2000 to 2006, the average yield for plantations and blocks was 600 kg/ha green bean. This is probably more the result of changes in management than of climate.

There is an often-stated belief that coffee has a biennial bearing pattern in PNG (that is, if yields are high in one year, they are lower the following year). However, surveys by the Queensland Department of Primary Industries and by CIC over a number of years do not support this theory (Table 5.4.1). Much published and unpublished data exist on coffee yields under experimental conditions, mostly from Aiyura in Eastern Highlands Province, but these are not reviewed here. Experimental yields range from less than 1 t/ha to more than 4 t/ha of green bean, with means in the range 1.5–2.5 t/ha.

**Processing, exporters and markets**

The Coffee Industry Corporation registered 17 exporters, 103 processors (58 ‘dry’ factories and 45 ‘wet’ factories) and 5 manufacturers, and estimated there were 5000 itinerant buyers, in PNG in 2007.4

---

4 Raw coffee fruit is called ‘cherry’. At wet bean factories the cherry is processed into ‘parchment’, which is a coffee bean encased in a layer of parchment. At dry bean factories the parchment is removed to reveal the green bean, the main export product.
The majority of exporters and factories are located in Western Highlands and Eastern Highlands provinces. Most smallholder coffee growers process their raw coffee fruit (‘cherry’) to parchment stage before selling it either directly to factories or, more commonly, to itinerant buyers. A limited amount of coffee is sold to buyers or factories in cherry form. From time to time, attempts are made to ban cherry purchases to prevent theft of cherry from trees.
In 2006/07, six exporters accounted for 85% of the coffee exported from PNG: PNG Coffee Exports (21% of the market), New Guinea Highlands Coffee Exports (19%), Niugini Coffee, Tea and Spice (17%), Monpi Coffee (13%), Kongo (8%) and Pacific Trading (7%). In 2006, PNG exported coffee to 29 countries, with 89% of the exports going to just four: Germany (40%), Australia (20%), the United States (20%) and Japan (9%) (Figure 5.4.5, Table A5.4.4). Minor destinations included Malaysia, New Zealand, South Korea and South Africa.

Future prospects

The PNG coffee industry, despite its problems, has maintained a reasonable degree of international competitiveness. During the early 2000s world coffee prices were at historical lows, but the devaluation of the kina helped maintain kina returns to PNG growers. In 2005, in association with adverse weather conditions in Brazil and an upturn in the normal coffee price cycle, Arabica prices reached their highest level since 1998. Prices have remained firm since. The average export price for PNG coffee in 2006 was 40% higher than in 2004. The World Bank predicts that coffee prices will remain relatively stable until 2010 and will then decline until 2015 (Figure 5.2.6).

Fundamental changes in the world coffee market will have major implications for the future of the PNG industry. Over the last decade or so the world coffee industry has boomed at the retail level but remained stagnant at the producer level. In the early 1990s the retail value of the world coffee industry was about US$30 billion; it now exceeds US$70 billion, but the growers’ share of profits has fallen from 40% to 10%. The future success of exporting countries, such as PNG, depends on being able to adjust to this new reality.

In addition, there has been a huge increase in the output of low-quality Robusta coffee from Vietnam and medium-quality Arabica coffee from Brazil. The abundant availability of low-priced coffee has brought about a permanent shift in demand. If PNG’s coffee industry is to remain viable in the longer term it must produce more, better-quality coffee. This can be done through a number of mechanisms including grower groups where members are committed to producing higher grade coffee and who are rewarded with higher prices for their products.

The PNG Government has set a production target of 90 000 tonnes by 2016. Expansion to these levels is likely to be constrained by limited areas of suitable land in the highlands and ongoing pressure on land; low world prices (Figure 5.2.6); inadequate road access for many producers (see Section 6.9); and possibly by increasing rainfall associated with global climate change (see Section 1.8). A potentially serious insect pest, coffee berry borer, is present in Papua (Indonesian New Guinea) and only urgent quarantine action along the border will prevent it moving into PNG in future years.5 If this pest becomes established in the PNG highlands it is likely to have a severe effect on coffee production.

The clearing of all coffee from a strip of land along the PNG side of the international border may prevent the coffee berry borer from moving into PNG. Most coffee in this area is unproductive, overgrown Robusta and its destruction will have little adverse effects on village incomes.
Coffee is the only major export cash crop in PNG with a strong seasonal production pattern. Arabica coffee is the main source of cash income for most villagers in the highlands.

The seasonal nature of cash income to villagers from coffee sales results in a markedly seasonal pattern of retail sales in the highlands. Sales of alcoholic drinks (mainly beer), rice, other imported food, fuel, soft drinks, clothes and other items are generally greatest during the main coffee harvesting season. Sales are lowest in January, February and March when very little coffee is sold.

This pattern is illustrated with data from the Kainantu area of Eastern Highlands Province. Monthly village coffee production in the Kainantu area, sales of alcoholic drinks from one store in Kainantu and sales of food in another store are shown for a three-year period in Figure 5.4.6 and Table A5.4.5. The close relationship between the quantity of coffee sold by villagers and sales of food and alcoholic drinks is evident. Many other activities in Eastern Highlands, Western Highlands and Simbu provinces show a similar pattern.

It has been claimed that the seasonal nature of coffee harvesting is responsible for food shortages in the highlands. However, a large study of the causes of subsistence food shortages in the highlands showed that there is no relationship between the coffee harvesting period and irregular subsistence food shortages. Rather, these shortages are caused by climatic extremes (frost, excessively high rainfall, drought) and variation in the planting rate of food gardens (see Section 5.20).

**Box 5.4 Coffee sales and retail spending cycles in the highlands**

Coffee sales and retail spending cycles in the highlands are illustrated with data from the Kainantu area of Eastern Highlands Province. Monthly village coffee production in the Kainantu area, sales of alcoholic drinks from one store in Kainantu and sales of food in another store are shown for a three-year period in Figure 5.4.6 and Table A5.4.5. The close relationship between the quantity of coffee sold by villagers and sales of food and alcoholic drinks is evident. Many other activities in Eastern Highlands, Western Highlands and Simbu provinces show a similar pattern.

It has been claimed that the seasonal nature of coffee harvesting is responsible for food shortages in the highlands. However, a large study of the causes of subsistence food shortages in the highlands showed that there is no relationship between the coffee harvesting period and irregular subsistence food shortages. Rather, these shortages are caused by climatic extremes (frost, excessively high rainfall, drought) and variation in the planting rate of food gardens (see Section 5.20).

**Figure 5.4.6** Smallholder coffee production and sales of food and alcohol in the Kainantu area, Eastern Highlands Province, 1982–1984. Data presented as a 3-month running mean. Source: Bourke (1988:328–9).
The most important issue for the PNG coffee industry is to improve the quality from existing plantings. If it can succeed in doing this, it has a bright future and coffee will continue to make a substantial contribution to highlanders’ living standards.

Sources


Cocoa is the third most important source of village agricultural income, after coffee and fresh food (Table 5.1.1, Figure 5.1.1). In the early to mid 1990s, an estimated 850,000 people (27% of the rural population) lived in households where cash income was earned from selling cocoa (Table 5.1.1, Figure 5.1.2). Cocoa generated an average of K218 million per year in export income from 2004 to 2006, which was 14% of the value of agricultural exports in this period (Figure 5.2.2).

In PNG, cocoa is grown up to 800 m altitude (Figure 1.13.3) where annual rainfall ranges from 1800 mm to over 5000 mm. Seasonality data indicate that more cocoa is produced between May and July than in other months, but the pattern varies considerably from place to place.

**Adoption and history**

Cocoa was introduced to PNG by German settlers around 1900. Commercial cocoa production developed slowly despite a series of subsidies and concessions introduced by the Australian Government during the 1920s. Low copra prices during the Depression also encouraged plantation owners to diversify into cocoa production. The industry was severely affected by World War II, when about two-thirds of PNG’s cocoa trees were destroyed.

Following the war, global demand for cocoa increased substantially and the Department of Agriculture, Stock and Fisheries promoted expansion of the industry. Copra plantation owners were encouraged to interplant cocoa with coconut, and soldier settlement cocoa estates (for Australian ex-servicemen) and smallholder blocks were established on the Gazelle Peninsula in East New Britain Province, around Lae in Morobe Province and around Popondetta in Oro Province. These efforts resulted in a major expansion of the industry: the total area planted to cocoa increased from about 3700 ha in 1951/52 to around 49,500 ha in 1965/66. Total production increased from 485 tonnes to around 15,500 tonnes over the same period (Figure 5.5.1, Table A5.5.1). The expansion occurred mostly in the plantation sector, which accounted for about 95% of all cocoa produced in the year 1965/66. However, after 1965 smallholder cocoa production increased significantly and by 1979 had surpassed plantation production (Figure 5.5.2, Table A5.5.2). This expansion in smallholder production was concentrated in East New Britain and Bougainville provinces, and these two provinces have continued to dominate the smallholder sector (see below).

---

1 Dates expressed as ‘1951/52’ (for example) represent a cocoa year, which runs from October to September.
Figure 5.5.1  Volume and value of cocoa exports, 1948–2006. Sources: 1948–1978: Bureau of Statistics, Konedobu; 1979–2006: Cocoa Board of PNG.

Figure 5.5.2  Cocoa production by sector, 1970/71–2005/06. Sources: 1970/71–1975/76: Department of Primary Industry; 1976/77–2001/02: Cocoa Board of PNG.
Most PNG cocoa is produced in the north-east lowlands of the Gazelle Peninsula in East New Britain Province and on north-east Bougainville Island (Figures 5.5.3, 5.5.4, Table A5.5.3). Other provinces that contributed to cocoa production in 2006 were East Sepik, Madang, New Ireland, Sandaun, West New Britain and Morobe.

In 2006, smallholders accounted for 90% of national cocoa production, with the plantation sector contributing the remainder. This reflects the continued decline of the plantation sector over the past 30 years (Figure 5.5.2).

There are no accurate estimates of the land area currently planted to cocoa in PNG. Based on production of 40 500 tonnes from smallholders and 4500 tonnes from plantations in 2006, and average yields of 0.25 tonnes/ha and 0.5 tonnes/ha respectively, the area devoted to smallholder cocoa is probably about 160 000 ha and for plantations, 9000 ha. The area of plantation cocoa in 1973 was 55 000 ha.

Levels of production

The expansion of the plantation sector in the post-war period, coupled with the later increase in smallholder production, saw the overall production of cocoa, measured as total exports, reach 35 500 tonnes in 1975 (Figure 5.5.1). Production then declined in the late 1970s and remained stagnant until the mid 1980s. Smallholder production increased steadily during this period and the decline in production after 1975 occurred in the plantation sector. Factors influencing the decline of the plantation sector included decreases in both yield and production on formerly expatriate-owned plantations that had been returned to local villagers; uncertainties associated with the Land Acquisition Act; and the increasing age of cocoa trees.3

The continued growth of the smallholder sector, coupled with a slight recovery in the plantation sector, saw exports reach 46 000 tonnes in 1989 (Figure 5.5.1, Table A5.5.1). During the 1970s and 1980s, Bougainville produced about half of PNG’s cocoa. The Bougainville civil war of 1989–1997 caused the closure of plantations and a marked decline in smallholder activity in that province. Production there fell from 18 600 tonnes in 1989, to 7500 tonnes in 1990, and remained in the range 3000–5000 tonnes from 1991 until 2001. National cocoa exports were affected by the decline in Bougainville production, but increased production in East New Britain from 1989 onwards reduced the impact and that province replaced Bougainville as the leading cocoa producer (Figure 5.5.5).

---

2 There are some large discrepancies between the national cocoa export figures and the national cocoa production figures, with the export figures frequently being higher than those for production. We are unable to account for these differences.

3 The plantation sector experienced some difficulties during the mid 1960s, including the outbreak of vascular streak die-back disease in East New Britain Province, and the devastating effect of weevil borers (Pantarhytes szeintivaijii and P. plutus), which saw the abandonment of large areas of cocoa plantings in the Lae and Popondetta areas. To some extent, the expansion of new plantings in Bougainville and New Ireland provinces compensated for these difficulties.
Figure 5.5.4  Locations where cocoa sales provided income for rural villagers, 1990–1995. Source: MASP.

Figure 5.5.5  Cocoa production in East New Britain and Bougainville provinces, 1978–2006. Source: Cocoa Board of PNG.
National production remained relatively low throughout the early to mid 1990s. Three factors contributed to depressed levels of production during this period. First was the continued slump in production in Bougainville Province, particularly in the plantation sector where production had essentially fallen to zero. Second was the decline in the plantation sector in general, due to rising costs of production associated with the devaluation of the kina and increasing wages, and also to land disputes on the Gazelle Peninsula. Third was the volcanic eruptions near Rabaul in 1994, and the drought in 1997, both of which adversely affected production.

Exports increased again from 1999 and reached a peak of 49 000 tonnes in 2005. This recovery was associated with smallholders’ response to higher export prices and increased production in Bougainville Province. The recovery in Bougainville was greatly assisted by aid-funded rehabilitation programs and road rehabilitation. Among the smaller cocoa-growing provinces, production has increased in East Sepik, Sandaun and Madang provinces over the past decade. In contrast, it has declined in New Ireland, West New Britain, Manus, Oro, Milne Bay and Central provinces (Table A5.5.3).

Mean smallholder yield of dried cocoa is typically 200–400 kg/ha, and up to 600 kg/ha. The Cocoa and Coconut Institute uses 250 kg/ha as a working average for smallholder yield (Table 5.5.1). Mean yields on plantations are higher at 400–600 kg/ha and are as high as 1500 kg/ha on the best plantations. Much published and unpublished data exist on cocoa yields under experimental conditions, mostly from Keravat and Tavilo in East New Britain Province, but these are not reviewed here.

Most smallholder cocoa trees are more than eight years old and are characterised by a lack of pruning. A lack of maintenance of cocoa leads to a high incidence of pests and diseases and under-harvesting. There is considerable scope for increasing yield per hectare of smallholder cocoa through a number of relatively simple means without expanding plantings. These measures include pruning trees, shade management, and control of the most important pests and diseases.5

---

### Processing, exporters and markets

About 2500 cocoa dealers licensed to buy wet bean from producers were registered in PNG in 2003. Dealers process the bean (which involves fermentation and drying) and sell it to exporters. Around 5500 licensed fermentaries were operating throughout the country, with more than half in East New Britain Province and many in villages. More than twenty cocoa exporters were registered but not all were active. In 2005, Agmark Pacific was the major cocoa exporter, accounting for 70% of the market. The next largest exporters were Sepik Coastal Commodities (16%) and Outspan Limited (6%).

In 2006, about 27% of cocoa produced in PNG was exported to the United States, 17% to Belgium, 16% to Malaysia, 16% to Singapore, 11% to Indonesia, and smaller volumes to Thailand and Germany (Figure 5.5.6, Table A5.5.4). The United States and Singapore have been the main export destinations for PNG cocoa since the early 1990s.

### Future prospects

The very high prices of the late 1970s and early 1980s resulted in large increases in cocoa plantings worldwide followed by a huge increase in global production over the next decade. The creation of large cocoa stocks dominated the market for more than 10 years, leading to a price slump of unprecedented duration. PNG’s smallholder cocoa sector survived the prolonged depressed market essentially intact. A competitive marketing system and the low value of the kina guaranteed a modest regular income for growers that could not be provided by any alternative income source.

---

4 Plantings in Bougainville Province tend to be younger, with extensive replanting following the civil war.

5 See Curry et al. (2007) for detailed suggestions on how to increase yield per hectare of smallholder cocoa.
In 2002, when civil unrest began to affect Côte d’Ivoire production (the world’s largest cocoa exporter), prices began to move up sharply and have remained at reasonably firm levels since then. Medium-term prices will depend on the political developments in Côte d’Ivoire. In late 2007 the World Bank projected an average price of about US$1.90/kg during 2008 and slightly lower in 2009. Longer term real prices are then projected to decline slightly as supply increases more rapidly than demand (Figure 5.2.6). Even at these prices, PNG smallholders will receive a good return to labour for planting, maintaining and harvesting cocoa (see Section 5.20). However, whether these prices are sufficient to bring about investment in new cocoa plantings remains to be seen.

### Table 5.5.1 Average yield of smallholder and plantation cocoa (kg/ha dry bean)

<table>
<thead>
<tr>
<th>Survey year</th>
<th>Average yield (kg/ha)</th>
<th>Location</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smallholder</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1973</td>
<td>310</td>
<td>East New Britain, Bougainville, Madang</td>
<td>Godyn (1974b:1)</td>
</tr>
<tr>
<td>1989</td>
<td>170</td>
<td>East Sepik</td>
<td>Yarbro and Noble (1989:1,15)</td>
</tr>
<tr>
<td>1989</td>
<td>100</td>
<td>North coast Madang Province</td>
<td>Yarbro and Noble (1989:1,15)</td>
</tr>
<tr>
<td>1989</td>
<td>200</td>
<td>Mean all respondents (5 locations)[c]</td>
<td>Yarbro and Noble (1989:1,15)</td>
</tr>
<tr>
<td>2000</td>
<td>250</td>
<td>‘Average smallholder’</td>
<td>Levett (2000:54)</td>
</tr>
<tr>
<td>Plantation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>500–600</td>
<td>‘Average plantation’</td>
<td>Levett (2000:54)</td>
</tr>
</tbody>
</table>

[a] Yarbro and Noble (1989) note that yield data for East New Britain and Oro provinces are probably the most reliable.

[b] Low yields on Karkar Island reflect young and newly bearing tree stock at the time of the survey.

[c] Yields (kg) per bearing tree were: 0.9, 0.7, 0.7,1.0 and 1.1 for the five locations surveyed by Yarbro and Noble, with an overall mean of 0.8 kg/tree.

[d] Godyn (1974a:23) notes that yields in 1972–73 were reduced by drought. In 1972–73 the highest production was more than 1500 kg/ha on one plantation, and less than 250 kg/ha on another 12 plantations. Yields per hectare tended to increase with plantation size.
The PNG Government has set a target of 100 000 tonnes of cocoa exports by 2016. Land in suitable growing environments (fertile soil and rainfall less than 3500 mm/year) is limited. Hence significant expansion will have to come from higher yields per tree rather than an increase in the area devoted to cocoa plantings. Cocoa pod borer, a serious insect pest, has the potential to cause a severe reduction in PNG cocoa production, as it has in Indonesia, Malaysia and the Philippines. It appeared in the Keravat area in East New Britain in early 2006 and has spread to other locations on the Gazelle Peninsula and has been found elsewhere since then.6

Further significant increases in export volume will depend on increasing smallholder yield per hectare. The best options for increasing the value of cocoa exports are through improving quality and entering into speciality niche markets.

6 Cocoa pod borer has been detected in the Aitape area of Sandaun Province, from where it could spread to cocoa-growing areas in East Sepik and Madang provinces. It is presumed to have been introduced on logging equipment imported from Malaysia that was not properly cleaned or inspected.


5.6 Copra and copra oil

Copra is an important source of village income (Figure 5.1.1). In the early to mid 1990s, an estimated 527 000 people (17% of the rural population) lived in households where cash was earned from selling copra (Table 5.1.1, Figure 5.1.2). From 2004 to 2006 copra and copra oil generated average annual export earnings of K93 million; this was only 6% of the total value of agricultural exports in this period (Figure 5.2.2). Most of this amount (85%) was earned from copra oil exports.

Three economic products are derived from the nut of the coconut palm: copra, copra oil and copra meal. Although coconut will regenerate naturally from seed in coastal locations, almost all coconut palms in PNG have been planted by people. In PNG, coconut is grown in environments where mean annual rainfall ranges from 1000 mm to 6500 mm. It is cultivated from sea level to 1000 m altitude; however, the commercial cultivation of coconut is mostly restricted to coastal locations. Coconut normally bears all year round, but production falls significantly during droughts.

Adoption and history

Although the cultivation and use of coconut in PNG long predates European settlement, the commercial cultivation of coconut palms in PNG commenced in the 1880s, in the Gazelle Peninsula area of East New Britain Province. Coconut meat, dried to copra, was initially in demand for soap manufacture and later for margarine production. Plantation development expanded quickly throughout the New Guinea Islands Region because of high copra prices during World War I. Commercial coconut planting commenced in the coastal areas of Southern Region in 1907, after Australia took over the administration of Papua from the British Colonial Office.

The production and export of copra increased rapidly during the first decades of the twentieth century. Export volumes were recorded as 10 324 tonnes in 1909/10 from a planted area of 16 000 ha, 31 500 tonnes in 1921/22 and 91 500 tonnes in 1936/37 (Figure 5.6.1, Table A5.6.1). Copra was the most important export commodity from PNG during this period. In 1921/22 it contributed 90% of all exports. Copra production and export declined significantly during World War II due to very low prices and the disruption of trade and commerce. Production and exports returned to pre-war levels in the early 1950s when copra exports comprised around 70% of total exports. However, the relative importance of copra and copra oil exports has declined greatly since then (Figure 5.2.3). Until the late 1950s, most copra produced in PNG was grown on plantations. Smallholders produced an estimated 20% of copra in 1954/55.

From the 1950s the Australian Administration adopted policies to develop smallholder and village copra production. Increased extension activities resulted in the establishment of an estimated 75 000 ha of smallholder and village coconut palms.
Copra and copra oil

Provinces that make significant contributions to smallholder production are Madang, New Ireland, Bougainville and West New Britain (Figure 5.6.3). Most plantation copra is produced in Madang and East New Britain provinces (particularly in the Gazelle Peninsula area). In 2005, East New Britain Province accounted for 46% of all copra produced and Madang Province 20%. Smaller amounts came from New Ireland, Bougainville and West New Britain provinces (Figure 5.6.4, Table A5.6.2).

It was estimated in 1998 that coconut plantations covered approximately 53 000 ha and smallholder plantings about 128 000 ha. In a large proportion of these areas coconut is interplanted with cocoa, an innovation that was first pioneered in PNG in the 1950s and that increases overall economic productivity of land under coconut for both plantation and smallholder producers. Most coconut palms in PNG are of the ‘tall’ variety and many are now aged, which reduces productivity. Age is thought to be a greater problem in the plantation sector, where approximately half of coconut palms are 70–80 years old.

Smallholder copra production is dominated by East New Britain Province, which contributes around one quarter of total production (Figure 5.6.2). Other provinces that make significant contributions to smallholder production are Madang, New Ireland, Bougainville and West New Britain (Figure 5.6.3). Most plantation copra is produced in Madang and East New Britain provinces (particularly in the Gazelle Peninsula area). In 2005, East New Britain Province accounted for 46% of all copra produced and Madang Province 20%. Smaller amounts came from New Ireland, Bougainville and West New Britain provinces (Figure 5.6.4, Table A5.6.2).

It was estimated in 1998 that coconut plantations covered approximately 53 000 ha and smallholder plantings about 128 000 ha. In a large proportion of these areas coconut is interplanted with cocoa, an innovation that was first pioneered in PNG in the 1950s and that increases overall economic productivity of land under coconut for both plantation and smallholder producers. Most coconut palms in PNG are of the ‘tall’ variety and many are now aged, which reduces productivity. Age is thought to be a greater problem in the plantation sector, where approximately half of coconut palms are 70–80 years old.
Figure 5.6.2 Copra production by sector and province, 2000 (by volume). Source: Kokonas Industri Koporesen.

Figure 5.6.3 Locations where copra sales provided income for rural villagers, 1990–1995. Source: MASP.
Levels of production

Since the 1970s, the smallholder sector has grown in importance relative to the plantation sector. In 1988, smallholders contributed around 70% of total production, and by 1998 this proportion had increased to 82%. The plantation sector has continued to be adversely affected by extreme fluctuations in world market prices and, more importantly, by the rising costs of inputs, particularly fuel and labour. The sector has also been constrained by investment uncertainty (particularly as a result of the Plantation Redistribution Scheme in the 1970s, which bought back plantation land from owners and returned it to the previous customary owners).

Smallholder producers are sensitive to variations in the export prices paid for copra and copra oil and this largely explains the peaks and troughs that have characterised PNG production levels from the 1970s to the 1990s (Figures 5.6.1, 5.6.5). Very low prices

---

**Figure 5.6.4** Copra production by province, 2005 (by volume. Source: Kokonas Indastri Koporesen.

between 1985 and 1995 saw copra production reach its lowest levels since the late 1940s (despite K35.4 million of government price assistance and stabilisation funding over the period 1990–95). However, price increases during the 1990s saw production increase again.¹

The marked decline in copra production in 1998, despite the fact that prices were still increasing, was associated with the opening of a new Copra Marketing Board copra oil mill in Madang. Since the 1960s, the proportion of copra being processed domestically into copra oil has steadily increased. By 1990, copra oil surpassed copra in total export value (Tables A5.6.1, A5.6.3).

Copra production was also adversely affected by significant declines in export prices in 2000 and 2001. In 2002, copra production fell to its lowest level since 1947 and in 2003 copra production reached a historical low of less than 9000 tonnes. Deteriorating infrastructure and increasing transport costs, fewer purchasing depots, and a switch from exporting copra to processing it into oil within PNG have contributed to this decline.

Copra oil production fell in 2001, but recovered in 2003. In 2006, the value of copra oil exports (K60 million) was more than seven times that of copra exports (K8 million).

Copra meal, a low-value by-product of copra oil production, is exported for stockfeed. Copra meal exports averaged 14 000 tonnes/year during the 1990s, with an average value of K1.6 million/year.

Average smallholder yields are typically in the range 400–700 kg of copra/ha, with a mean of about 500 kg/ha (Table 5.6.1). Like other export tree crops, plantation copra yields are higher than those for smallholders, with a range of 700–1000 kg/ha in nationwide surveys and an overall average of about 900 kg/ha.²

¹ Kina prices of both copra and copra oil trebled between 1992 and 1998 due to a combination of the devaluation of the kina and increasing world market prices.
² An average full-sized coconut weighs about 1.44 kg. About 6000 full-sized nuts will make one tonne of copra; 1000 full-sized nuts will make 170 kg of copra, which will yield 70 litres of copra oil.

Copra production is labour intensive. It involves collecting fallen coconuts, de-husking and splitting them, and removing and drying the coconut meat. Nowhere in the world has coconut harvesting been mechanised. The Copra Marketing Board (CMB), which became the Kokonas Industri Koporesen (KIK) in 2002, has always regulated the marketing and export of copra in PNG. The CMB enjoyed a monopoly over all aspects of the copra industry. However, in recent years KIK has issued a limited number of private sector export licences, mostly for copra oil.

Until recently, KIK purchased copra from growers at fixed prices at depots and sub-depots.³ However, between 2001 and 2005 a significant reduction in the number and geographic extent of active purchasing depots occurred, from 22 depots in 11 provinces in 2001, to 15 depots in 10 provinces in 2002, and 10 depots in 9 provinces in 2005 (Table 5.6.2), a reflection of the shift in copra purchasing activity from CMB/KIK to the copra oil mills. Most copra in the Islands Region is now purchased by Coconut Products in Rabaul. This change has disadvantaged smallholder producers who do not have access to the mills and who were previously serviced by CMB/KIK depots, which have now ceased purchasing.

Two large copra oil mills currently operate in PNG: Copra Oil Production Madang Ltd in Madang and Coconut Products at Toboi near Rabaul.⁴ The Toboi mill is over 50 years old and has been extensively refurbished. The Madang mill was set up by KIK, but later sold to a private company.³ In addition to these two mills, a number of very small operations produce copra oil using direct micro-expelling

³ Three different prices were offered depending on quality. Hot Air grade received the best price, Fair Merchantable Standard received the middle price and Smoke grade copra the lowest price.
⁴ The Toboi mill has a capacity of around 70 000 tonnes of copra oil per year, while the Madang mill has a capacity of about 30 000 tonnes per year.
⁵ Coconut Oil Production Madang Ltd is currently owned by a New Zealand-based company, Sleepyhead Manufacturing Co Ltd, a mattress manufacturer that has diversified into food production.
5.6 Copra and copra oil

The Middleton family operation on Karkar Island, Madang Province, produces high-quality copra oil that is used locally to make a number of products including soap, cosmetics and shampoo.

In 2001, 55% of the copra produced in PNG was exported to Europe, particularly to the United Kingdom and the Netherlands; 40% was exported to Japan; and 5% to Singapore (Table A5.6.4). These countries were the major export destinations for PNG copra throughout the 1990s. In 2001 a major shift in the destination of PNG copra took place, with more going to Europe and less to Japan. In 2005, most copra was being exported to Germany (83%) and the remainder to Australia (8%), Singapore (7%), Solomon Islands and India (Figure 5.6.6). This shift in the destination of exports occurred at the same time as the rapid decline in copra export volumes, and fluctuations in the figures need to be viewed in that context. The main export destination for copra oil in 2005 was Australia, with Europe a minor destination (Figure 5.6.6). By 2008, most copra in PNG was being processed into copra oil and exported to Europe.

### Future prospects

For many households, copra provides the only source of cash income, but the PNG copra industry is in crisis, with production falling sharply in recent years. Internationally, the PNG copra industry is at best only marginally competitive. Copra oil prices declined for several decades until 2001 when the price for copra increased and reached US$1130 per tonne.

---

### Table 5.6.1

Average yield of smallholder and plantation copra (kg/ha)

<table>
<thead>
<tr>
<th>Survey year</th>
<th>Average yield (kg/ha)</th>
<th>Location</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smallholder</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1971–74</td>
<td>500</td>
<td>All PNG</td>
<td>Wheeler et al. (c. 1978:12)</td>
</tr>
<tr>
<td>1989</td>
<td>510</td>
<td>East New Britain Province</td>
<td>Yarbro and Noble (1989:22)</td>
</tr>
<tr>
<td>1989</td>
<td>570</td>
<td>East Sepik Province</td>
<td>Yarbro and Noble (1989:22)</td>
</tr>
<tr>
<td>1989</td>
<td>580</td>
<td>North coast Madang Province</td>
<td>Yarbro and Noble (1989:22)</td>
</tr>
<tr>
<td>1989</td>
<td>1210</td>
<td>Karkar Island, Madang Province</td>
<td>Yarbro and Noble (1989:22)</td>
</tr>
<tr>
<td>1989</td>
<td>700</td>
<td>Mean all respondents (4 areas)</td>
<td>Yarbro and Noble (1989:22)</td>
</tr>
<tr>
<td>Plantation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1951</td>
<td>710</td>
<td>All PNG</td>
<td>Bureau of Agricultural Economics (1953:38)</td>
</tr>
<tr>
<td>1971–72</td>
<td>950</td>
<td>All PNG</td>
<td>Wheeler et al. (c. 1978:12)</td>
</tr>
<tr>
<td>1972–73</td>
<td>910</td>
<td>All PNG</td>
<td>Wheeler et al. (c. 1978:12)</td>
</tr>
<tr>
<td>1973–74</td>
<td>800</td>
<td>All PNG</td>
<td>Wheeler et al. (c. 1978:12)</td>
</tr>
</tbody>
</table>

[a] Yield per bearing palm was 7.0, 6.2, 5.0 and 11.6 kg/palm in the four survey areas, with an overall mean of 7.7 kg/palm (Yarbro and Noble 1989:22).
in late 2007, the highest nominal price since 1984. Price increases have been brought about by structural changes in the world copra oil market. These have been driven by the diversion of other edible oils, particularly palm oil, away from their traditional uses into the rapidly expanding biofuel market. Nevertheless, the World Bank forecasts a significant fall in real copra oil prices through to 2015.

Table 5.6.2 Copra purchases by depot, 2005

<table>
<thead>
<tr>
<th>Depot</th>
<th>Province</th>
<th>Copra purchases (tonnes)</th>
<th>Purchasing agent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alotau</td>
<td>Milne Bay</td>
<td>1,296</td>
<td>Kumpa Resources Limited &amp; Allen Enterprises</td>
</tr>
<tr>
<td>Madang</td>
<td>Madang</td>
<td>20,138</td>
<td>Coconut Oil Production Madang Ltd and Bogia Cooperative</td>
</tr>
<tr>
<td>Lae</td>
<td>Morobe</td>
<td>752</td>
<td>Agmark Pacific Ltd</td>
</tr>
<tr>
<td>Kavieng</td>
<td>New Ireland</td>
<td>7,327</td>
<td>Coconut Products &amp; NACA</td>
</tr>
<tr>
<td>Toboi</td>
<td>East New Britain</td>
<td>46,276</td>
<td>Coconut Products</td>
</tr>
<tr>
<td>Wewak</td>
<td>East Sepik</td>
<td>664</td>
<td>Sepik Coffee Agmark JV Limited</td>
</tr>
<tr>
<td>Buka</td>
<td>Bougainville</td>
<td>10,161</td>
<td>Coconut Products</td>
</tr>
<tr>
<td>Kimbe</td>
<td>West New Britain</td>
<td>7,908</td>
<td>Kimbe Bay Shipping, Island Copra Traders Ltd</td>
</tr>
<tr>
<td>Namatanai</td>
<td>New Ireland</td>
<td>5,163</td>
<td>Coconut Products</td>
</tr>
<tr>
<td>Manus</td>
<td>Manus</td>
<td>170</td>
<td>Silan Limited</td>
</tr>
<tr>
<td>Total purchases</td>
<td></td>
<td>99,855</td>
<td></td>
</tr>
</tbody>
</table>

Source: Kokonas Indastri Koporesen.

Figure 5.6.6 Destination of copra and copra oil exports, 2005 (by volume). Source: Kokonas Indastri Koporesen.
When prices are poor, the comparatively low yields of PNG copra make it uncompetitive. The once vibrant trade in copra at the village level is now stifled by the closure of buying depots, a deterioration in roads and shipping services, increasing transport costs, and the absence of financial services to support copra purchases by private buyers.

The demand for copra is derived from the demand for copra oil and prices of the two products follow each other closely. Europe was the main buyer for copra. The European Union (EU) applied a zero tariff on oilseeds and meals (including copra), but a much higher tariff on vegetable oils (including copra oil). This resulted in a significant trade distortion that encouraged the importation of copra over copra oil and explains why the EU became the world’s largest importer of copra.

The World Trade Organization Uruguay Round led to a reduction of the tariff margin between copra crude oil and refined oil. Since then there has been a steady decrease in Europe’s copra crushing capacity and an increase in oil imports. The last Europe-based copra crushing operation (Walter Rau in Germany) closed in 2007 and there is no longer any market for copra in Europe. The copra market is now limited to buyers in Bangladesh, the Philippines and mills in other Pacific island countries (Fiji, Solomon Islands and Vanuatu). The increasing interest in copra from these countries is a reflection of supply problems facing their own industries rather than of growing international demand for copra. These markets, while not sustainable in the long term, provide PNG a few years breathing space to develop a copra industry that is based entirely on oil exports.

Beyond conventional copra and copra oil, some high-value coconut products offer better longer term prospects. These include virgin coconut oil, coconut cream, coconut timber and biofuel.
5.7 Oil palm

Palm oil has been PNG’s most valuable agricultural export since 2000, when it overtook coffee in this role (Figure 5.2.3). Palm oil exports averaged K420 million per year from 2004 to 2006, which was 30% of the value of agricultural exports for that period (Figure 5.2.2). Oil palm production has expanded at a much greater rate than other export tree crops (Table 5.2.2). However, a smaller proportion of the rural population is engaged in growing oil palm than for the other major export and domestically marketed crops. Approximately 130 000 settlers or villagers derived income from selling oil palm in 1995 (4% of the rural population) (Table 5.1.1, Figure 5.1.2). In 2007, the Oil Palm Research Association estimated that about 166 000 people (3% of the rural population) lived in households that produced oil palm. Many other people derive income directly or indirectly from the PNG oil palm industry, including those working on the nucleus estates.

Four economic products are derived from the fruit of the oil palm: crude palm oil, palm kernel oil, refined palm oil and palm kernel expellent. Of these, crude palm oil is the most significant in terms of export volume and value. Oil palm is grown exclusively in lowland locations, up to a maximum altitude of 200 m. It is cultivated in areas where mean annual rainfall ranges from 2000 mm to 4200 mm. The production of palm fruit is mildly seasonal in West New Britain Province, with about 60% of the crop harvested in January to June each year.

Adoption and history

Although oil palm has been grown in PNG since the 1920s, commercial development did not commence until 1967 with the establishment of a private sector/government joint venture at Hoskins in West New Britain Province (WNB). This is now the largest oil palm development in PNG. Other large projects are at Bialla (WNB), Popondetta (Oro Province), Gurney and Sagarai (Milne Bay Province), along the coast south-east of Kavieng (New Ireland Province) and in the Ramu and Markham valleys in Madang and Morobe provinces (Figure 5.7.1). All these developments are based on a nucleus estate and smallholder (NES) model, in which a commercially operated estate produces oil palm and also provides a market, processing and technical services for smallholder producers who cultivate oil palm on land adjacent to the nucleus estate.

Initially the smallholder component of the NES model was based on a land settlement scheme (LSS) system (see Section 6.7), which granted settlers 99-year leases over blocks of at least six hectares on land purchased from customary owners. However,

1 Crude palm oil is extracted from the fleshy part of the fruit; palm kernel oil is extracted from the kernel; refined palm oil is processed at Kumbango in West New Britain from crude palm oil; and palm kernel expellent is a residual product exported for stockfeed. Palm kernel is not exported, except for planting material.
no further land settlement schemes have been undertaken since the mid 1990s due to a shortage of land for further settlement and problems associated with the system. An important issue is the number of people living on blocks of a fixed area. Population density on blocks in the Hoskins LSS has risen from 6 persons/block in the early 1970s to 13 persons/block in 2000, and it is predicted that there will be 20 persons/block by 2011. This rising density is leading to a number of problems, including social instability, conflict over allocation of labour inputs and income, and disputes over inheritance of the blocks.

The existing LSS system has been supplemented by the village oil palm (VOP) system, which provides smallholders with blocks of two or four hectares on customary-owned land, with a Clan Land Usage Agreement giving the blockholder security of tenure and usage rights over the land. The three oldest NES developments, at Hoskins, Bialla and Popondetta, have nucleus estate, LSS and VOP components, while the newer NES developments in New Ireland and Milne Bay provinces have only nucleus estate and VOP components (Table 5.7.1).

With no further land available for land settlement schemes since the mid 1990s, many migrants have entered into informal arrangements to access customary land in the oil palm-growing areas of West New Britain Province. These arrangements are known as customary purchase blocks. Such plantings were providing a growing proportion of fruit from smallholders for the mills in the Hoskins area by 2007.

The latest trend in oil palm development on customary-owned land is for landowning groups to form companies that lease customary land to oil palm plantation companies in exchange for rent and royalties. This system is known as the mini estate system. It is used by New Britain Palm Oil Limited, Higaturu Oil Palms, Milne Bay Estates Limited and Poliamba Limited in West New Britain, Oro, Milne Bay and New Ireland provinces respectively. Most new plantation development since the late 1990s has
Oil palm production (Figure 5.7.2). Popondetta and Bialla are the next most significant project areas in terms of production, followed by Milne Bay and New Ireland. Although the Hoskins project area accounts for the greatest volume of smallholder production, the Bialla and Popondetta project areas have the largest smallholder components as a proportion of total NES production (Table 5.7.1).

In 2007, 70,000 ha (55% of the total area) was planted to oil palm on plantations (including mini estates) and 58,000 ha planted on smallholdings (distributed between 5100 LSS blocks and 12,400 VOP blocks). In 2007, the Hoskins project area accounted for half of the total area planted to oil palm on plantations (Figure 5.7.3). Hoskins also had the largest area of smallholdings, although Popondetta and Bialla also had significant areas of smallholder oil palm plantings.

been on customary land, with extensive plantings in West New Britain Province in particular using this form of land tenure.²

Distribution of production and planting

Both smallholder and plantation production are dominated by the Hoskins project area, which, in 2007, contributed more than half of total national production (Figure 5.7.2). Popondetta and Bialla are the next most significant project areas in terms of production, followed by Milne Bay and New Ireland. Although the Hoskins project area accounts for the greatest volume of smallholder production, the Bialla and Popondetta project areas have the largest smallholder components as a proportion of total NES production (Table 5.7.1).

Table 5.7.1 Summary statistics for oil palm project areas, 2007

<table>
<thead>
<tr>
<th>Company</th>
<th>Hoskins</th>
<th>Bialla</th>
<th>Popondetta</th>
<th>Milne Bay (Alotau)</th>
<th>New Ireland (Lakuramau)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area planted (ha)(a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plantation</td>
<td>34,774</td>
<td>8,909</td>
<td>9,009</td>
<td>11,634</td>
<td>5,689</td>
<td>70,015</td>
</tr>
<tr>
<td>Smallholder(b)</td>
<td>25,324</td>
<td>14,580</td>
<td>14,285</td>
<td>1,757</td>
<td>2,114</td>
<td>58,060</td>
</tr>
<tr>
<td>Total area</td>
<td>60,098</td>
<td>23,489</td>
<td>23,294</td>
<td>13,391</td>
<td>7,803</td>
<td>128,076</td>
</tr>
<tr>
<td>Number of blocks(c)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSS(d)</td>
<td>2,350</td>
<td>1,851</td>
<td>929</td>
<td>nil</td>
<td>nil</td>
<td>5,130</td>
</tr>
<tr>
<td>VOP(d)</td>
<td>4,471</td>
<td>1,593</td>
<td>5,191</td>
<td>536</td>
<td>648</td>
<td>12,439</td>
</tr>
<tr>
<td>Production fresh fruit bunch (tonnes)(a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plantation</td>
<td>744,271</td>
<td>180,122</td>
<td>170,206</td>
<td>239,516</td>
<td>117,896</td>
<td>1,452,011</td>
</tr>
<tr>
<td>Smallholder</td>
<td>368,729</td>
<td>159,020</td>
<td>162,846</td>
<td>10,376</td>
<td>18,448</td>
<td>719,419</td>
</tr>
<tr>
<td>Total production</td>
<td>1,112,999</td>
<td>339,142</td>
<td>333,052</td>
<td>249,892</td>
<td>136,344</td>
<td>2,171,430</td>
</tr>
</tbody>
</table>

² Customary landowners at Bialla have not entered into mini estate agreements with Hargy Oil Palms Limited. Instead, four Landowner Development Corporations have pooled their resources and are managing their own oil palm plantations with technical support from the company. This arrangement is known as the Community Oil Palm Development (COPD) system.
Levels of production

Exports of crude palm oil have increased exponentially since the early 1970s (Figure 5.7.4, Table A5.7.1) because of an expansion in both smallholder and plantation production (Figure 5.7.5). During the 1980s, smallholder and plantation production of oil palm fruit were approximately equal. However, the establishment of the NES project areas in Milne Bay and New Ireland provinces, which have relatively insignificant smallholder components (4% and 14% of production in 2007 respectively), has caused plantation production to increase at a greater rate than smallholder production since the early 1990s. Plantations continue to dominate production: in 2007 they accounted for two-thirds of total national production.

The volume of fresh fruit harvested has continued to set new records in most years, exceeding two million tonnes for the first time in 2006 (Table A5.7.2). More than 360 000 tonnes of palm oil with an export value of K430 million was extracted from this fruit (Figure 5.7.4, Table A5.7.1). The provisional value in 2007 (K670 million) is much greater, the outcome of particularly high world prices and increased production.

Box 5.7 The Mama Lus Frut Scheme

In 1997, the Oil Palm Industry Corporation, in conjunction with the Hoskins project area and local women’s groups, initiated a program for the collection and sale of palm fruit that separates from the bunches during harvesting and transport. Loose fruit is usually very ripe and therefore has considerably higher oil content (about 40%) than the rest of the fresh fruit bunch (about 22%).

Under this scheme, women are issued with their own account by the milling company and the income from the loose fruit that they collect on family blocks is paid directly to their own bank accounts (as distinct from their husband’s – or the blockowner’s – account).

Between 1997 and 2003, about 4000 women in the Hoskins area, drawn from 88% of all smallholder blocks in that project area, were issued with a harvest card. The loose fruit that drops off the bunch at harvest represents 14% of the total crop, but a greater proportion (about 26%) of smallholder oil palm income is paid directly to women. The additional income consists of loose fruit harvested by the women or by their husbands. In 2003, women collected more than 55 000 tonnes of oil palm and earned an average weekly income of K49. The scheme has increased net household income by a modest 5%. The scheme has also been adopted in the Bialla and Popondetta project areas.

Benefits associated with the scheme include:

- It provides an important source of income for women in an industry that, like other export cash crop industries in PNG, has been traditionally dominated by men.
- The more equitable distribution of income to household members results in fewer conflicts between husbands and wives over money.
- A greater proportion of income from oil palm is spent on family needs.
- There is greater involvement by women in management of the family block.
- There is a more complete harvest resulting in higher overall income for smallholders.
- Provision of a mechanism by which men can contribute to household expense by weighing fresh fruit bunch (which they have harvested) on their wife’s card, so that the income goes into the wife’s bank account.
- A higher utilisation of fixed milling assets.

---

1 See Koczberski (2007) for more information on the Mama Lus Frut Scheme.
Yield of fresh fruit bunch per hectare varies between locations and over time. However, accurate comparisons are not possible because data on area planted include both mature and immature palms. Thus yields calculated from the total production and total area planted underestimate yield from mature palms. Nevertheless, available data indicate that smallholder yields are considerably lower than those for plantations (Table 5.7.2). An average yield for mature plantation palms is about 30 t/ha; for settler blockholders it is about 18–20 t/ha; while village oil palm is less again at about 10 t/ha. There are considerable yield data from experimental plantings at Dami in West New Britain Province. Experimental yields are typically 30–32 t/ha and up to 40 t/ha.

### Processing, exporters and markets

Each of the NES project areas has at least one palm oil mill, which process fresh fruit bunch (FFB) produced on both plantations and smallholdings. The FFB is processed to produce crude palm oil and palm kernel. Three of the five project areas also have facilities to further process palm kernel into palm kernel oil and palm kernel expellent.

New Britain Palm Oil Limited (NBPOL), which operates the Hoskins NES, is one of only a handful of oil palm producers in the world that operates commercially viable breeding and germplasm export programs. In 2007, about 4 million seeds were sold by NBPOL. These are supplied to all the plantation operations in PNG and exported to a number of countries, particularly Indonesia, but also to Malaysia, Sri Lanka, Thailand, the Philippines, Honduras, Cameroon, Solomon Islands and Vanuatu. Export of seed generates significant income for the company. Demand from Indonesia is especially large and NBPOL anticipates exporting about 20 million seeds in 2008.

The NES companies maintain a monopoly on purchasing FFB from smallholder producers. Prices are calculated according to a formula devised by the PNG Palm Oil Producers’ Association. The formula is based on export prices, and the transport costs and oil palm extraction rates of each NES project area.

<table>
<thead>
<tr>
<th>Project area</th>
<th>Plantation</th>
<th>Smallholder</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoskins</td>
<td>21.4</td>
<td>14.6</td>
<td>18.5</td>
</tr>
<tr>
<td>Bialla</td>
<td>20.2</td>
<td>10.9</td>
<td>14.4</td>
</tr>
<tr>
<td>Popondetta</td>
<td>18.9</td>
<td>11.4</td>
<td>14.3</td>
</tr>
<tr>
<td>Milne Bay</td>
<td>20.6</td>
<td>5.9</td>
<td>18.7</td>
</tr>
<tr>
<td>New Ireland</td>
<td>20.7</td>
<td>8.7</td>
<td>17.5</td>
</tr>
<tr>
<td>Total</td>
<td>20.7</td>
<td>12.4</td>
<td>17.0</td>
</tr>
</tbody>
</table>

Yields were derived by dividing production by the area under oil palm in 2007 (Table 5.7.1). The area includes mature and immature palms. The proportion of immature palms is unknown, but it varies between locations and over time. Thus these yield estimates are crude and underestimate yield for mature palms, which is the most reliable statistic to compare yields between sectors or locations and over time.

Source: Ian Orrell, Oil Palm Research Association.

---

3 Palms commence bearing within two years of planting and reach maximum yield by about the sixth year. They continue to bear for many decades, but are usually killed by poisoning after 20–25 years when they become too tall to harvest.

4 New Britain Palm Oil Limited opened a palm oil refinery near Kimbe in January 2003. The refinery (which also includes a refraction plant) is able to process 300 tonnes of crude palm oil per day. Crude palm oil is processed into refined palm oil, palm olein, palm stearin and fatty acid distillate. Most of these products are produced for the export market, but small quantities are sold domestically.

5 For example, the price paid to smallholder growers in West New Britain in February 2008 (K362/tonne for FFB) was derived from the following formula: price of crude palm oil delivered to Rotterdam, Holland US$1100/tonne; palm kernel oil delivered to Rotterdam US$1360/tonne; and palm kernel extract delivered to Australia US$57/tonne. Based on average extraction rates from one tonne of FFB of 22.3% for crude palm oil; 2.3% for palm kernel oil; and 3.0% for palm kernel expellent, and after subtracting the cost of transporting the oil from New Britain to Europe, each tonne of FFB was worth US$250/tonne (K704/tonne). Smallholders were paid 57% of the value of one tonne of FFB (K704 × 0.57 = K401). After subtracting the cost of transporting FFB (K34/tonne), and three levies for research and outreach (K5/tonne), the price paid to growers was K362/tonne (K401 – K39 = K362).
among project areas. A large number of smallholder producers have received credit from the Rural Development Bank or from the NES companies, and repayments are deducted from the payments that smallholders receive for fruit.

The European Union is the sole export market for PNG’s palm oil, with the United Kingdom the biggest buyer.

**Future prospects**

The area planted to oil palm continues to increase as existing projects expand and new projects commence. New Britain Palm Oil Limited is undergoing an accelerated planting program, with 3000–5000 ha of new plantings planned each year for several years.\(^6\) This company has announced plans to increase its plantings in PNG to about 65 000 ha. The new plantings are on the north coast of West New Britain Province on the Talasea Peninsula and west of there between the Kulu and Via rivers. Land is accessed through agreements with local landowning groups, and palms are planted on both plantations and in village-operated blocks. Hargy Oil Palms Limited is also increasing plantings in the Bialla area of West New Britain. As well as these formal arrangements for new plantations and village oil palm, it is

---

\(^6\) NBPOL had been planting at about 2000 ha/year prior to 2007.

likely that the area planted under informal tenure arrangements by migrants in West New Britain, and possibly elsewhere, will continue to expand rapidly while the price remains high.

A number of other projects have commenced in PNG in recent years. Ramu Agri-Industries Ltd began planting oil palm in the Ramu Valley in 2003, and had planted 6500 hectares by early 2008. A mill with a capacity of 25 000 tonnes of crude palm oil per year commenced processing fruit in early 2008. An associated village oil palm scheme in the Markham Valley in Morobe Province commenced in 2006, with initial plantings of 100 ha, with 2 ha per household. The village component in Phase 1 of the project consists of 750 ha and can be expanded to 1500 ha.

Plantings commenced by 2007 in several other smaller projects in the Bereina area of Central Province (Mekeo Hinterland Oil Palm) and in the Aitape and Bewani areas of Sandaun Province. Feasibility studies for further projects have been conducted in other locations, including on the Sepik Plains north of the Sepik River in East Sepik Province, near Madang town, and on north-west Bougainville Island.

Oil palm is PNG’s most efficient agricultural industry, with yields among the highest in the world. The global price rose rapidly from a low point in 2001, to about US$430/tonne in 2004, and had climbed to US$1100 by early 2008. Recent increases have been in response to strong demand by developing countries, particularly China, India and Pakistan; a slowdown in global production growth in 2007; and increased use of competing vegetable oils for biofuels. The World Bank predicts that the price will peak at about US$900/tonne in 2008 and will then decline until 2015 (Figure 5.2.6). These prices will be more than sufficient to provide good returns to the efficient PNG oil palm industry.

Given current and future plans for expansion, PNG production is likely to continue to increase in the medium term. The high prices being realised in 2007 and 2008, and possibly beyond, mean that palm oil will continue to generate more export income for PNG than any other export crop. However, the limited availability of suitable environments for oil palm is likely to restrict further expansion after around 2030.

Sources


7 Biofuels are substitutes for liquid fuels derived from petroleum, and are made from crops such as oil palm, soya bean, canola, coconut, sugar cane or corn (maize).


5.8 Forest products

Forest products make a significant contribution to export income earned by the renewable resource sector in PNG. They generated an average of K417 million per year in export income between 2004 and 2006, which was 5% of all export income in this period (Figure 5.2.1). The most important forest product exports are logs, which were worth US$187 million (K570 million) in 2007. This is a decline in value of 50% from the logging boom in the mid 1990s when log exports averaged US$385 million between 1993 and 1996. An estimated 10,000 people were directly employed in logging in 2007, a small number compared with the 600,000 smallholders who sell fresh food domestically, for example.

PNG has around 317,500 km² of tropical forest covering almost 70% of the national land area. PNG’s forests are extremely diverse, ranging from mangroves, swamp forests and eucalypt savanna, to lowland rainforests and montane forests. The most common forest types occur on lowland hills, in lower montane areas and on lowland plains. These three types of forest account for 90% of all forests in PNG and are considered to be the main merchantable forests. Economically valuable trees in PNG number around 400 species, but loggers have tended to focus on only 30–50 species. A characteristic of PNG forests is very high species diversity.

Nearly all forests in PNG are growing on customary-owned land. For this timber to be harvested, the state must first acquire timber rights from the landowners before allocating the rights to logging companies. Prior to 1992, this was done either through the negotiation of a Timber Rights Purchase or a Local Forest Agreement. Since 1992, when a new Forestry Act came into force, state acquisition of timber rights has been through the negotiation of Forest Management Agreements between the PNG Forest Authority and customary owners.

History

The Australian administrations of Papua and New Guinea first attempted to survey the timber potential of parts of Papua in 1908 and parts of New Guinea in 1921. In 1923 and 1924 Charles Lane-Poole completed a survey of Papua and New Guinea and recommended the establishment of a forest service. By the time a forest service had been established in 1938, a number of Europeans had commenced sawmilling operations to service the domestic market, and copra plantation owners in the Islands Region were exporting logs and processed timber to the American veneer market. After World War II a significant expansion of sawmilling operations took place to meet the domestic demand for reconstruction materials. The colonial territories had achieved self-sufficiency in sawn timber production by the time a plywood mill was established at Bulolo in Morobe Province in 1953. The mill resulted in an increase in the export of both processed and unprocessed timber, and timber rapidly became the second most important
export commodity after copra. By 1957, forest plantations had been established in the Bulolo Valley and near Port Moresby and Rabaul.\textsuperscript{1}

However, the pace of development of the forestry export industry was thought to be unsatisfactory and, encouraged by the World Bank, a shift occurred in policy emphasis towards the clear-felling of natural forest for pulpwood or woodchip production. This strategy culminated in a woodchipping project in Madang conducted by Jant Pty Ltd (New Guinea) and using logs from the nearby Gogol Valley.\textsuperscript{2}

After Independence in 1975 the number of logging concessions increased gradually and by 1985 logging operations existed in most lowland provinces. The greatest number of logging concessions were in the Islands Region, particularly Manus, West New Britain and New Ireland provinces. These areas were favoured because they possessed the highest stocking density of commercial timber species and because their coastal locations allowed easy access for shipping raw logs.

In the mid 1990s CSIRO and the PNG Forest Authority created the Forest Inventory Mapping System, a geographical information system containing data about forestry and land use in PNG. The research showed that 35% of the forests of Manus, West New Britain and New Ireland provinces had been logged between 1975 and mid 1996. In comparison, only 10% of the forest area of the mainland lowland provinces was logged over the same period, while in the Highlands Region logging activity was negligible.\textsuperscript{3}

In the early 1990s, when most concessions in the Islands Region had been allocated, the logging industry shifted its attention to the mainland lowland provinces, particularly Western and Gulf.

### Forest areas

Information in the Forest Inventory Mapping System (FIMS) suggests the following:

- In 1975, the 'Gross Forest Area' was 330 650 km\textsuperscript{2}.
- Between 1975 and mid 1996, 19 850 km\textsuperscript{2} of forest had been logged and was regenerating.
- Between 1975 and mid 1996, 13 150 km\textsuperscript{2} of forest was permanently converted to other land uses. Of this area, 3550 km\textsuperscript{2} was logged and then converted; and 9600 km\textsuperscript{2} was cleared, but not logged commercially, and subsequently converted.
- Almost all (97%) logging and clearing activities involved the three main types of merchantable forest. These are classified in FIMS as: forest on lowland hills (less than 1000 m altitude), forest on lowland plains (less than 1000 m altitude) and lower montane forest (1000–3000 m altitude).

Over the period 1975 to mid 1996 the 'Gross Forest Area' of PNG was permanently reduced from 330 650 km\textsuperscript{2} to 317 500 km\textsuperscript{2}, or by about 4%, through both logging and land clearance. Of the 317 500 km\textsuperscript{2} remaining in mid 1996, around 70% was forest on lowland hills, 20% was forest on lowland plains and 10% was lower montane forest.

---

\textsuperscript{1} The Bulolo operation was purchased by PNG Forest Products Pty Ltd in the late 1970s. This company, which is partly owned by the PNG Government, continues to process mostly plantation timber, particularly klinki pine (\textit{Araucaria hunsteinii}) and hoop pine (\textit{A. cunninghamii}), into veneer and then plywood.

\textsuperscript{2} The Gogol project was originally intended to operate on a cyclical pattern of clearing and replanting. However, about 50% of the landowners refused to allow replanting, which meant that the project had to be expanded beyond its initial boundaries.

\textsuperscript{3} Logging activity in the Highlands Region focused on sawmilling for the local timber market. Significant plantations were established in the 1960s and 1970s in Eastern Highlands Province and in the Wahgi swamp/Kudjip area of Western Highlands Province.

\textsuperscript{4} Not all of the forests included in the Gross Forest Area are suitable for commercial logging activities. Analysis of forest areas, using FIMS, found that of the 1996 Gross Forest Area, 20% was subject to 'extreme physical limitations' and was not suitable for logging by conventional means. A further 40% was subject to 'serious physical limitations' that could constrain commercial logging potential. (An additional category has been considered: 'fragile forests', consisting of forest types and conditions where regeneration is much slower than the normal cycle, or where the forest may not recover at all from commercial forestry.)
Processed timber and plantations

Logs comprise more than 90% by volume of timber product exports from PNG. However, processed timber has increased in importance over the past decade, rising from 8% of exports (by value) in 2001 to 21% in 2005. Processed timber products include veneer, woodchip, plywood, balsa wood and timber from a number of native or introduced species, with kwila the most important of the hardwoods (Table 5.8.1). Veneer is manufactured from forest timber at Panakawa near Balimo in Western Province. Woodchip is processed at a plant in Madang from planted and native forest in the Gogol Valley southwest of Madang, with planted Acacia mangium now the main species harvested. Plywood is made in Bulolo from hoop and klinki pine. Balsa wood is processed at four mills from village and plantations plots on the Gazelle Peninsula in East New Britain Province (see Section 5.13).

In 2004, about 52,000 ha of land was under plantation forestry, around 60% of which was managed by the private sector and the rest by the PNG Government. The expected total volume of round wood to be harvested from the current standing trees in the plantations at maturity is 10 million m³ of hardwood and 4 million m³ of softwood. As well, there is an estimated one million m³ of rubber wood (Hevea brasiliensis) that could be harvested in the future.

The volume of plantation timber (mostly as round logs) exported in 2004 was 247,214 m³, worth US$15.5 million (K46 million). The largest plantation areas are at Open Bay in East New Britain Province, Stettin Bay in West New Britain Province, the Wau–Bulolo area in Morobe Province and the Gogol Valley in Madang Province. These four areas account for about 70% of plantation forestry in PNG, with the remaining distributed among 13 locations in 10 provinces.

Logs

The distribution of approved logging concession areas as at mid 1996, with the exception of Bougainville Province, was mapped using FIMS (Figure 5.8.1). The largest concession areas were in Gulf and Western provinces, followed by West New Britain, Sandaun, East Sepik, East New Britain and Central provinces. Gulf Province had the highest proportion of its forest resources in logging concessions (70%). In the Islands Region the proportion was around 30%, except for West New Britain, which had 60% of its remaining forest resources in concession.

Table 5.8.1 Volume and value of processed timber exports, 2004(a)

<table>
<thead>
<tr>
<th>Product</th>
<th>Volume (m³)</th>
<th>Value (kina millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veneer</td>
<td>59,249</td>
<td>35.3</td>
</tr>
<tr>
<td>Woodchips</td>
<td>51,756</td>
<td>8.0</td>
</tr>
<tr>
<td>Mixed sawn</td>
<td>26,586</td>
<td>18.2</td>
</tr>
<tr>
<td>Kwila</td>
<td>10,562</td>
<td>13.9</td>
</tr>
<tr>
<td>Plywood</td>
<td>3,899</td>
<td>4.5</td>
</tr>
<tr>
<td>Balsa wood</td>
<td>3,623</td>
<td>3.0</td>
</tr>
<tr>
<td>Teak</td>
<td>1,518</td>
<td>1.9</td>
</tr>
<tr>
<td>Other processed products(b)</td>
<td>1,412</td>
<td>0.3</td>
</tr>
<tr>
<td>Pencil cedar</td>
<td>1,314</td>
<td>0.5</td>
</tr>
<tr>
<td>Ton (taun)</td>
<td>1,218</td>
<td>0.3</td>
</tr>
<tr>
<td>Terminalia</td>
<td>1,100</td>
<td>0.2</td>
</tr>
<tr>
<td>Malas</td>
<td>1,048</td>
<td>0.2</td>
</tr>
<tr>
<td>Red canarium</td>
<td>700</td>
<td>0.1</td>
</tr>
<tr>
<td>Rosewood</td>
<td>472</td>
<td>0.7</td>
</tr>
<tr>
<td>Pinus</td>
<td>462</td>
<td>0.3</td>
</tr>
<tr>
<td>Furniture components (kwila)</td>
<td>238</td>
<td>0.3</td>
</tr>
<tr>
<td>Mersawa</td>
<td>216</td>
<td>0.1</td>
</tr>
<tr>
<td>Plantation</td>
<td>98</td>
<td>0.1</td>
</tr>
<tr>
<td>Total processed timber</td>
<td>165,471</td>
<td>87.9</td>
</tr>
</tbody>
</table>

(a) Data are for the first eight months of the year only. The total volume for the full year was 220,000 m³, valued at K104 million. The volume in 2005 was 250,000 m³, valued at K106 million, which was 21% of the value of all timber exports in that year.

(b) Other processed timbers are burckella, calophyllum, dillenia, red cedar, red planchonella and white planchonella.

Sources: PNG Forest Industries Association; Bird et al. (2007c: Table 7).
In 2007, West New Britain, Sandaun and Gulf provinces made the largest contributions to national log export volume, accounting for 32%, 15% and 14% of exports respectively (Figure 5.8.2, Tables A5.8.1, A5.8.2). Other provinces that made significant contributions to the total volume of logs exported in 2007 were East New Britain (11%) and Western (8%). Between them, these five provinces accounted for 80% of all log exports in 2007.

There has been a change in the provincial contributions to log exports since the mid 1990s, when the island of New Britain contributed more than half of log exports. Logs from New Britain peaked at 60% of total exports in 1994 (50% WNB, 10% ENB). This declined to about 30% by 2001, but the contribution increased again to 43% by 2007. In 1996, West New Britain Province accounted for 40% of all logs exported from PNG, while East New Britain contributed 16%, Sandaun Province 12%, Western Province 9% and Gulf Province 6% (Figure 5.8.2). The shift in logging activity from New Britain to Western and Gulf provinces follows logically from the distribution of approved logging concessions and from the fact that New Britain was one of the most heavily logged regions until the mid 1990s.

### Levels of export

Log exports increased gradually during the 1960s from 136 000 m³ in 1961 and then remained in the range 360 000–690 000 m³ a year during the 1970s (Figure 5.8.3, Table A5.8.3). In the early 1980s log export volumes increased significantly, reflecting the expansion in logging concessions that occurred during this period. Between 1979 and

---

5 There is some concern about the accuracy of log export data during the 1970s and 1980s because of evidence presented by the Barnett Inquiry that illegal and unreported (or misreported) exporting was occurring during this period. The log export data reported since the early 1990s is thought to be more accurate due to improvements in the regulation of the industry and the outsourcing (since 1994) of export monitoring to a private contractor (SGS PNG Ltd).
Figure 5.8.2 Log exports by province, 1996 and 2007 (by volume). Source: SGS PNG Ltd.


* ‘Others’ in 1996 were Milne Bay, Morobe, New Ireland, Oro (all about 2% each), Manus and East Sepik provinces.
* ‘Others’ in 2007 were Manus and Madang provinces (Table A5.8.1).
There has been much speculation and debate about the extent to which the log export industry in PNG is controlled by a small number of Malaysian companies. In 1998, it was estimated that around 50% of log exports were under the control of a single Malaysian company, Rimbunan Hijau (operating through a large number of subsidiaries), while other Malaysian companies (some with apparent commercial or other links with Rimbunan Hijau) controlled a further 30–35% of the industry.

All of PNG's log exports are to Asian countries. Until the late 1990s, the principal destination for PNG logs was Japan. For example, in 1996 Japan was the destination for 64% of log exports, while South Korea and China made up 18% and 2% respectively. Since 2000, there has been a long-term decline in the Japanese and South Korean markets, and a corresponding expansion into the Chinese market. In 2007, the main destination was China, which was 83% of the export market (Figure 5.8.4, Tables A5.8.4, A5.8.5). Smaller volumes went to Japan (5%), Vietnam (5%), India (3%) and South Korea (2%). A range of factors has caused these changes in export destinations, including the Asian financial crisis in 1997 and material substitutions in the Japanese building industry.

### Future prospects

Despite a long and controversial history (see Box 5.8), the PNG forest industry continues to make an important contribution to the national economy. Locally it is a useful source of employment, although nowhere as many rural people earn money from forestry as from agriculture. Although the volume of log exports has returned to levels experienced in the boom period of the mid 1990s, the value is much less because of lower world prices. A number of commentators have expressed concern about the ability of PNG forests to sustain the current rate of logging. Some have suggested that PNG may be following the same path as some other countries in the Asia–Pacific region that have harvested all their easily accessible forest resource. Some of these countries, including Thailand and the Philippines, are now net importers of tropical timber.
Box 5.8 A troubled history

From time to time over the past 20 years the logging industry in PNG has been the subject of intense public debate and controversy. In the late 1980s, repeated allegations of impropriety on the part of both private and public sector interests led the then Prime Minister (Paia Wingti) to commission an official inquiry into ‘aspects of corruption in the forest industry’. The Commission of Inquiry, which was headed by an Australian member of the PNG judiciary, Justice Tos Barnett, lasted for two years and generated 20 volumes of reports. The reports described a ‘forest industry out of control’, dominated by foreign investors who had formed ‘partnerships’ with PNG’s political leaders through dubious means, including bribery. The Commission further argued that the failure of the State to adequately and effectively control the forest industry meant that these foreign companies were maximising log exports at the expense of the environment, the sustainability of the forest resources and the domestic processing industry.

Following the Inquiry, a new national forest policy was approved in 1990. This focused on sustainable harvesting and greater decision-making by resource owners. A new Forestry Act was passed in June 1991, but was not gazetted until 12 months later. The legislation established a system of provincial committees and a National Forest Authority under the direction of a board representing a range of stakeholders in the forestry sector, with the aim of reducing the arbitrary power of the Minister for Forests. To support the new policy and legislation, and based partly on the World Bank-led Tropical Forests Action Plan forest sector review, a National Forest and Conservation Action Plan was effected to strengthen capacity in the sector. Extensive concessions were approved during the period leading up to the gazettal of the new Act. Thereafter there was a lull in the issuing of new projects, although a few controversial and major new projects and project extensions were still approved (including Turama Extensions and Vailala Blocks 2 and 3 in Gulf Province, and the Kiunga–Aiambak ‘roading’ Timber Authority in Western Province).

For a detailed discussion of the Barnett Inquiry, and the history of forest policy in PNG up until the late 1990s, see Filer and Sekhran (1998).

Ongoing concerns remain about the destruction of high-biodiversity forest; loss of income to the PNG Government because of alleged transfer pricing mechanisms by log export companies; and the social disruption caused by payment of relatively large sums of money to small groups of people.

The World Bank forecasts an increase in the real price for logs and sawnwood to the year 2015 (Figure 5.2.6). The forecast for rising prices for logs and sawnwood contrasts with the bank’s prediction for falling real prices for tropical tree crops. There is strong market demand for high-value tropical hardwoods and this is likely to continue, particularly as China and India have a large and growing demand for timber. The combination of strong demand and reduced supply, because of the depletion of native forests in Indonesia, Brazil and central Africa, is causing prices to rise. This in turn is causing an increased interest in hardwood plantations.

In the future, the PNG forest industry is likely to rely more on woodlots planted and managed by villagers or plantations rather than the exploitation of native forests. Possible hardwood species include teak, kwila, New Guinea walnut (*mon*), *Calophyllum* spp., rosewood, *kamarere* and *ton* (*taun*). As well, there is likely to be larger plantings of fast-growing species such as *Acacia mangium*, *A. crassicarpa* and *Eucalyptus pellita* for chipping, sawn timber or fuelwood. Other multipurpose species with potential to provide timber include rubber, aged coconut palms and *galip* nut.
A key factor determining which species will be adopted as cash crops by villagers will be whether people are prepared to wait for long periods to harvest and receive income from the sale of timber. Certification schemes guaranteeing that timber comes from a well-managed forest will increase opportunities for access to overseas markets.

Sources


Shearman, P. and Cannon, J. (2002). PNG forest resources and the log export industry: a quantitative analysis of forest resources, the impact of commercial logging and the future for the log export industry. The Papua New Guinea Eco-Forestry Forum, Boroko.
5.9 Marine resources

The PNG fisheries zone of 2.4 million square kilometres is the largest in the South Pacific. The coastline and offshore islands of PNG comprise a great diversity of marine environments. The Gulf of Papua contains large delta areas, mud flats and mangrove swamps, while the north coast of the mainland and the coasts of the high islands are characterised by fringing coral reefs and narrow lagoons. Some of the smaller island groups are adjacent to large submerged reef systems or broad shallows. Extensive inland river systems are present in some provinces, such as East Sepik and Western.

PNG’s fisheries reflect the diversity of its marine environments. Along the coasts of the mainland and islands, fishing activities include gleaning on reef flats; spear fishing; shallow water hand-lining from dugout canoes, outrigger canoes and outboard-powered fibreglass dinghies; netting; and trapping in the freshwater reaches of the larger rivers. In the swampy coastal areas, fishing activities centre around netting barramundi, catfish and shark, while in the southern part of Western Province a village-based lobster fishery supplies a commercial facility at Daru. Invertebrates are collected throughout the coastal and island areas for commercial purposes, the most important being bêche-de-mer (sea cucumber) and trochus shell. Giant clams are widely harvested for subsistence. Pearl farming is conducted around two islands in Milne Bay Province, with juvenile oysters derived from a hatchery on Samarai Island. Commercial prawn trawling is carried out in the Gulf of Papua.

A domestically based foreign-owned purse seine fishery is rapidly expanding within PNG’s Exclusive Economic Zone (see Section 2.10). Aquaculture is practised in many inland locations including parts of the highlands.

Subsistence fisheries

Little reliable information exists on the subsistence fisheries sector, but it is thought to be the most valuable component of PNG’s fishing industry in terms of both volume and value. It is estimated that more than 500 000 people participate in both coastal and inland subsistence fisheries, harvesting 25 000–50 000 tonnes of marine produce per year. The best estimate of fish production at the household level comes from the 1996 PNG Household Survey. This survey recorded production of fresh fish, dried fish and shellfish as 50 000 tonnes/year, with an estimated value of K60 million (K142 million in 2007 currency equivalent). Around 60% of the subsistence catch comprises an estimated 20% invertebrates; 30% coastal bay, lagoon and reef fish; and 10% pelagic fish (fish that live in the open sea).
the past decade, the prices of domestically marketed foods have increased (Figure 4.3.1) and the volume of imported fish has decreased (Figure 2.10.1). Hence the value of fish and shellfish sold in 2007 will have increased from the early to mid 1990s, but no recent estimates are available.

Numerous types of marine and some freshwater fish are sold, most of which are native species. Some introduced species are important in a number of locations, particularly tilapia (\textit{Tilapia mossambica} and \textit{T. rendalli}) in the Sepik River area and in parts of Madang and Morobe provinces. Some trout are caught for sale from high-altitude streams (over 2000 m).

Family-based fish farms increased from 5400 in 2001 to an estimated 8000 farms by 2006. As well, an estimated 10 000–15 000 potential fish farmers have constructed earthen ponds, which are not stocked. Most (83%) of the fish farms are in Simbu, Eastern Highlands and Western Highlands provinces, with a further 13% in Morobe, Southern Highlands and Enga provinces. The remainder are scattered in

\textbf{Local area marine food sales}

Many people earn some income from selling fresh fish, dried fish and other marine foods including shellfish, lobster, octopus, crab, turtle, prawns and dugong (Figure 5.9.1). Fish is sold in fresh food markets; from informal roadside stalls; and directly to individuals, hotels and other institutions with large boarding populations. Long-distance trade in fresh fish to the larger urban areas is limited, and is constrained by inadequate transport and cold storage facilities, particularly access to ice. Fish and other marine food is sold, and sometimes bartered, in a number of locations, especially from small islands, so that people can buy carbohydrate foods such as sago, sweet potato, imported rice, flour and banana (see Box 5.3).

In the period 1990–1995, sales of fish and shellfish generated an estimated income of K3.8 million for more than 400 000 rural villagers (Table 5.1.1). Over
There has been a sharp increase in the overall volume and value of marine exports since the late 1990s (Figure 5.9.2, Table A5.9.1). The major commercial fisheries in PNG are, in order of value, tuna, bêche-de-mer, shell products such as trochus and mother of pearl, shrimp, shark, lobster, and fish and crab (Figure 5.9.3). Prior to the late 1990s, shrimp was the most consistently valuable commercial fishery. However, over the past decade, the tuna fishery has dominated the industry. In 1996 tuna accounted for about 14% of the total value of marine exports but, by 2006, tuna products had increased to around 75% of the total value of marine exports.

Tuna caught in PNG waters accounts for 20–30% of the South Pacific tuna catch and about 10% of the global catch. About 30% of tuna processed in PNG is sold on the domestic market, with local consumption of tinned tuna estimated to be about 15 000 tonnes in 2006 (Table A2.1.1). PNG supplies about 10% of the global market for bêche-de-mer and is the third largest producer.

The increase in the harvesting and export of tuna, and of the value of fisheries exports in general, has occurred as a result of the establishment of the national fisheries policy framework (as articulated

---

1 GIFT is an abbreviation for Genetically Improved Farmed Tilapia (*Oreochromis niloticus*). This species was introduced into PNG in 1999 and first released to fish farmers in 2002.

---

### Commercial fisheries

There has been a sharp increase in the overall volume and value of marine exports since the late 1990s (Figure 5.9.2, Table A5.9.1). The major commercial fisheries in PNG are, in order of value, tuna, bêche-de-mer, shell products such as trochus and mother of pearl, shrimp, shark, lobster, and fish and crab (Figure 5.9.3). Prior to the late 1990s, shrimp was the most consistently valuable commercial fishery. However, over the past decade, the tuna fishery has dominated the industry. In 1996 tuna accounted for about 14% of the total value of marine exports but, by 2006, tuna products had increased to around 75% of the total value of marine exports.

Tuna caught in PNG waters accounts for 20–30% of the South Pacific tuna catch and about 10% of the global catch. About 30% of tuna processed in PNG is sold on the domestic market, with local consumption of tinned tuna estimated to be about 15 000 tonnes in 2006 (Table A2.1.1). PNG supplies about 10% of the global market for bêche-de-mer and is the third largest producer.

The increase in the harvesting and export of tuna, and of the value of fisheries exports in general, has occurred as a result of the establishment of the national fisheries policy framework (as articulated

---

### Figure 5.9.2 Volume and value of marine product exports, 1977–2006.

access and licensing fees to the NFA.\textsuperscript{3} Domestically based foreign-owned fleets that operated in PNG during the 1970s left in the early 1980s due to unfavourable duties imposed on tuna exports. Until 1995 distant water fleets paying access fees were the only commercial tuna fisheries in PNG. With policy and governance reform during the late 1990s, the domestic tuna industry expanded rapidly. This includes a domestically based purse seine fleet, which is intended to supply the increasing number of onshore export-oriented processing plants, and a domestic long-line fleet.

Since the domestic long-line fleet is made up of vessels that are smaller, cheaper and of lower technology than the purse seine fleet, this sector was able to incorporate more PNG business people and employees on the vessels. However, with increasing fuel and freight prices, this fishery has proved uneconomic for operators away from the transport hub of Port Moresby, and during 2004–2005 the number of vessels active in the fishery declined by about half.

A ‘pump boat’ handline tuna fishery operated by local fishermen was established near Lae in 2006, with 12 local fishing groups involved. (See footnote 5, Section 2.10 for a definition of pump boat.) There are plans to extend the use of pump boats to New Ireland, Manus and Sandaun provinces.

### Processing, exporters and markets

Tuna not only accounts for around 75% of the value of PNG’s marine exports, but also represents an important source of revenue in the form of access and licensing fees paid by foreign fishing nations. Most tuna is caught by foreign purse seine vessels. Annual bilateral access agreements are negotiated with a number of countries, particularly Taiwan, Korea, and the Philippines; and a multilateral

---

\textsuperscript{2} The NFA is a non-commercial statutory authority established and operating under the Fisheries Management Act 1998 and related regulations. The NFA is responsible for the management and development of the fisheries sector in PNG. The NFA receives and manages revenue generated from access fees from deepwater fishing nations, licensing fees, donor funding, and penalties from prosecutions under the Fisheries Management Act (see Section 6.4).

\textsuperscript{3} Tuna export figures include exports from local processing plants, the domestic long-line catch and the domestic purse seine catch. The export figures do not include catch taken by bilateral access vessels and locally based foreign vessels, despite the fact that some of this catch is transhipped in PNG ports for export. The NFA figures probably underestimate the value of marine exports because of the way the data are compiled.

---

Figure 5.9.3 Value of marine exports by product, 2006. Source: National Fisheries Authority.
agreement exists with the United States. Under these agreements, approximately 130 purse seine vessels fish PNG waters each year. Frozen tuna from the foreign fishing vessels is transhipped in the ports of Wewak, Lorengau, Kavieng, Rabaul, Lae and Madang (Figure 6.9.1) for shipment to canneries in Thailand, the Philippines and American Samoa. The foreign fishing vessels catch around 250 000–300 000 tonnes of tuna per year, with an estimated value of US$350–450 million. Access fees paid to the PNG Government by foreign-owned fishing companies increased from US$5.8 million (K15 million) in 1999 to US$13.6 million (K48 million) by 2003.

The domestic long-line industry catches mainly yellowfin tuna and, to a lesser extent, bigeye. Forty licensed locally owned long-line vessels were estimated to be operating in 2003. (According to industry sources, the official figures have consistently underestimated the number of boats because the figures are based on licences and there are chronic problems with the licensing system. There may actually have been between 70 and 80 vessels operating around the peak of the industry in 2003, and about 35 operating in 2005.) Around 1000–2000 tonnes are harvested each year. Most of the fresh catch is exported in chilled form to Japan, while the remainder is exported to Australia. Tinned tuna is exported to the United States and European markets, while fishmeal is mostly exported to Australia and Japan.

The main export destinations for all marine products are Europe and Asia, particularly Germany, the United Kingdom, Hong Kong and Japan (Figure 5.9.4).

Tuna fisheries in particular have the potential to provide substantial long-term economic benefits for PNG. While few Papua New Guineans are employed on, or manage boats in, the purse seine fleets, the domestic fishery generates thousands of jobs in the processing sector onshore and should continue to do so. The domestic long-line fishery has suffered from declining catches as well as freight problems and is unlikely to recover unless these issues are addressed. Small village-based commercial tuna fisheries
'piggybacking' on large-scale operations in Lae could be an important source of income generation and small business experience, if environmental and economic factors are carefully managed, although similar activities have failed in Madang.

The sea cucumber (bêche-de-mer) fishery can benefit rural people because bêche-de-mer is predominantly export-oriented, although there are concerns over the sustainability of this fishery. The National Fisheries Authority has recently developed a K15 million Fisheries Credit Facility with the National Development Bank to assist rural fisher groups access microfinance.

Future prospects for fisheries in PNG depend upon several factors: the NFA's policy objectives and regulatory ability; greater compliance by all stakeholders; the provision of technical and material support (particularly processing and post-harvest handling); adequate and affordable transport; marketing networks; and a better understanding of the susceptibility of most commercial species to over-harvesting.

Sources


National Fisheries Authority (c. 2002). PNG country report for workshop on coastal fisheries management, Japan. National Fisheries Authority, Port Moresby.


5.10 Sugar

Sugar cane is indigenous to PNG. It is widely cultivated in village gardens all over PNG, throughout the year, and is chewed to extract the sweet juice. Modern sugarcane varieties cultivated for refined sugar are complex hybrids (Saccharum spp.).\(^1\) Commercial cultivation and production of sugar is confined to the Ramu Agri-Industries Ltd nucleus estate at Gusap–Dumpu in the Ramu Valley of Madang Province.\(^2\) This section focuses on commercial sugar production, with village production for chewing cane covered in Section 3.1. The nucleus estate is located at an altitude of 400 m in an environment where mean annual rainfall is about 2000 mm. The cultivation of sugar at the plantation is seasonal; cane is planted from late February to May to reduce problems associated with insect pests and weeds, and to take advantage of optimum growing conditions.\(^3\) Cane is harvested from April to October using mechanical harvesters.

**Adoption and history**

Proposals to establish a sugarcane industry in PNG were first made in the 1930s, with the identification of a possible site for a commercial plantation and processing operation in Oro Province. The establishment of a sugarcane industry was given further consideration in 1951 and again in 1964. The 1964 study concluded that an industry would not be economically viable until domestic sugar consumption reached about 30 000 tonnes which, it was thought at the time, would be achieved by 1975, but was not reached until the early 1980s. An intensive agronomic research program was commenced in 1965, focusing

\(^1\) Historically, a number of cane species were used to extract sugar in New Guinea, China and India. The New Guinea species was *Saccharum officinarum*; the Indian species was *S. barberi*; and in China people used *S. sinense*. People in India discovered how to crystallise sugar from cane about 1700 years ago, whereas people in New Guinea and elsewhere in the South Pacific chewed the cane for juice. New Guinea is a centre of diversity for *Saccharum* species, with *S. officinarum*, *S. spontaneum*, *S. edule* and *S. robustum* being endemic. In the 19th century the New Guinea chewing cane (*S. officinarum*) was crossed with a wild cane that is native to South-East Asia and New Guinea (*S. spontaneum*). All modern commercial varieties of sugar cane have been bred from crosses between these two species.

\(^2\) The Ramu Agri-Industries Ltd (previously Ramu Sugar Ltd) operation is referred to as a nucleus estate, as opposed to a plantation. Ramu Agri-Industries leases some land from customary landowners, which it uses for sugarcane cultivation. The landowners (known as ‘outgrowers’) do some manual weed control on the cane, but most operations, including soil tillage, planting, weed control and harvesting, are done by Ramu Agri-Industries. The word ‘estate’ is used in this section to distinguish the company-operated part of the nucleus estate from the smallholder, or outgrower, component.

\(^3\) Because sugar cane is endemic to this region, many pests and diseases of the crop exist in PNG and make commercial cultivation more difficult. By comparison, introduced crops, such as coffee, have fewer pest and disease problems.
on the Markham Valley. Other studies followed in the 1970s and a 20 hectare pilot project was initiated by the Department of Agriculture, Stock and Fisheries in the Kemp Welch area of Central Province.

After Independence in 1975, the PNG Government moved ahead with plans to establish a national sugar industry for the purposes of import replacement and export diversification. Several potential sites for a sugarcane plantation were identified, and the Gusap–Dumpu site was eventually selected on the basis that it did not require irrigation or flood protection works. In 1979 a detailed soil survey was undertaken, about 7000 ha of suitable land was identified, and the first sugar cane was planted.

The total area planted to sugar cane on the estate increased rapidly from three hectares in 1979, to 1350 ha in 1982 and 6000 ha in 1989. The area planted to sugar cane on the estate remained at 5000–6000 ha from 1990 to 2006, but expanded in 2007 (Table A5.10.1). The 1990s saw a marked expansion in the area planted to cane by the company on land owned by local villagers (‘outgrowers’), from 800 ha in 1995 to 2200 ha in 1999. The area had decreased to 1200 ha by 2007 because of competing claims for payment for use of land by various landowners. The company responded by increasing the area under cane on its estate. In total, about 10 000 ha of company and outgrower land is involved, including that under cane, under short or long fallow, or abandoned.

### Levels of production

The aggregate production of sugar from the nucleus estate (including outgrower production) has fluctuated over the past 20 years, particularly between 1982 and 1991, but has nevertheless increased from 11 000 tonnes in 1982 to 49 000 tonnes in 2002 (Figure 5.10.1, Table A5.10.1). The contribution of outgrowers to sugarcane production

---

Figure 5.10.1 Commercial sugar production, 1982–2007. Source: Ramu Agri-Industries Ltd.

---

4 PNG leaders sometimes accused Australia of reluctance to establish a domestic PNG sugar industry, to protect Australian sugar exports. Given the small proportion of Australian sugar exported to PNG, this is unlikely to have been the case.
increased during the 1990s. By 2001–2003, about 150 outgrowers provided land which produced around 30% of total sugar cane. However, this proportion had declined to less than 15% by 2007 because of ongoing problems with land ownership.

Because of detailed company records, there are better data on crop yield for commercial sugarcane production than for any other agricultural crop in PNG (Table 5.10.1). Cane yields averaged 58 t/ha between 1982 and 2007, with a range of 28–88 t/ha. This resulted in a mean sugar yield of 5.3 t/ha, with a range of 2.0–8.2 t/ha. The fluctuations in crop yield (and hence in annual production) have been caused by insect pests and diseases and, to a lesser extent, by weeds and climatic variability. For example, the marked decline in production in 1986 was due to the Ramu stunt disease epidemic of 1984–1985, which required that the entire estate be replanted. Other important pests have been moth stem borer, cicadas and white grub.

Efforts to control these problems have been reasonably successful and have resulted in an increase in sugar production since 1992. Crop yields (and total production) were poor in 2006 and 2007 because of an increase in ratoon stunting disease, caused by a bacterial infection. The problem was made worse by inadequate weed control. These problems have been addressed, including heat-treating planting material to kill the bacteria.

### Processing, exporters and markets

Most of the sugar produced at the nucleus estate is sold domestically. The domestic sugar industry is protected from imports by a 70% tariff (Table 4.1.1) and Ramu Agri-Industries Ltd enjoys a near monopoly in the PNG market. The import tariff has resulted in high domestic retail prices for sugar in comparison with world prices. The tariff will decrease to 40% in early 2011.

Since 1993, domestic sales of sugar have ranged between 30 000 and 37 000 tonnes per year. Consumption levels of sugar in PNG have declined from about 8 kg/person/year in the early 1980s to less than 6 kg/person/year by 2006 (Figure 5.10.2).

![Figure 5.10.2 Volume of domestic sales, per person consumption and sugar exports, 1983–2006.
Source: Ramu Agri-Industries Ltd.](image-url)
About 7000–10 000 tonnes per year of sugar is exported, but only in years when production is surplus to domestic requirements (Figure 5.10.2). Consequently, no sugar was exported in 1985, 1993 and 1996.\(^5\)

Molasses is a by-product of the sugar refining process and about 15 000 tonnes are produced each year. About 2000–3000 tonnes of molasses is sold for livestock feed. It is also used to produce about two million litres of ethanol (alcohol), most of which is exported and is worth K2–2.5 million per year.

### Future prospects

Ramu Agri-Industries anticipates that sugar yields per hectare will increase because of the use of more productive cane varieties that have been selected in the company's breeding program. The company is aiming to achieve yields of 6.5–8.0 t/ha of sugar, compared with 4–7 t/ha in recent years. It plans to increase production to 50 000 tonnes/year by 2010. However, there are potential threats to increased output. Sugarcane smut, a fungal disease that is not in PNG but is present in Indonesia and Australia, is a risk to future production on the estate, as well as to village production of chewing cane.

The company anticipates that sugar consumption in PNG will increase at about 4% per year, which will mean a domestic demand of 45 000 tonnes by 2014. However, given the current rate of population growth, consumption will still be about 6 kg/person/year. Ramu Agri-Industries is seeking to have the maximum allowable quantity exported to the United States increased from 7500 tonnes/year to 11 000 tonnes/year, as the US pays about twice the world price for sugar as an indirect form of aid.

Because import protection on sugar will be reduced and domestic demand is limited, Ramu Agri-Industries has embarked on an ambitious program of diversification, commencing with oil palm and

---

\(^5\) In 2004, exports reached an all-time high of 19 000 tonnes (Table A5.10.1), following several years of record production. In that year, 10 000 tonnes went to Sri Lanka, 7000 tonnes to the United States and the balance to various Pacific islands.
cashew. More than 8000 ha of oil palm will be planted by early 2009, and about 15 000 ha will be planted by 2015. An area of 100 ha will be planted to cashew in 2008, which will be increased to 500 ha by 2010 if this venture is successful. A number of other agricultural products are being examined in detail, including timber for fuelwood and hardwood for export; noni, from which the juice would be extracted for export; edible bamboo for the Asian market; and jatropha oil for use as a biodiesel fuel.

Sources


Rubber is a minor cash crop in a limited number of PNG locations (Table 5.1.1, Figure 5.1.1). From 2004 to 2006 rubber generated average export earnings of K19 million per year, which was 1% of the value of agricultural exports in this period (Figure 5.2.2). In 2007 exports were worth K24 million. The significance of rubber in the economy has declined from the 1950s, when rubber exports made up around 12% of agricultural exports (Figure 5.2.3).

Natural rubber is used for many household and industrial purposes, most importantly the manufacture of motor vehicle tyres and tubes. Other uses include the manufacture of window parts, various items used in engines (belts, hoses, dampeners), gloves, toy balloons, adhesives and rubber bands.

In PNG rubber is grown from near sea level up to about 700 m altitude, in environments where mean annual rainfall ranges from 1500 mm to over 5000 mm. Production is non-seasonal.

### Adoption and history

Commercial rubber was first planted in PNG in 1903. Most production was in the Australian Territory of Papua (now the Southern Region of PNG). In German New Guinea, attempts to build a rubber industry were based on assam rubber (*Ficus elastica*), which is inferior to para rubber (*Hevea brasiliensis*). Consequently, very little rubber was produced in German New Guinea.

In Papua, plantations were first developed at Galley Reach, Sogeri and Cape Rodney in Central Province and in the Kerema area of Gulf Province. They subsequently expanded into the Kokoda area of Oro Province and parts of New Ireland Province. The principal exports from Papua in the 1930s and 1940s were copra and rubber, and rubber contributed almost 30% by value in the 1930s.

Prior to World War II smallholder rubber planting was confined to a few villages in Oro Province. The Department of Agriculture, Stock and Fisheries (DASF) promoted the development of village rubber production in the 1960s, particularly in Gulf and Western provinces. Between 1964 and 1970 smallholder rubber planting was also promoted on settlement and resettlement schemes in Central Province; at Gavien near Angoram in East Sepik Province; and at Murua in Gulf Province. As a result, the number of smallholder and village rubber producers increased from less than 2000 in 1970–71 to around 3300 in 1976–77. These schemes were not associated with plantations.

### Distribution of production and planting

Rubber has been grown and produced in eight lowland provinces (Table 5.11.1, Figure 5.11.1). In 2005, 4100 ha was planted to rubber on settlement schemes, 4500 ha in villages, 9500 ha on plantations.
Province (owned by the Belgian company SIPEF) has 60% of the total area of plantation rubber, and is the only plantation presently producing rubber.

**Levels of production**

Rubber exports were in the range 1000–2000 tonnes/year between 1936 and 1951, except in 1943 when production was disrupted by World War II. After the war, rubber production continued to be dominated by the plantation sector, with production, measured as exports, rising steadily to over 6000 tonnes in 1970 (Figure 5.11.2, Table A5.11.1).

1 Figures on area planted to rubber are from DAL and the Ministry of Agriculture and Livestock (2007). They underestimate the area planted in Western Province, where about 3800 ha has been planted since 1999 (Table 5.11.2).

2 The production data presented here have been assembled from a number of different sources in order to construct a long-term data run. For some years, there is a certain amount of variation between different data sources. We have presented data that is likely to be the most accurate.
A significant decline in production followed in the 1970s due to stagnation in the plantation sector and still insignificant smallholder production. The decline of the plantation sector was attributed to the continued use of clonal seedling planting material, rather than higher-yielding bud-grafted material; increased costs of production, particularly labour costs; uncertainty caused by land disputes and the threat of compulsory government land acquisition; and a high turnover of workers and resultant poor tapping standards that reduced the economic life of trees. The area of rubber on plantations declined dramatically after 1970, with several plantations cutting out rubber in favour of other enterprises, such as beef cattle.

Smallholder production increased steadily during the 1980s and by 1990 had overtaken plantation production (Figure 5.11.3, Table A5.11.2). Between

---

**Table 5.11.1 Rubber plantings by area and sector, 2002**

<table>
<thead>
<tr>
<th>Settlement scheme</th>
<th>Number of settlers</th>
<th>Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cape Rodney Agricultural Development Project (Central Province)</td>
<td>2,026</td>
<td>3,400</td>
</tr>
<tr>
<td>Bailebo (Central Province)</td>
<td>57</td>
<td>84</td>
</tr>
<tr>
<td>Murua (Gulf Province)</td>
<td>36</td>
<td>118</td>
</tr>
<tr>
<td>Gaven (East Sepik Province)</td>
<td>154</td>
<td>538</td>
</tr>
<tr>
<td>Subtotal</td>
<td>2,273</td>
<td>4,140</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Village planting</th>
<th>Number of growers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Province[a]</td>
<td>1,999</td>
</tr>
<tr>
<td>Gulf Province</td>
<td>65</td>
</tr>
<tr>
<td>Central Province</td>
<td>378</td>
</tr>
<tr>
<td>Oro Province</td>
<td>298</td>
</tr>
<tr>
<td>East Sepik Province</td>
<td>635</td>
</tr>
<tr>
<td>Sandaun Province</td>
<td>526</td>
</tr>
<tr>
<td>Manus Province</td>
<td>128</td>
</tr>
<tr>
<td>New Ireland Province</td>
<td>333</td>
</tr>
<tr>
<td>Subtotal</td>
<td>4,362</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plantation sector</th>
<th>Number of workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galley Reach Plantation (Central Province)</td>
<td>600</td>
</tr>
<tr>
<td>Sogeni Rubber Development Corporation (Central Province)</td>
<td>40</td>
</tr>
<tr>
<td>Epo Estate (Gulf Province)</td>
<td>30</td>
</tr>
<tr>
<td>Other small plantations</td>
<td>30</td>
</tr>
<tr>
<td>Subtotal</td>
<td>700</td>
</tr>
<tr>
<td>DAL Bisianumu rubber experiment station</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7,355</strong></td>
</tr>
</tbody>
</table>

[a] The figures for Western Province refer to plantings made in the 1960s and 1970s. They do not include 3786 ha planted by 3768 growers between 1999 and 2006 (Table 5.11.2). Most of these figures for other provinces in Table 5.11.1 refer to old plantings, many of which are unproductive and are not being tapped.

Source: DAL.

Figure 5.11.3 Rubber production by sector, 1985–2001. Source: DAL.
the Murua scheme in Gulf Province, Cape Rodney in Central Province and the Gavien scheme in East Sepik Province, which produce food and betel nut for urban markets.

The average yield of cup lump rubber by village producers in the Kiunga area is about 650 kg/ha (400 kg/ha processed rubber). The best producers obtain up to 1650 kg/ha cup lump (1000 kg/ha processed rubber). Planting material with higher yield potential of over 2000 kg/ha of processed rubber has been distributed by North Fly Rubber Limited in Western Province over the past ten years.

A 1949 survey of plantations in Central and Oro provinces recorded average yields of 450 kg/ha of processed rubber, a similar yield to that currently obtained at the Galley Reach Plantation near Port Moresby.3

**Table 5.11.2 Rubber plantings in Western Province, 1999–2006**

<table>
<thead>
<tr>
<th>District</th>
<th>Area (ha)</th>
<th>Number of growers</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Fly</td>
<td>2740</td>
<td>2577</td>
</tr>
<tr>
<td>Middle Fly</td>
<td>1026</td>
<td>1163</td>
</tr>
<tr>
<td>South Fly</td>
<td>20</td>
<td>28</td>
</tr>
<tr>
<td>Total</td>
<td>3786</td>
<td>3768</td>
</tr>
</tbody>
</table>

Note: In the 1960s and 1970s, 2063 ha of polyclonal seedlings were planted by 1999 growers and most of this is nearing the end of its economic life.

Production has been in the range 370–1000 tonnes/year of processed rubber between 1994 and 2007. It was 811 tonnes in 2007, the highest figure since 1996.

Source: Chew Boo, North Fly Rubber Limited.

1992 and 1996 a sharp increase occurred in smallholder production that coincided with increasing export prices for rubber. The promotion of rubber in the Kiunga area of Western Province by North Fly Rubber Limited also contributed to the significant rise in smallholder production during this period. Total smallholder and plantation annual production reached an all-time high of 7000 tonnes in 1996.

This was followed by a sharp decline in production in 1997, due to a fall in export prices and other factors which adversely affected smallholder production, including the closure of the processing factory at Gavien in East Sepik Province following damage by fire; low production at Kiunga in Western Province after large compensation payments from Ok Tedi Mining Limited to people living downstream of the mine; and the 1997 drought and very low water levels in the Fly River in Western Province that effectively paralysed the transport of cup lump rubber from Balimo and Lake Murray to the factory at Kiunga, a distance of more than 1300 km. Production remained 4000–5000 tonnes/year from 1997 to 2007, divided evenly between smallholders and plantations.

Although settlers on rubber settlement schemes often produce little or no rubber, they are active agricultural producers and derive significant income from the sale of fresh food and betel nut. Typical are

Most rubber produced in PNG is initially extracted on-farm as cup lump rubber and is then processed into PNG Certified Rubber 10. Three factories currently purchase and process cup lump rubber; at Doa Plantation (at Galley Reach west of Port Moresby), Moreguina (near Cape Rodney, south-east of Port Moresby) and Kiunga (Western Province). Galley Reach Holdings Ltd buys cup lump rubber from elsewhere in PNG, transports it to Port Moresby and processes it at its Doa Plantation factory. This company produced about 85% of total rubber exported in 2006. Current government policy is that only processed rubber should be exported, but it does not have the power to ban the export of unprocessed cup lump rubber.

Old rubber trees provide high quality timber suitable for making furniture. The timber can be harvested after economic tapping ceases, which is

---

3 Cup lump rubber contains 40% moisture. To convert cup lump yields to processed rubber, multiply by 0.6. Kiunga smallholder yield data was supplied by Warren Dutton. The 1949 survey of plantations was conducted by the Bureau of Agricultural Economics (1952).
at about 35 years after planting. Sales of old rubber trees for timber increase the economic viability of rubber production.

Most rubber produced in PNG is exported to Europe, particularly to Germany, France, the Netherlands and Belgium (Figure 5.11.4, Table A5.11.3).

**Future prospects**

Following historical lows in world rubber prices in 2001, natural rubber prices staged a remarkable recovery. By 2007, prices were about four times as high as they were in 2001. High oil prices have increased the cost of making synthetic rubber and strong demand for vehicle tyre production has emerged, especially from China. Markets now favour natural rubber and firmer prices can be expected for the next few years. The main future uncertainty in the rubber market is the price of crude oil, which affects the competitiveness of synthetic rubber.

Primary constraints on the PNG rubber industry are the poor state of transport infrastructure and the general lack of financing for new planting. Low returns to labour also limit smallholder interest in rubber (Table 5.20.1).

Significant new plantings have been made in recent years only in Western Province. More than 2700 ha of smallholder rubber has been planted in the Kiunga area and over 1000 ha (out of a target of 2200 ha) in the Lake Murray area since 1999 (Table 5.11.2). New plantings are planned in the Bosset, Suki and Balimo areas in the southern part of Western Province.

There are plans to increase plantings to a total area of 10 000 ha in the province, with new plantings in the north, middle and south Fly River areas.

The expansion in Western Province is supported by North Fly Rubber Limited, Ok Tedi Mining Limited and the PNG Sustainable Development Program. A total of almost K20 million has been provided, directly and indirectly, from the revenue of the Ok Tedi copper mine in the past decade. The transport costs of moving seedlings from Kiunga to Lake Murray, Suki and Balimo, cup lump rubber from these areas to Kiunga for processing, and processed rubber to a main port for export, is heavily subsidised. Without these subsidies, rubber production in Western Province is unlikely to be economic unless further large areas of high-yielding rubber are planted within the next decade to create economies of scale.

The PNG National Agriculture Development Plan has a goal of rubber production of 29 000 tonnes by 2016, more than seven times production in 2007. If the higher prices of 2007 and 2008 continue, it is likely that rubber production in PNG will increase, but the target of 29 000 tonnes in less than a decade is completely unrealistic. Since 1992, no significant area of smallholder rubber has been planted other than the heavily subsidised plantings in Western Province.

---

4 Rubber trees are planted at a density of 400 trees/ha. Tapping commences at year 7 and can continue for about 35 years. Tapping can be done every second day. A grower can tap about 500 trees (1.25 ha) each day.


5.12 Tea

In PNG tea is mostly grown in Western Highlands Province between 1200 m and 1950 m altitude in areas where mean annual rainfall is around 2500 mm. A non-producing tea plantation exists at a former government estate at Garaina in Morobe Province at an altitude of around 600 m. Production of tea in PNG is non-seasonal.

**Adoption and history**

Tea was established as an experimental crop on a government-owned plantation at Garaina in Morobe Province in 1950. A small factory was built at Garaina in 1962 and PNG tea was exported for the first time in 1963. The high yields and good quality that were obtained at Garaina encouraged the Department of Agriculture, Stock and Fisheries to promote the cultivation of tea as a viable cash crop for both plantation and smallholder producers.

The Department’s policy was to develop the industry on the nucleus estate model, where a commercially operated estate produces tea and also provides a market, processing and technical services for smallholder producers who cultivate tea on village land adjacent to the nucleus estate. In order to facilitate smallholder development, the government established about 3000 ha of land settlement schemes, mostly in Western Highlands Province. However, tea failed to gain acceptance among smallholders. They preferred other cash crops, especially coffee and fresh vegetables, and disliked the continuous labour inputs required for harvesting (‘plucking’) tea leaves and the generally high level of skills required to cultivate tea.

Consequently, the tea industry in PNG remained dominated by six foreign-owned estates and factories that were established in Western Highlands Province in the late 1960s and early 1970s. In 1977 these factory estates grew 80% of PNG’s tea. The remainder came from five smaller estates (three in Western Highlands Province and two in Simbu Province) and from smallholder producers (mostly in Western Highlands Province). It was estimated that smallholders contributed less than 3% of total tea production in 1975/76.

The Garaina estate in Morobe Province ceased to function as a tea research station in the late 1970s, but people living in the area continued to harvest and sell a limited amount of tea from the site. Smallholder interest in tea cultivation continued to decline to the extent that, by 1992, production of tea from sources other than the factory estates was around 24 tonnes per year, or less than 0.5% of total production. Smallholder tea is no longer produced in PNG.
In PNG tea is produced and exported only by W.R. Carpenter and Co. The company recently purchased a tea plantation from a second company, and a third company abandoned its operations. This mostly foreign-owned company currently operates five separate estates with a combined area of 2200 ha.

Levels of production

The production of tea, measured in terms of export volumes, increased sharply between 1970 and 1980 and reached almost 8000 tonnes in 1980 (Figure 5.12.1, Table A5.12.1). By the mid 1970s most of the factory estates were fully planted, and production continued to increase as the tea plantings matured. Production levels remained relatively high until 1985, in association with the high world tea prices in the early to mid 1980s. However, prices fell severely after 1985 and in 1991 reached their lowest point (in real terms) since the early 1950s. This saw a corresponding decrease in PNG tea exports, to 4700 tonnes in 1991 and 3400 tonnes in 1994. Exports increased again after the recovery of world market prices during the mid to late 1990s, coupled with the devaluation of the kina, and reached a historical maximum of 9300 tonnes in 1996. Both prices and export volumes have remained relatively stable since then, with volumes averaging more than 7000 tonnes per year.

---

1 Because 90% of the tea produced in PNG is exported, exports are a good indicator of total production levels.

---

About 10% of tea produced in PNG is consumed domestically and the remainder is exported. Domestic sales from the Western Highlands estates are around 700 tonnes per year (equivalent to PNG tea consumption of 0.1 kg/person/year). The export market has changed significantly in recent years. In 2006, 30% of tea exports went to Russia, 15% to Germany, 10% to the United Kingdom, 10% to the United States, 9% to India and 4–6% each to Belgium, Canada, Indonesia and Australia (Figure 5.12.2). Throughout the 1990s, Australia and the United States were the major importers of PNG tea (in most years receiving more than 50% of exports and around 20% of exports, respectively; Table A5.12.2). However, when the two major importers of PNG tea in Australia moved their packing plants to India and Indonesia, PNG exports to Australia collapsed. By 2006, the most important export destination for PNG tea was Russia, a market that only appeared in 2002.

The World Bank predicts that real tea prices will decline by about 12% between 2006 and 2015 (Figure 5.2.6). Global demand for black tea has weakened. This is partly because of a change by consumers from brewed tea to use of tea bags, which require less tea, but also because of a switch by some western consumers from black tea to green tea. Because of the static price of black tea, rising costs of production and the high cost of shipping from PNG compared with that from major overseas ports, PNG’s tea producer is struggling to remain profitable. Prospects for expansion of PNG tea production are limited by constant law and order problems, land compensation demands, and the poor outlook for improved global prices.

* ‘Other’ countries are not specified in the 2000 data source. In 2006, ‘other’ countries are New Zealand, Pakistan, Malaysia, Chile, Singapore and Fiji.

Figure 5.12.2 Destination of tea exports, 2000 and 2006 (by value). Sources: 2000: DAL (2001); 2006: Carpenter Estates.
Sources


5.13 Balsa

Balsa is a fast-growing tree that produces a very light wood used mainly to make model aircraft. The wood is also used in full-scale aircraft, table tennis bats, surfboards, fishing lures and as insulation. Balsa exports from PNG generated an average of K6 million per year from 2004 to 2006, which was about 1% of the value of forest product exports in this period. The value increased to K10 million in 2007. Commercial production of balsa wood in PNG is presently restricted to the north-east lowlands of the Gazelle Peninsula in East New Britain Province. Balsa is currently cultivated in areas below 300 m in altitude and where mean annual rainfall ranges between 2000 mm and 3000 mm, but it may grow well in other environments in PNG.

Adoption and history

Balsa was introduced to PNG in the late 1930s, with further introductions made between 1948 and 1961, mostly to East New Britain Province (ENB). The commercial potential of the crop was investigated in 1952 and 1956 and trial shipments were made to Australia. By the 1960s, a processing mill had been established at Keravat in ENB and a small industry had started to develop on the Gazelle Peninsula. In the 1980s and early 1990s, smallholder participation in the balsa industry on the Gazelle Peninsula was supported by extension activities provided by the National Department of Forestry and the ENB Division of Primary Industry. However, by 1995 extension activities had ceased, which resulted in harvesting rates exceeding replanting rates and a corresponding decline in available balsa. This situation was compounded by the Rabaul volcanic eruption of 1994, which defoliated many trees and caused activity in the industry to cease.

Following the eruption, recognition of the economic potential of balsa, coupled with concerns about the lack of extension services and information about the state of the industry, led provincial and national authorities to request overseas assistance. This resulted in the establishment of the East New Britain Balsa Industry Strengthening Project, funded by the International Tropical Timber Organization (ITTO). The project operated from 1996 to 2003.

Distribution of production and planting

On the Gazelle Peninsula in 2001 there were more than 200 hectares of smallholder balsa plantings and over 80 hectares of private, company-owned balsa plantations. The number of balsa growers in the Gazelle Peninsula area is unknown, but was about 200 in 2001. The area planted, and possibly the number of growers, has increased considerably since then.

Balsa is also grown in other parts of PNG including on New Ireland, Buka, Bougainville and Nissan islands, and in West New Britain and East Sepik provinces. However, much of this balsa cannot be
Processing, exporters and markets

Three mills were operating on the Gazelle Peninsula in ENB in 2001 and these processed balsa purchased from both smallholder and commercial plantation producers. By 2007, there were four mills in ENB, and it was anticipated that this would increase to seven mills by late 2008. The East New Britain mills could conceivably cater for balsa produced in other parts of PNG. However, in order to be economic, the balsa would have to be processed into ‘flitches’ before being shipped to East New Britain for final processing, which means that flitch-processing plants would have to be established in the other balsa-growing areas. Economic potential would also depend upon adequate roads and shipping.

Levels of production

No data is available on balsa production or exports prior to 1996. Annual production, measured in terms of the volume of wood sold to the three balsa mills, averaged 10 000 m³ over the period 1997–2001. Export of milled timber was 2000–4000 m³/year between 1996 and 2004, but increased to 11 000 m³ in 2007 (Figure 5.13.1, Table A5.13.1).

1 Data are from ITTO reports and one of the balsa mills, GS Models at Keravat. The recovery rate of milled timber depends on the product, with thinner sheets having a lower rate. The rate varies between mills in ENB because they produce different products, with an average recovery rate of 29% in 1997–2000, as measured by the volume of exports as a proportion of the volume purchased by the three mills in ENB in that period.

2 The East New Britain mills have purchased small amounts of balsa from West New Britain and New Ireland provinces. However, the balsa industry in these areas is only marginally economic due to the high cost of log haulage.
The balsa mills in East New Britain Province export processed balsa in the form of planed sheets, blocks and strips of various shapes and sizes. Until 2003 balsa was exported to Australia, China, Germany, Italy and the United Kingdom, but since then a greater proportion has gone to China and India. In 2007 the main export destinations were China (43%), India (20%), Australia (14%) and Germany (10%) (Figure 5.13.2, Table A5.13.2).

**Future prospects**

Because balsa is a fast-growing crop, it can be integrated into village agricultural systems. It has more in common with an agricultural crop than a timber crop. The volume and value of balsa grown in ENB has grown rapidly since 2005. The area planted to balsa has expanded and some plantations have replaced old coconut stands with balsa. While prices remain high, the prospects for further growth are good. There is potential for expansion to other lowland areas, but this would depend on mills being established there.

**Sources**


---

* 'Other' countries in 2001 were Spain, Taiwan, Japan and Malaysia. 'Other' countries in 2007 were Hong Kong, Japan, Malaysia, New Zealand, Taiwan and Vietnam.
Vanilla is used as a natural food and drink flavouring and as an ingredient in perfume. There are two commercial types of vanilla – Bourbon (Vanilla planifolia) and Tahitian (V. tahitensis). Both are grown in PNG. Bourbon vanilla is higher yielding, contains more vanillin and has a wider market. Tahitian vanilla needs a shorter period to induce flowering and is thus suited to a wider range of environmental conditions.

Vanilla is successfully grown from sea level to 600 m altitude, although it bears at over 1400 m in PNG. The daily temperature range for its optimal growth is 21–32 °C, with an average around 27 °C. Annual rainfall should be in the range 1700–2500 mm and evenly distributed throughout the year. However, two drier months are required to slow vegetative growth and induce flowering. Areas that do not have this dry season are not suitable for vanilla. The crop requires well-drained soils that are preferably deep and fertile and rich in organic matter. The crop's environmental requirements significantly limit the locations in which vanilla will flower. In PNG, extensive planting has been undertaken in locations where there is no regular dry season. These plantings are not likely to be successful.

Vanilla occupies a very small world niche market. Over the last 20 years, world consumption has varied between 1800 and 3000 tonnes, with production varying between 1200 and 4000 tonnes. This small market is characterised by extreme price fluctuations, made up of high price peaks and prolonged troughs of relatively low prices (Figure 5.14.1). Prices have been particularly sensitive to events in Madagascar, which produces 60–75% of world vanilla. Recent vanilla price fluctuations have been extreme. A severe cyclone that disrupted production in Madagascar in early 2000 triggered a rapid rise in world vanilla prices, which reached more than US$200/kg by the end of 2000. For three years, farmers throughout the vanilla-growing world earned unheard-of returns and responded accordingly. Farmers worldwide began feverishly planting and rehabilitating vanilla. By early 2004, the production from these increased plantings was entering a market that had contracted due to extremely high prices. By July 2004 the inevitable price collapse had begun. Prices have continued to fall since then and were about US$20/kg in mid 2007.

### Adoption and history

Vanilla is a very recent cash crop in PNG. The PNG Spice Industry Board believes around 50 000 people were involved in the vanilla industry at the end of 2003. Five years earlier only a few hundred households were growing vanilla. Such meteoric industry growth is unprecedented in PNG agriculture.

The crop was first introduced to PNG in the 1960s at the Lowlands Agricultural Experiment Station at Keravat, East New Britain Province. At about the same time, plantings were made in the Wosera area of East Sepik Province. The original Wosera plantings were mainly of the Tahitian variety and were subsequently abandoned.
The foundations of today’s industry were laid in 1993, when Allan Bird (Bangui Bio Products Ltd) planted vanilla on a large block near Maprik in East Sepik Province. He encouraged smallholders around him to also plant. This provided the critical mass upon which a substantial smallholder-based industry could quickly develop once the right price incentives existed.

Nowhere in the world was the response to the huge increase in world vanilla prices as spectacular as in PNG. A combination of factors explains the PNG vanilla phenomenon:

- PNG vanilla farmers had not experienced the previous periods of low prices and expected the high prices to continue in the future.
- The declining value of the kina compared with the US dollar significantly increased the kina price received by PNG growers. The grower price increased 1300% over a two-year period to reach more than K700/kg.
- Environmental conditions in parts of East Sepik Province proved ideal for vanilla production.
- The establishment of the Bangui Bio Products Ltd plantings at Maprik had given surrounding smallholders experience in growing and producing vanilla.

Vanilla proved very attractive to villagers because it does not demand large areas of land to produce a good income.

Distribution of production and planting

Around 50–75% of PNG vanilla comes from East Sepik Province, with production concentrated in the Maprik, Dreikikir and Wosera areas. Other major producing provinces are Central, Morobe, East New Britain and Madang. Vanilla is now planted extensively in all the lowland and island provinces. While the main production areas of East Sepik Province provide ideal conditions to grow vanilla, the effect of climate was not taken into account in the rush to join the 2000 boom in the development of the industry. Many areas in which vanilla has been planted in PNG are much more humid than the vanilla-producing areas of Madagascar, Indonesia and Tonga. These locations are likely to prove unsuitable, particularly for the Bourbon variety.
The annual production and export of vanilla in PNG increased rapidly from about one tonne in 1997 to an estimated 200 tonnes by 2003 (Table 5.14.1, Figure 5.14.2). Within six years PNG had become the third largest producer in the world (after Madagascar and Indonesia), contributing about 10% of world production in 2003–2004. PNG production declined rapidly after 2004.

Bank of PNG data indicate that the export value of vanilla was K102 million in 2003 and K50 million in 2004, dropping to K3 million in 2005. However, these figures are probably lower than actual exports because of vanilla smuggled across the border to Indonesian Papua.¹

¹ In 2004 Indonesia exported around 350 tonnes of vanilla, of which about 50 tonnes was likely to be re-exports of vanilla originally imported from PNG. Estimates of exports from PNG are not precise.

The distinctive flavour and fragrance of good quality vanilla is developed by a slow curing process that is labour intensive and takes three to six months to complete. In PNG, villagers do their own curing. In other major vanilla-producing countries, curing is undertaken by specialist businesses and not by farmers. In PNG, grower curing has helped spread the benefits of the industry widely and has allowed for the participation of people in the most isolated of locations, but it has seriously lowered the quality of PNG vanilla. Many growers have little understanding of the slow and demanding requirements for successful curing. They tend to confuse the complex fermentation of vanilla curing with a drying process that they are familiar with for cocoa and copra. A necessary condition for producing quality vanilla is that the beans be harvested fully ripe. Beans that are immature when harvested will have low vanillin content and will quickly go mouldy regardless of how well they are cured.

The lack of knowledge of processing requirements is a consequence of the rapid expansion of the industry – and the lack of extension support provided. During

![Figure 5.14.2](image-url)
In the short term, villagers benefited from the competition created by the large number of exporters. The intense competition helped increase buying prices. However, many traders had little understanding of the product and were willing to purchase inferior quality vanilla at inflated prices. This has had a harmful effect on the quality of PNG vanilla and its overall reputation in the world market.

The United States, France, Germany and Indonesia have been the main markets for PNG vanilla.

**Future prospects**

The vanilla industry that existed in PNG at the beginning of 2004 was based on unrealistic expectations and was not sustainable. By July 2004 prices had fallen to K125–140/kg for Grade 1 vanilla. Growers were starting to realise that poor quality (low vanillin content, over-dried, off-flavour and mouldy) product is unmarketable.

K70–80/kg is a reasonable price to plan for over the next few years. This price is unacceptably low for many present growers, particularly in light of the unrealistic expectations that were created by the boom. These growers will choose to stop producing. Some growers who have already invested in a vanilla plantation will continue to produce.

Vanilla's high unit value and non-perishability (when cured) make it particularly attractive to remote locations with poor or non-existent road access. Vanilla fits well into PNG agricultural systems and is particularly compatible with cocoa in East Sepik Province. Cocoa provides a regular low cash return throughout much of the year and vanilla gives a significant return once a year. Cocoa, with appropriate pruning, can even be used as a support tree for vanilla.

A sustainable PNG vanilla industry could have an initial annual production base of 40–50 tonnes. This would constitute a minor but significant

### Table 5.14.1 Estimated volume of cured vanilla bean exports, 1997–2006

<table>
<thead>
<tr>
<th>Year</th>
<th>Estimated exports (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>1</td>
</tr>
<tr>
<td>1998</td>
<td>4</td>
</tr>
<tr>
<td>1999</td>
<td>8</td>
</tr>
<tr>
<td>2000</td>
<td>24</td>
</tr>
<tr>
<td>2001</td>
<td>50</td>
</tr>
<tr>
<td>2002</td>
<td>160</td>
</tr>
<tr>
<td>2003</td>
<td>200</td>
</tr>
<tr>
<td>2004</td>
<td>215</td>
</tr>
<tr>
<td>2005</td>
<td>68</td>
</tr>
<tr>
<td>2006</td>
<td>26</td>
</tr>
</tbody>
</table>

Sources: Based on data from Agmark Pacific Ltd, PNG Spice Industry Board and Bank of PNG. These estimates are crude.

the price boom, the practice of some traders and exporters of paying the same price regardless of quality provided little incentive to growers to learn and adopt correct curing techniques.

Vanilla marketing in PNG is disorderly and largely unregulated. At the end of 2004, 70 vanilla exporters were licensed with the Spice Industry Board. However, only 45 of these actually recorded exports and the ten largest exporters accounted for more than 90% of shipments. Several of these larger companies are representatives of overseas vanilla and spice companies, although most exporters are PNG-based companies. Some exporters apply strict standards and pay significant price premiums for quality. These exporters conduct their own farmer training programs. The results of these efforts in terms of quality have been outstanding and provide an example of how the industry can progress.

Vanilla buying is conducted over a three-month period, starting in February. All vanilla purchases are on a cash-on-delivery basis. Most East Sepik growers bring their cured bean to Wewak for sale. Buying is also conducted at Maprik, either by agents, middlemen or by exporters themselves. For security reasons large volumes are often purchased on-farm. Larger companies fund purchases from their own resources. Those linked to overseas spice companies have been financed by their overseas parent companies. Small companies found it difficult to generate a timely cash flow and many are no longer operating.

In the short term, villagers benefited from the competition created by the large number of exporters. The intense competition helped increase buying prices. However, many traders had little understanding of the product and were willing to purchase inferior quality vanilla at inflated prices. This has had a harmful effect on the quality of PNG vanilla and its overall reputation in the world market. The United States, France, Germany and Indonesia have been the main markets for PNG vanilla.
export industry, equivalent to rubber. Like rubber, the vanilla industry is well suited to isolated, poor, lowland areas. The industry could earn high income windfalls similar to the 2000–2004 boom, but these will be infrequent exceptions rather than the norm. The PNG vanilla industry must also make the transition to centralised curing if it is to have a sustainable future.

Even at a price of K70/kg, vanilla provides a good return to labour and land, in suitable growing areas. Farm management models indicate that 0.5 ha of vanilla earns an average of nearly K5000 per year, with returns to labour of over K50 per person-day, provided that growers produce quality bean. This is considerably higher than for most other cash crops in PNG (Table 5.20.1).

**Sources**


A number of crops that yield spices or flavourings are grown in PNG and have potential as export cash crops. Vanilla has been the most significant in recent years (see Section 5.14). Chilli and cardamom were reasonably significant export crops in the 1970s and 1980s, but production of both has declined to low levels. Minor or potential export spice crops include annatto (bixa), black pepper, cinnamon, citronella grass, ginger, Japanese mint, lemon grass, nutmeg, patchouli and turmeric. The export of organically certified essential oils from cardamom, cinnamon, citronella grass, lemon grass, nutmeg and patchouli began in East New Britain Province in 2006.

The value to the national economy of these spices and flavourings is small. However, they provide useful income to villagers, particularly in more remote locations where production and marketing of coffee, cocoa, oil palm or fresh food is difficult. The potential for expansion, or even a return to past production levels, is limited, mainly by poor world prices and consequent low returns to labour inputs. Other factors that limit potential include lack of technical information for growers, poor marketing and inadequate transport.

**Chilli**

Chilli is a type of capsicum used to flavour food in many parts of the world. The most common variety grown in PNG is the particularly pungent ‘birds eye’. It is rarely used in cooking in PNG but is an export cash crop. Birds eye chilli grows between sea level and 1800 m and occasionally as high as 2400 m. Production is non-seasonal. Chilli was introduced commercially on Aropa Plantation in Bougainville Province around 1955. Village plantings were made in the Dogura area of Milne Bay Province from 1959 and production reached 2 tonnes/year between 1959 and 1964. In the 1960s birds eye chilli was promoted as a cash crop in the Popondetta and Tufi areas of Oro Province and around Erave in Southern Highlands Province.

By the early 1970s the main chilli-producing provinces were Oro, Southern Highlands and Milne Bay. The volume exported increased during the 1970s, peaking in 1978–1981 at 190–265 tonnes/year (Figure 5.15.1, Table A5.15.1). Production dropped significantly from 1982. Export prices doubled between 1981 and 1982 and peaked at K6700/tonne in 1986 (equivalent to K29 400/tonne in 2005 buying power), but production fell because of problems with provincial governments’ buying systems. A second
factor was the poor quality of the PNG product and consequent loss of reputation of PNG chilli on the world market.

Production continues in a number of lowland and highland provinces, with several companies exporting. Production levels slowly declined from 1990, to less than 10 tonnes/year. Production has increased somewhat in recent years, with purchases from villagers in East New Britain Province of 19 tonnes in 2001 and 15 tonnes in 2002. Most chilli is grown in village plantings.

In the past, chilli has been grown by smallholders, either before export tree crops commenced bearing or in more remote locations where other cash crops cannot be grown or marketed. Smallholders were prepared to grow chilli when the marketing infrastructure was working, but it was never a popular crop. It provides low returns to labour and irritates the skin and eyes when the fruit is harvested and handled. However, demand exists and exporters struggle to meet it. Chilli production is likely to continue at low levels provided that marketing arrangements continue, but it is unlikely that production will return to that experienced in the late 1970s and early 1980s unless prices, and hence returns to labour, increase greatly.

**Cardamom**

Cardamom is a spice that is a common ingredient in cooking, particularly in South Asia and the Middle East. It is used to flavour tea and coffee in the Middle East and is also used as a medicine. In PNG cardamom grows from sea level to 1900 m but its usual altitude range is 550–1700 m. It was introduced into PNG in the mid 1960s. It is an ideal cash crop for intermediate altitude areas where road access is poor or non-existent, provided that prices are high.

Commercial production commenced in 1973, with early plantings in the Afore area of Oro Province and the Karimui Plateau in Simbu Province. Other plantings were on the Huon Peninsula of Morobe Province, particularly in the Pindiu area; the Baining Mountains and inland Pomio areas in

Spices and flavourings

East New Britain; and the inland Wakunai area of Bougainville Province. Plantations were established by international companies near Karimui (300 ha) in the late 1970s and near Bundi in Madang Province (160 ha) in the early 1980s. Exports commenced around 1974 and peaked at 320–390 tonnes/year from 1985 to 1987 (Figure 5.15.2, Table A5.15.1). The maximum production followed peaks in the world price from 1983 to 1985. Prices dropped in the late 1980s and PNG exports followed the price down. Both plantations ceased operating at about this time and all production since then has come from village plantings.

Renewed interest in cardamom occurred from 1998, with most production coming from the Baining Mountains, and lesser amounts from the Pomio and Wakunai areas, Karimui Plateau, the Huon Peninsula, and Jimi Valley in Western Highlands Province. Between 1998 and 2003, purchases from villagers in East New Britain Province were in the range 32–60 tonnes/year, averaging 48 tonnes/year. But world prices declined steeply in 2003, resulting

in low returns to village growers. In 2004 the export price was less than K2/kg, compared with the peak price of more than K10/kg in 1984 (equivalent to K49/kg in 2004 kina value). Total exports were about 30 tonnes in 2003 and 20 tonnes in 2004, with 21 registered exporters.

Pacific Spices, a company based near Rabaul in East New Britain, commenced buying cardamom again in 2006 and has since exported 80 kg of cardamom oil to Japan, the United Kingdom and Australia. A Port Moresby-based company, Paradise Spices, has been buying cardamom from Simbu and Western Highlands provinces. Purchases from village growers in 2006 and 2007 were less than the period 1998–2003, which in turn was much less than in the mid to late 1980s.

Prospects for further expansion or even maintenance of cardamom exports are constrained by two main factors. The first is low world prices, and hence low prices paid to growers and poor returns to their labour. The second is the poor state of roads or lack

of roads in the intermediate altitude locations where cardamom grows. It is difficult to see a significant increase in production while prices remain depressed and road access is difficult to most producing areas.

**Minor and potential spice export crops**

**Annatto (bixa)**
The red dye annatto is extracted from the pulp surrounding the seeds of bixa and yields a red food colouring and a food flavouring. In PNG bixa usually grows between sea level and 1650 m and occasionally as high as 1900 m. The plant is a native of tropical America and was probably introduced into PNG from Indonesia between 1600 and 1870 (Table 1). A few plants are occasionally grown in lowland and intermediate altitudes and the dye is sometimes used as body paint. Bixa has potential as a cash crop, but has not been grown commercially in PNG.

**Black pepper**
Black pepper is one of the most commonly used spices worldwide. It was introduced into PNG by German settlers in the early colonial period. It grows and bears from sea level to about 700 m and occasionally as high as 1100 m. Pepper was grown experimentally at the Lowlands Agricultural Experiment Station (LAES), Keravat, from 1932, but was not promoted as a cash crop on the Gazelle Peninsula of East New Britain Province until the early 1970s. It was not widely adopted by villagers because labour requirements are high and returns to labour are very much less than for cocoa, betel nut and fresh food. A significant export market did not develop and exports averaged only 1.2 tonnes of peppercorn per year from 1971 to 1976. A very small amount of pepper has been grown for local sale or export since then; for example, 900 kg was sold by two growers in 1991.

Interest in pepper production has been renewed recently. Paradise Spices in Port Moresby is buying pepper for export from growers on the Gazelle Peninsula in East New Britain Province and the Bereina area of Central Province. Pacific Spices has planted about 5 ha and has developed an export market for organically grown pepper. Exports have grown from about one tonne in 2001 to about four tonnes in 2007.

**Cinnamon**
Dried leaves and dried inner bark of cinnamon are used in many parts of the world as a food flavour. Bark from native cinnamon trees is sometimes used in PNG as a food flavouring, a traditional medicine and for ritual purposes. The species that is commonly grown in the tropics (Cinnamomum verum) was introduced to PNG early in the colonial period and has been grown at LAES for many decades. Pacific Spices has purchased several tonnes of bark from the Pomio area, presumably harvested from a native species. About 500 litres of oil were extracted from the bark and exported. Small quantities of dried bark have also been exported. Paradise Spices has purchased cinnamon in Milne Bay Province and exported this as ground cinnamon bark.

**Citronella grass**
Citronella oil is distilled from citronella grass and is used as an insect repellent, as a perfume in soaps and cosmetics, and as a flavouring. Citronella was introduced to PNG in the late 1960s and some small experimental plots were planted. It is being grown commercially on a small scale on a number of plantations and in village plots on the Gazelle Peninsula. Pacific Spices commenced exporting oil in 2007.

**Ginger**
The underground stem (rhizome) of ginger is used as a spice throughout the world. It is also used for medicinal purposes. Ginger is an ancient introduction to PNG and grows between sea level and 1950 m and occasionally as high as 2200 m. It is a widely grown minor garden crop in PNG and used in cooking, as a medicine and in magic. Small quantities are sold in local food markets. Ginger yields well, even under coconut shade (Table 2.4.7). Paradise Spices is buying ginger in a number of lowland and highland provinces and exporting small quantities of ginger root flakes. Pacific Spices is growing ginger on a plantation with a view to extracting the essential oil for export.
**Japanese mint**

An essential oil is extracted from Japanese mint and used to flavour sweets and beverages, including herbal tea. The mint was introduced from Japan in 1968 when there was interest in establishing an industry in PNG. Agronomic trials were conducted at LAES in the early to mid 1970s. No commercial production has followed the experimental work.

**Lemon grass**

Lemon grass is grown to produce an essential oil that is used as a perfume. Lemon grass is also widely used in cooking to flavour food and drinks. In PNG lemon grass grows from sea level up to about 2000 m and occasionally up to 2100 m. It is an ancient introduction and is sometimes grown in villages. It is used to make a herbal drink (lemon grass tea) and is said to have medicinal and magical properties. It is grown commercially in a number of plantations and in village plots on a small scale on the Gazelle Peninsula. Pacific Spices has exported small quantities of lemon grass oil.

**Nutmeg**

Two spices are produced from the fruit of nutmeg trees: nutmeg and mace. The former is the tree seed and the latter is the dried reddish seed covering. They are used throughout the world to flavour foods and an essential oil is extracted for the perfume and pharmaceutical industries. *Myristica fragrans* is native to east Indonesia and is the nutmeg of commerce. It was introduced into PNG in the early colonial period and has been grown experimentally at LAES for many decades. A naturally occurring species of nutmeg in the island of New Guinea, *M. argentea*, has been exported in the past, at least from west New Guinea; for example, in 1894, 77 tonnes of nutmeg recorded as originating in ‘New Guinea’ was sold in Holland.

In 2007 there was about 15 ha of nutmeg in village plantings and 10 ha on two plantations on the Gazelle Peninsula. Pacific Spices processed and exported 1–2 tonnes of nutmeg per year between 2001 and 2007. The company has also extracted and exported some nutmeg oil. Paradise Spices has purchased some nutmeg in Milne Bay Province and exported this as whole or ground nutmeg seed.

**Patchouli**

An essential oil is extracted from the dried leaves of patchouli and used in perfumes, incense and as a scent in household products. Patchouli was introduced to PNG for experimental purposes in the late 1960s. It is grown commercially on a small scale on the Gazelle Peninsula and Pacific Spices has exported small quantities of oil.

**Turmeric**

The underground stem (rhizome) of turmeric is boiled, dried and ground into a deep orange-yellow powder. It is commonly used as a spice in curries and other South Asian cooking, to colour food, and as a dye. It is also used in traditional medicine in Asia. Turmeric is an ancient introduction to PNG. It is widely grown up to about 1000 m altitude and is mainly used as a dye rather than as a food flavouring. Turmeric has been grown for export in Madang, East Sepik and East New Britain provinces. Between 2001 and 2007, Pacific Spices purchased and exported about 4 tonnes of turmeric per year. Paradise Spices recently purchased turmeric for export from Central, East New Britain and Milne Bay provinces.

**Sources**


Lowlands Agricultural Experiment Station (1978). *Lowlands Agricultural Experiment Station* 1928–1978. Lowlands Agricultural Experimental Station, Keravat.


Pyrethrum produces a daisy-like flower that is used to make a natural insecticide. It grows best at high-altitude locations in the equatorial tropics, including in PNG and East Africa, and in some temperate-climate locations, such as Tasmania, Australia.

The active ingredient, pyrethrin, is extracted from dried pyrethrum flowers and used to make insecticides for household, agriculture, public health and food industry uses. These include aerosols, sprays, pet shampoo and mosquito coils. Pyrethrum is valued because it is highly effective at repelling or killing a broad range of insects, but is not toxic to mammals, including humans, and breaks down quickly in sunlight, leaving no residues.

Pyrethrum thrives at very high altitudes in the PNG highlands and flower production rises steeply with increasing altitude (Figure 5.16.1). Production of pyrethrum is weakly seasonal, being slightly higher in September–March and lower in April–August.

**Adoption and history**

Pyrethrum plants were first introduced into PNG in 1938. A number of other introductions were made in the 1950s, with plants from Kenya in 1957 forming the basis for selection of planting material in PNG. Agronomic research commenced at Aiyura in Eastern Highlands Province in 1961, but it was quickly found that the station (1600 m altitude) was too low for pyrethrum production. A new research station was established in 1966 at Tambul in Western Highlands Province (2300 m) and the pyrethrum selection program was moved there. The current germplasm collection is maintained at the Taluma Research Station on the Sirunki Plateau in Enga Province.

A processing facility was established in 1964 by Stafford Allen Ltd (PNG) at Kagamuga near Mount Hagen in Western Highlands Province. The enterprise was not profitable and the Australian Administration purchased the facility in 1973 through the company Kagamuga Natural Products Pty Ltd. The factory operated for another 20 years, but closed in 1994. The plant has a capacity to process 420 tonnes of dried flower per year.

**Distribution of production and planting**

All crop production was done by villagers and pyrethrum was usually interplanted among sweet potato and other crops. The Department of Agriculture, Stock and Fisheries purchased dried flowers from growers. In the late 1960s production was encouraged in many places throughout the highlands, including the Lagaip, Kandep, Wabag and Wapenamanda areas of Enga Province; the Tambul area of Western Highlands Province; the Nipa, Margarima, Ialibu and upper Mendi areas of Southern Highlands Province; the Kerowagi,
Gumine and Gembogl areas of Simbu Province; and the Okapa, Henganofi and Lufa areas of Eastern Highlands Province.

Pyrethrum was initially grown by villagers at altitudes as low as 1800 m, but within a few years the producing areas shrank to a limited number of very high altitude locations where the crop was most productive. By the early 1970s much of the production was concentrated in the Laiagam area (Enga Province), with significant amounts also grown in the Tambul and Gembogl areas. In 1974 an estimated 22 300 villagers grew pyrethrum. By the late 1970s production was confined to a narrow very high altitude band, mostly in Enga Province (96–99%), and the high-altitude upper Nebilyer Valley in Western Highlands Province.

**Levels of production**

During the period 1965 to 1993, between 200 tonnes and 400 tonnes of dried flowers were purchased per year, with a peak of just under 600 tonnes in 1967 (Figure 5.16.2, Table A5.16.1). The volume of pyrethrum extract exported followed the pattern of flower purchases (Figure 5.16.3, Table A5.16.2). The pyrethrum processing factory closed in 1994 and no flowers were purchased between 1995 and 1999.

In 1995, the Enga provincial government, concerned about the lack of cash-earning opportunities for villagers in high-altitude parts of the province, formed the Enga Pyrethrum Company to revive the industry. The company initially operated erratically but was revived in 1999 when the company took possession of the Kagamuga processing plant near Mount Hagen. Because pyrethrum was no longer being grown by villagers, it was necessary to multiply and distribute planting material again. This commenced in 1999 and dried flowers were

---

1 Under optimum conditions, pyrethrum yields about 1200 kg dried flower/ha/year. This contains about 22 kg of the active ingredient (pyrethrin) at 1.8% pyrethrin content. In practice, average grower yields were about 650 kg dried flower/ha/year and PNG pyrethrum has averaged 1.4–1.5% pyrethrin content. A yield of 650 kg dried flower/ha/year containing 1.4% pyrethrin would produce 9 kg of pyrethrin/ha/year.

purchased from 2000 onwards. In 2003–2006 the Enga Pyrethrum Company produced pyrethrum extract which it exported to the United States. The volume of exports has been small compared with volumes in the mid 1960s to early 1990s.

### Sources


---

**Processing, exporters and markets**

One of the most important issues for regeneration of the PNG pyrethrum industry is to ensure that production takes place only at high altitudes (2400–2800 m) so that growers achieve the highest possible yields and the best returns on their labour.

Botanical Resources Australia Pty Ltd, a company based in Hobart, Australia, has signed an agreement with the Enga Government to import PNG’s pyrethrum extract from 2006 to 2008 with an option to extend this arrangement beyond 2008. This company is one of the largest pyrethrum producers in the world and has supplied about 40% of global natural pyrethrum products in recent years.

Enga Pyrethrum Company paid K1.50/kg for dried flowers in 2006 (K2/kg delivered to the Kagamuga factory). This was a much lower price in real terms than was paid in the past. For example, in 1989–1993, the price received by growers was K1.50/kg. However, the kina now has much less purchasing power than in the 1980s and early 1990s because of depreciation of the currency and inflation (see Section 4.2). At current prices, growers are receiving a gross payment of about K2 per day’s labour input. With such a low return to labour, production may not return to the levels experienced from the mid 1960s to the early 1990s (see Section 5.20). The PNG pyrethrum industry may become viable again but this will depend on improved productivity by the growers and the factory producing a reliable supply of good quality product for the export market.

---

2 The Kagamuga factory processes dried flowers into crude pyrethrum extract, which contains about 26% pyrethrin.
5.17 Other income from plants

Sales of fresh food and export cash crops are the major income sources for most rural Papua New Guineans. In addition to the major sources (described in earlier sections of Part 5) many other, non-food, products derived from plants are sold within PNG and sometimes exported. The most important are betel nut, firewood and tobacco. These and some other, mostly small volume, plant-derived income sources are described in this section.

Betel nut and betel pepper

Production, trading, transport and retailing of the stimulants betel nut and betel pepper is a significant economic activity. In the period 1990–1995, sales of betel nut and betel pepper generated an estimated K20 million income for rural villagers, which was 10% of the total income earned by villagers in PNG from agricultural production. It was the fourth most important source of income from agriculture for rural villagers after Arabica coffee, fresh food and cocoa (Figure 5.1.1, Table 5.1.1). About a third of the rural population lived in locations where betel nut was sold, a proportion exceeded only by those involved in selling fresh food or coffee (Figure 5.1.2). The amount earned from betel nut sales has increased since 1995 because of price rises over the past 10–15 years and increased sales in the highlands. The amount earned by retailers of betel nut is much higher than that received by producers because large profit margins occur in betel nut trading.

Betel nut grows in the lowlands and at intermediate altitudes (see Section 3.5). It is generally consumed with the catkins, leaves or stems of the lowland betel pepper plant and with slaked lime. Highlanders began consuming betel nut after the Highlands Highway was upgraded to an all-weather road in the mid 1960s and highland men began working as labourers on lowland plantations. Consumption has increased over the past 40 years and significant quantities are now transported into the highlands to meet the demand. Growth of urban populations has also created a large demand for betel nut. Thus there is a demand for betel nut, pepper and lime from highland rural villagers, who cannot grow betel nut (35% of the national population), as well as from the 19% of the national population who are not rural villagers.

Lowland villagers have responded to the demand for betel nut, betel pepper and lime by expanding plantings. Large numbers of people are involved either in growing, trading and transporting betel nut or retailing it (Figure 5.17.1). In the major urban centres betel nut is sold in markets separate from fresh food markets. Betel nut is moved long distances to markets in the highlands, to Port Moresby, and

---

1 Two food crops were previously grown as cash crops and exported from PNG. These were peanut and purple passionfruit (see Sections 3.2 and 3.3).
2 Clay pots and salt, although not made from plants, are included in this section for convenience.
to mining settlements such as Lihir, Ok Tedi and Porgera. It is also moved shorter distances and sold in all urban centres and numerous other locations (Figure 5.17.2). Most betel nut is moved by road, river or sea transport, but some is flown within PNG, as well as to Australia.

Up to the mid 1970s the demand for betel nut and betel pepper in the highlands was met from production in the Markham Valley and other locations in Morobe Province with road access to the Highlands Highway. With the growth in consumption in the highlands, the area from which betel nut is drawn has expanded greatly to include coastal locations in Sandaun, East Sepik, Madang, Morobe, Oro and Milne Bay provinces; along the Sepik, Keram and Yuat rivers in East Sepik Province; in the lower Ramu River area and Karkar Island in Madang Province; and the west coast of New Britain.

Highlanders travel to lowland locations to buy betel nut from individual producers or from markets. They on-sell to intermediate traders who in turn retail it in highland towns and villages. There are wholesale betel nut markets in Popondetta, Wewak and near Madang town. Betel pepper is sold by Karkar Island traders to highland traders at Kabugum village on the mainland. Lime, manufactured from shells in coastal villages near Lae, is purchased by highland traders in Lae market. 40-Mile market in the Markham Valley was a significant trading point for betel nut producers from the valley and nearby areas. Producers sold betel nut to highlanders who moved it to their home areas, as well as to other traders who sold it in Lae city. An unknown disease has been killing betel nut palms in the Markham Valley since 2003 and the 40-Mile market closed in mid 2007 when supply in this area ceased.

Betel nut and betel pepper sold in the large markets in Port Moresby come from the Bereina area in Central Province and coastal and riverine parts of Gulf Province as far west as Kerema. It is also transported from coastal locations south-east of Port Moresby in Central and Milne Bay provinces.

**Figure 5.17.1** Locations where sales of betel nut provided income for rural villagers, 1990–1995. Source: MASP.
Figure 5.17.2  Betel nut trade routes, 2007. Source: Author’s observations and Tim Sharp (pers. comm.).
Producers or traders sell betel nut and betel pepper to highland traders at a number of locations in Port Moresby and several sites along the Hiritano Highway. These traders sell to other traders or directly to consumers in the city.

### Firewood

Firewood is sold in many urban markets and some rural markets in PNG, particularly in the highlands, but also near major lowland urban centres (Figure 5.17.3). In the period 1990–1995, sales of firewood generated an estimated K5 million income for rural villagers (Figure 5.1.1). Almost a quarter of the rural population (23%) lived in locations where firewood was sold (Figure 5.1.2, Table 5.1.1).

In the highlands, cool night-time temperatures necessitate the use of open fires for heating, as well as cooking. Timber is the most common source of energy used by villagers for cooking. It is also used in urban areas, with much of the firewood purchased in local markets, although kerosene stoves are commonly used in towns. *Casuarina oligodon* is the most common tree species used for firewood in the highlands. A 1978 study in a Simbu Province village recorded average firewood consumption of 1.3 kg/person/day. A 1980 study in Enga Province estimated that average firewood consumption was 2.25 m³/person/year for rural people and 1.9 m³/person/year for urban people. In rural lowlands villages, most firewood comes from trees cleared during shifting cultivation. Fuelwood plantings to supply PNG’s biggest cities have been promoted sporadically in the Atzera Hills near Lae and in the Port Moresby area.

Firewood is also used for processing tea, sugar cane, copra and cocoa; for small-scale bread baking; and for making slaked lime for use with betel nut. Some of this timber is purchased from villagers; for example, Ramu Agri-Industries Ltd buys firewood locally. Firewood is scarce in some lowland rural
locations, including in some villages on the Gazelle Peninsula, but it is not usually traded for cash. Given the increasing population pressure in some rural locations, ongoing urbanisation and the high cost of imported kerosene (Figure 4.3.4), demand for firewood is likely to continue to increase. Expanded production of timber for firewood, construction and industrial use has the potential to generate good income for rural villagers.

**Tobacco**

Tobacco, grown for own use or sale, is one of the most widely grown plants in PNG villages (Figure 3.5.1). Leaves are fire-cured and rolled in newspaper to form a cigarette or sometimes smoked in a pipe. Cured tobacco leaves are sold in many markets or directly to consumers (Figure 5.17.4) and are sometimes sold as cut leaf or as cigarettes rolled in newspaper in some highland markets. In the period 1990–1995, sales of tobacco generated an estimated K3 million income for rural villagers (Figure 5.1.1). About a fifth of the rural population lived in locations where tobacco was sold (Figure 5.1.2, Table 5.1.1). The quantity sold per person was generally low, as was income per person.

Commercial tobacco production has a long and not particularly successful history in PNG. The German-owned Neuguinea Kompagnie grew up to 240 ha of tobacco for export at several sites near modern Madang between 1888 and 1902, but rapid losses of soil fertility and pests and diseases caused the crop to be abandoned. Tobacco was also grown as a minor export crop on a number of plantations in East New Britain and Bougainville in the 1930s; for example, 10 ha of plantation tobacco was grown in the Territory of New Guinea in 1933.
Tobacco was grown by two companies in the Madang and Port Moresby areas from 1958 and in the Goroka area from 1960. In 1977 a total of 90 ha of estate tobacco was grown in the Goroka area, the Markham Valley, and on a small estate in the Saidor area of Madang Province to supply a factory in Goroka manufacturing cigarettes, twist tobacco and coarse-cut tobacco products for the domestic market. Estate production in the Goroka area ceased in the late 1970s, and large-scale commercial tobacco production in the Markham Valley ceased in the 1980s.

Tobacco was promoted as a cash crop for villagers in Eastern Highlands Province between 1970 and about 1978. By 1971 there were about 150 growers in the Bena Bena and Asaro valleys. In 1975 an area of 97 ha was planted to produce flue-cured tobacco (used in cigarette manufacture) by 500 village growers in the Goroka and Asaro areas. Village growers, dissatisfied with prices paid by the buying companies, ceased production for cigarette manufacture in the late 1970s. The proportion of locally grown tobacco used in manufacture was small, even in the mid 1970s. In 1977 only 3% of PNG requirements were grown locally, with the rest imported. Cigarettes for domestic sale are currently manufactured by British American Tobacco (PNG) Limited at a plant in Madang using imported leaf.

Marijuana is an illegal cash crop that is grown in at least five provinces (see Section 3.5). The quantity grown and value are not known, but anecdotal information and a limited number of published papers indicate that significant quantities are sold, particularly in the larger urban centres; that marijuana cultivation is an income source for some people in rural locations; that its sale is used to fund purchases of guns and ammunition; and that the returns for some middlemen are large. Marijuana is reportedly exported via Torres Strait or other routes to Australia, where it has a reputation for a high content of the active ingredient (THC). However, the extent of international marijuana trade, including the guns-for-drugs trade to Australia, is probably overstated.

Prices in the producing areas are much less than in Australia. By 2007 marijuana was being sold more or less openly in markets in at least three highlands provincial capitals and by many street sellers in Port Moresby. Arrests for growing are sporadic.

Kava was grown and used in a limited number of places in PNG, including locations in Western Province, some small islands in Manus Province and near Madang town. It is still used occasionally in some of these locations, but its use and consumption remain limited. An export market for kava developed in the Pacific in the late 1990s, with demand in Europe and the United States, but kava was exported from PNG only on a very small scale. The PNG Spice Industry Board reported in 2001 that small quantities were grown and processed in several locations in Madang and East Sepik provinces. The dried kava was exported to Japan and Australia. Reports of liver damage from overconsumption of dried kava have caused European and American markets to be restricted.

Building material. Most houses in rural PNG are made from locally grown plant material, including timber, woven cane (used for walls and partitions) and thatch for roofing. People normally gather the material for their houses themselves, but some building material is sold at roadside markets or within villages, particularly sheets of woven cane.

---

3 In the early 1990s marijuana was regularly offered in rural parts of the highlands at K5–7 for a cigarette pouch, containing 30–50 grams. The same quantity was worth several hundred dollars on the street in Australia at the time. The price in highland markets in 2007 was 50 toea per cigarette, or K15 for a one kilogram rice bag, containing perhaps 300–500 grams. These weights are estimates.
Canoes are widely used to transport people and goods in rivers and the ocean. Timber with particular characteristics is needed to construct the various parts of canoes, including hulls, outriggers and masts. Where this is not available locally, it is sometimes purchased from villagers in other locations. Making and selling canoes is a specialised activity on, for example, Panoe and Gawa islands in Milne Bay Province. Large ocean-going canoes from these two islands are exported to nearby islands in south-east and north-east Milne Bay Province respectively.

Carvings, bowls and other artefacts are commonly made from wood in PNG. They are sold for local use, in urban markets, to tourists, and some are exported. Occasionally people sell timber to others for carving; for example, on Kiriwina Island in Milne Bay Province, timber for carving is sold by people on the south of the island to people in the north. People from Ialibu in Southern Highlands Province and south-west Bougainville Island are renowned for the high-quality items they make from woven cane, such as trays, table mats, baskets and handbags. People from other highlands locations have copied these products and are also weaving items for sale. The volume and value of trade in carvings, woven items and other wooden artefacts is unknown, but is significant. Such items are sold in all major and many smaller urban centres.

Clay pots are made in a number of locations, particularly along the New Guinea north coast, parts of Milne Bay Province such as the Amphlett Islands and in parts of East Sepik Province. They are traded for food in a number of locations in Milne Bay and Manus provinces (see Box 5.3) and are sometimes sold for cash.

Clothing in the pre-European period was made from plant material, including reeds (for skirts), bark (for belts), gourds and shrubs. In parts of the highlands, men covered their buttocks with Cordyline fruticosa leaves. In the western part of the highlands, women’s skirts were made from the Eleocharis dulcis reed. Traditional clothing has become uncommon, however, and has been largely replaced by second-hand clothing imported from Australia. Traditional clothing is now worn mostly for ceremonial occasions or in some remote locations by older people. Some clothing made from local plant material is sold occasionally.

Furniture. High-quality furniture is made from PNG hardwood timber and cane, but domestic demand is small and little furniture is exported. Most hardwood timber is exported as round logs to China, Japan and Korea (see Section 5.8).

Kapok was introduced to PNG in the 1880s as a potential export crop. It grows from sea level to 1250 m altitude. Kapok was exported from about 1900 until about 1940, with most production from plantations in East New Britain and Madang provinces and small amounts from most other lowland provinces.

Mats and brooms. Floor and sleeping mats are made from pandanus leaves, particularly on some small islands. These have been largely replaced by imported manufactured items, but continue to be made in some locations and may be occasionally sold. Brush brooms are made from locally grown plants and are commonly sold in markets.

Ropes were made in PNG from fibres from a number of plants. Imported rope has largely replaced locally produced rope. Ropes for tethering pigs are sold in highlands markets, but even they are mostly made from imported fibre except in remote locations.

Sisal was introduced into PNG as a potential export crop in the early 1900s. By 1917, 2400 ha was being cultivated in Central Province and processing equipment had been set up in four locations. Some sisal fibre was exported until the mid 1920s, when production ceased.

String bags (bilums) were made from fibre from the bark of a number of plants, including the tulip tree, a species of Ficus, a Syzygium species and Hibiscus tiliaceus. Nowadays, bilums are mostly made from imported wool or string because these fibres last longer. Nevertheless, bilums made from locally grown plant fibre are still widely used in some parts of PNG, including in the Telefomin and Okompan areas of Sandaun Province. A large number of bilums are sold in urban markets each year. They are widely used within PNG by women, men and children, and are increasingly used in Solomon Islands, and a small number are exported to Australia.
**Tools** are made from a range of material, including timber, bamboo, fibre and bone. Metal axe heads and spade blades have almost completely replaced those made from stone and timber. Wooden digging sticks are still widely used in the highlands. Axe handles are homemade and are sometimes sold in highlands markets.

**Weapons**, including bows, arrows, spears, shields and axes, were very widely used in PNG for hunting birds and game animals and for fighting. These have been partially replaced by firearms, including shotguns and high-powered rifles. However, traditional weapons are still made and used, and a small proportion are sold. Stocks for homemade shotguns are commonly made from wood in the highlands, and presumably some are occasionally sold.

**Other items** made from plants include musical instruments, lime containers (for use with betel nut), bamboo smoking pipes and household vessels. These are not seen in markets, but some are probably sold occasionally.

### Salt

The production and trading of salt has been reported from many parts of PNG. Salt was extracted from sea water, springs and plant ash. To extract salt from springs, grass, leaves or sticks were placed in the spring for a period, then dried and burnt and the ash collected. Where saline springs were absent, people made salt from a number of plants, for example, from the perennial cane grass, *Coix gigantea*, in the Wonenara area of Eastern Highlands Province. Bars of salt were traded long distances in some inland locations. It is not known whether these practices still persist as imported salt is widely available, but it is possible that locally manufactured salt is still traded in some places.

### Minor forest products

**Cajuput oil** is produced from distilling the leaf of *Asteromyrtus symphyocarpa*, a tree that occurs naturally in seasonally inundated areas of Western Province south of the Fly River. Stills are operated by village communities. The oil produced is sold in bulk to local buyers including trade stores in Daru. Trade store owners ship the oil to Port Moresby where it is bottled as Waria Waria oil and retailed through pharmacies and supermarkets or through direct orders. The oil is used externally for the relief of coughs and colds, aches and pains and as a mild antiseptic for wounds. The village industry started in 1996 with the first commissioned still. Current production is around 200 litres per year and is worth about US$8000.

**Copal gum** is a resin extracted from the bark of kauri trees (*Agathis* spp.), used chiefly for making varnishes. Natural stands occur in Sandaun and East Sepik provinces with some smaller stands elsewhere in the lowlands. Copal was exported from Sandaun Province, at least until the late 1970s.

**Dammar resin** is extracted from the sapwood of a tree species (*Vatica papuana*) that is present in southern Western Province and some islands in Milne Bay Province. Exports from Tagula (Sudest) Island in Milne Bay Province commenced in 1887 and continued intermittently until the 1970s.

**Eaglewood** trees grow in New Guinea rainforest below 600 m altitude. The tree produces a fragrant resin that has been exported from PNG since 1998 (see Box 5.17). Over the period 1999–2007 official exports averaged 5.5 tonnes/year, with a mean value of US$438 000/year (Table 5.17.1). The volume peaked in 2001–2003.

**Ivory nut** is the seed of a plant related to sago and was once used to make buttons. It was exported from PNG between about 1900 and the 1930s.

**Massoi bark** (*Cryptocarya massoy*) is an aromatic bark used as a medicine in South-East Asia. The tree is widely distributed in the lowlands of mainland PNG provinces. Some massoi bark was exported from Sandaun Province from near the Indonesian border, at least until 1990.
The eaglewood tree produces a fragrant resinous wood that is highly sought after in parts of Asia and the Middle East where it is used for religious and medicinal purposes. High-quality resin can attract very high prices per kilogram. In PNG, a species of eaglewood, *Gyrinops ledermannii*, was first harvested for resin production in about 1998 in the Yapsiei, May River and Ama areas of Sandaun Province. Since then, there has been a significant expansion in the rates of harvesting and export of eaglewood resin (which is often referred to in PNG by its Indonesian name ‘gaharu’). Gaharu is primarily harvested in parts of Sandaun, East Sepik and Madang provinces, although a limited amount of harvesting occurs in other parts of the country. The presence of eaglewood has also been confirmed in Gulf, Central, Southern Highlands and Western provinces and there are anecdotal reports of its presence in Enga, Milne Bay and Oro. In PNG, eaglewood grows in rainforest between 70 m and 600 m altitude (but has been recorded at over 1000 m), and where mean annual rainfall ranges between 1700 mm and 5200 mm and is not strongly seasonally distributed. It is important to note that only a small percentage of eaglewood trees contain gaharu. The resin is produced as a chemical defence following injury to the tree. The ability to recognise which individual trees contain gaharu is important for the sustainable management of the resource.

The natural distribution of eaglewood is associated with some of the poorest and remotest rural communities in PNG. This presents both the opportunity to increase income levels in these communities and the challenge of overcoming problems associated with poor access to markets and information. Access to information is particularly important because destructive and inappropriate harvesting and management practices have already led to the severe depletion of trees in some areas. WWF (formerly The World Wide Fund for Nature) has developed a plan, already implemented in some communities, that assists villagers to manage their eaglewood resources through ‘14 steps for sustainable gaharu harvest’.

According to official records, there are two main gaharu exporting companies operating in PNG, which between them employ about 24 agents who purchase gaharu from several hundred rural households. Prices are determined by the grade of gaharu. Currently there are five grades designated according to the colour, shape and density of the wood. The PNG Forest Authority introduced pricing guidelines in early 2001 to prevent unscrupulous buyers from exploiting villagers who may not be aware of the true value of gaharu. The top grade of gaharu currently attracts a premium price of US$560/kg.

The unreported and unlicensed trade in gaharu is thought to be much larger than the legal trade and is a threat to the sustainable management of eaglewood. The main destination for gaharu from PNG is Singapore, with smaller amounts exported to Malaysia and Indonesia.

For more information on eaglewood in PNG see Gunn et al. (2004).
Other income from plants

From the 1890s onwards. Over the period 1997–2007 exports averaged 43.6 tonnes/year, with a mean value of US$57 000/year (Table 5.17.1).

Seeds of a number of native plants, orchids, trees and palms have been exported from PNG for use in horticulture and forestry. Several tree species including *Acacia mangium*, *A. crassicarpa*, *Eucalyptus pellita* and *E. deglupta* (*kamarere*) have formed the basis of major plantation developments in South-East Asia since their introduction to commercial forestry there in the mid 1980s.

Tannins are extracted from the bark, roots or leaves of plants. A factory to extract tannin from mangroves was established at Aird Hills in Gulf Province in 1954, but closed after operating for three years.

Tigaso oil (sometimes spelt digaso oil) is the dark brown oily sap of a tree (*Campnosperma brevipepitolata*). People in the Lake Kutubu to Mount Bosavi area of Southern Highlands Province extract the oil by hollowing out one side of the trunk of a mature tree and allowing the sap to accumulate in the hole. They then trade the oil long distances to higher altitude locations in Southern Highlands and Western Highlands provinces where these trees do not grow. People mix the oil with sweet-smelling noni (*Morinda citrifolia*) is common in many coastal locations and interest in its commercial production is increasing. A number of products made from noni, particularly noni juice, have become popular as herbal medicines in Western countries and the Pacific since the 1990s. The juice and other products are exported from a number of Pacific island countries. One business has been buying noni fruit in Lae in recent years.

**Rattan.** There are approximately 60 species of rattan cane in PNG. Rattan cane was exported from PNG in the 1980s and 1990s and has been used for local furniture manufacture. The current status of exports is not known.

**Sandalwood** (*Santalum macgregorii*) is a tree endemic to PNG that is found in the seasonally dry lowlands of Central and Gulf provinces together with a separate population in Western Province. The natural distribution of the species has been dramatically reduced by fire and harvesting to the point where it is under threat of extinction in the wild. Sandalwood is highly sought after, particularly in Asia and the Middle East, for carving, incense, perfume and medical preparations derived from the oil. Exports of PNG sandalwood are recorded from the 1890s onwards. Over the period 1997–2007 exports averaged 43.6 tonnes/year, with a mean value of US$57 000/year (Table 5.17.1).

**Seeds** of a number of native plants, orchids, trees and palms have been exported from PNG for use in horticulture and forestry. Several tree species including *Acacia mangium*, *A. crassicarpa*, *Eucalyptus pellita* and *E. deglupta* (*kamarere*) have formed the basis of major plantation developments in South-East Asia since their introduction to commercial forestry there in the mid 1980s.

Tannins are extracted from the bark, roots or leaves of plants. A factory to extract tannin from mangroves was established at Aird Hills in Gulf Province in 1954, but closed after operating for three years.

**Tigaso oil** (sometimes spelt digaso oil) is the dark brown oily sap of a tree (*Campnosperma brevipepitolata*). People in the Lake Kutubu to Mount Bosavi area of Southern Highlands Province extract the oil by hollowing out one side of the trunk of a mature tree and allowing the sap to accumulate in the hole. They then trade the oil long distances to higher altitude locations in Southern Highlands and Western Highlands provinces where these trees do not grow. People mix the oil with sweet-smelling noni (*Morinda citrifolia*) is common in many coastal locations and interest in its commercial production is increasing. A number of products made from noni, particularly noni juice, have become popular as herbal medicines in Western countries and the Pacific since the 1990s. The juice and other products are exported from a number of Pacific island countries. One business has been buying noni fruit in Lae in recent years.

**Rattan.** There are approximately 60 species of rattan cane in PNG. Rattan cane was exported from PNG in the 1980s and 1990s and has been used for local furniture manufacture. The current status of exports is not known.

**Sandalwood** (*Santalum macgregorii*) is a tree endemic to PNG that is found in the seasonally dry lowlands of Central and Gulf provinces together with a separate population in Western Province. The natural distribution of the species has been dramatically reduced by fire and harvesting to the point where it is under threat of extinction in the wild. Sandalwood is highly sought after, particularly in Asia and the Middle East, for carving, incense, perfume and medical preparations derived from the oil. Exports of PNG sandalwood are recorded from the 1890s onwards. Over the period 1997–2007 exports averaged 43.6 tonnes/year, with a mean value of US$57 000/year (Table 5.17.1).

**Seeds** of a number of native plants, orchids, trees and palms have been exported from PNG for use in horticulture and forestry. Several tree species including *Acacia mangium*, *A. crassicarpa*, *Eucalyptus pellita* and *E. deglupta* (*kamarere*) have formed the basis of major plantation developments in South-East Asia since their introduction to commercial forestry there in the mid 1980s.

Tannins are extracted from the bark, roots or leaves of plants. A factory to extract tannin from mangroves was established at Aird Hills in Gulf Province in 1954, but closed after operating for three years.

**Tigaso oil** (sometimes spelt digaso oil) is the dark brown oily sap of a tree (*Campnosperma brevipepitolata*). People in the Lake Kutubu to Mount Bosavi area of Southern Highlands Province extract the oil by hollowing out one side of the trunk of a mature tree and allowing the sap to accumulate in the hole. They then trade the oil long distances to higher altitude locations in Southern Highlands and Western Highlands provinces where these trees do not grow. People mix the oil with sweet-smelling

---

**Table 5.17.1 Volume and value of eaglewood and sandalwood exports, 1997–2007**

| Year | Eaglewood | | | | Sandalwood |
|------|-----------|-----------------|-----------------|---|---|---|---|
|      | Volume (kg) | Value (US$) | Volume (kg) | Value (US$) |
| 1997 | – | – | 22,000 | 46,956 |
| 1998 | – | – | 20,000 | 47,000 |
| 1999 | 1,011 | 136,888 | 19,000 | 47,930 |
| 2000 | 2,670 | 541,442 | 42,000 | 36,269 |
| 2001 | 10,529 | 1,644,687 | 53,259 | 47,554 |
| 2002 | 9,380 | 521,838 | 126,092 | 153,387 |
| 2003 | 12,127 | 502,982 | 76,760 | 117,718 |
| 2004 | 4,560 | 205,462 | 52,160 | 67,560 |
| 2005 | 5,046 | 208,452 | 50,870 | 40,346 |
| 2006 | 3,556 | 142,597 | 2,000 | 2,000 |
| 2007 | 928 | 33,690 | 15,354 | 22,419 |

Source: Anna Martin, PNG Forest Authority.
leaves and rub the mixture on their bodies and hair as a cosmetic and a perfume before ceremonies. A related species (*Buchanania* sp.) is used for the same purpose. It is reported that petroleum-based oils, such as engine oil, and vegetable cooking oil are now being used as a substitute, but the trade in tigaso oil continues. The oil was carried in bamboo tubes until the late 1980s, but by the mid 1990s it was being stored in plastic containers and was flown out from Pimaga airstrip for sale in the highlands.

The island of New Guinea has the greatest concentration of orchid species in the world, with more than 10% of an estimated 30,000 world orchid species. This presents an unrealised potential for development of a horticulture industry to export orchids. Self-sown orchids are said to be exported illegally. Temperate-climate flowers, like roses, grow well in the highlands. Export potential, for example to Japan, is severely constrained by a lack of air cargo capacity and reliability.

**Ornamental horticulture**

Cut flowers are rarely sold in fresh food markets in PNG, unlike some other Pacific island centres, such as Honiara. Some flowers are sold at a craft market in Port Moresby, where they sell readily. For many years villagers have sold rings of alpine flowers to motorists near Daulo Pass in Eastern Highlands Province. These are worn or placed on vehicles to indicate that someone has been on a journey via Daulo Pass. Everlasting daisies are used as hair decoration in parts of Southern Highlands Province and may be sold occasionally.

There is potential for significant expansion of ornamental horticulture in PNG, with possible markets being:

- Domestic markets, particularly in the larger urban areas.
- Export of domesticated indigenous orchids and palms.
- Export of temperate-climate flowers, such as roses, from the highlands.

Domestic demand is unsatisfied and production could be expanded. The market includes restaurants, hotels, business houses and funeral-related sales. Currently plastic flowers are used in many PNG funerals, but this could change if a good supply of fresh flowers was available. Cut flowers for hotels and restaurants are sometimes supplied from within PNG, but imported flowers are mostly used, including orchids from Malaysia and Singapore. The value of flowers imported in 2004 was K139,000 (Internal Revenue data).

**Sources**


5.17 Other income from plants


5.18 Income from animals

Small amounts of income are derived from the sale of a wide range of animal products in PNG. This is illustrated by the variety of animal products sold in one small highlands urban market (Table 5.18.1). The income received is usually small and irregular, but larger amounts can be earned, particularly from the sale of chickens. The quantities sold and income earned from animal products are not well known. Changes have occurred in recent decades in the type of product sold; for example, there has been an increase in the total number of live chickens sold and a probable decrease in other items, such as meat from hunted wild animals. Income from fish and other marine and freshwater animals, other than crocodiles, is covered in Section 5.9.

### Domestic animals

The most important domestic animals marketed live and as meat are pigs, chickens and cattle (Table 2.6.3). Minor domestic animals sold for meat include goats, sheep, ducks and rabbits. Dogs, cats, cassowaries and other captured birds and mammals are occasionally sold as pets. Future prospects for expanded production of domestic animals are discussed in Section 2.6.

**Pigs** are the most important domestic animal in PNG, but the sale of pig meat or live animals is only a minor source of income in most locations, even in the highlands where pigs are most numerous (Table 2.6.2). In some places where other sources of income are unavailable, for example in the Tari basin in Southern Highlands Province, sale of pork or live pigs is the single most important income source. The price of large animals is often very high, particularly in the highlands, where a large pig may fetch more than K1000. Sale of pig meat is a common response to the need for cash. For example, during the 1997 drought and associated food shortages villagers in parts of the highlands killed pigs, which were becoming difficult to feed, and sold the meat to raise cash to buy imported rice and flour. Pigs and pig meat are significant in customary exchanges in parts of the highlands.

As well as significant village production, there is a small commercial pig sector in which animals are raised to be sold to abattoirs or directly to individual buyers for local slaughter.

**Chickens** are sold as live animals and occasionally as meat. The chickens are either from free-range village production or from peri-urban and village small-scale 'chicken projects'. Large numbers of broilers are grown by smallholders and sold to one large firm near Lae. Chicken eggs are a minor source of income. Peri-urban chicken production has grown rapidly over the past 20 years and is a profitable enterprise for people who live near an urban area or other market. Prices of live chickens in local markets

---

1. See Hide (2003:102–110) for a review of the scattered information on trade, exchange and sale of pigs and pork in PNG.
are generally higher than for equivalent-sized frozen birds produced by two large companies and sold in retail stores and supermarkets.

**Cattle** are sold as live animals for slaughter through abattoirs, directly to consumers or as meat in food markets. In the period 1990–1995, sales of cattle and beef meat generated an estimated income of K2.4 million per year for rural villagers (Figure 5.1.1, Table 5.1.1). It was estimated that 13% of the rural population lived in locations where cattle were sold (Figure 5.1.2). There are small village herds in most lowland and highland provinces, with the greatest concentration in Morobe Province.

### Crocodiles

There are two species of crocodile in PNG. Saltwater crocodiles (*Crocodylus porosus*) inhabit both fresh and salt water and are endemic to the western Pacific, South-East Asia and Australia. Their skins are very highly valued for making fashion accessories such as handbags, shoes, purses, wallets and belts. The second species, the New Guinea freshwater crocodile (*C. novaeguineae*), is endemic to the island of New Guinea only and lives in fresh water. Freshwater crocodile skins are not as highly valued as the saltwater species.

Crocodile skins have been exported since the 1950s (Table A5.18.1). In the mid 1960s large animals became over-harvested and the stock of wild animals rapidly declined. In 1966 it became illegal to sell crocodile skins with a belly width greater than 51 cm. This law reversed the decline of large wild animals, but resulted in greater harvesting of smaller animals.

Crocodiles in PNG are hunted in the wild and are farmed. In places with extensive wetlands, villagers hunt wild crocodiles and sell the skins to traders. The skins are sold to export companies and sent to tanneries overseas. Young animals are sold to large commercial crocodile farms or raised in small village enclosures.

In the period 1990–1995, sales of crocodiles or crocodile skins generated income of almost one million kina per year for rural villagers (Figure 5.1.1, Table 5.1.1). It was estimated that 4% of the rural population lived in locations where crocodiles or skins were sold (Figure 5.1.2). Most young crocodiles sold to large farms come from Ambunti District in East Sepik Province. The bulk of skins from wild animals come from Gulf and Western provinces, but crocodile skins are produced in most lowland provinces (Figure 5.18.1).

The value of crocodile skin and crocodile meat exports was estimated in 2005 as K35 million. In 2006 the Department of Environment and Conservation (DEC) issued 68 licences for crocodile traders, 24 for buyers, 18 for exporters and 3 for crocodile farming. Most skins exported from PNG are from freshwater crocodiles (60–70% since 1998) (Figure 5.18.2). The number of skins exported from freshwater and saltwater wild animals has been 20 000–25 000 skins per year since 2001. Specialists in DEC consider that this level of export does not present a threat to the number of wild animals. As well, 5000–8000 skins from farmed saltwater crocodiles are exported each year. The total number of skins exported has been 25 000–33 000 per year (average 29 000) since 1998 (Table A5.18.2). There was a surge in the number

<table>
<thead>
<tr>
<th>Table 5.18.1 Animal products sold in Kainantu market, 1979–1982</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live animals</td>
</tr>
<tr>
<td>Meat</td>
</tr>
<tr>
<td>Eggs</td>
</tr>
<tr>
<td>Other</td>
</tr>
</tbody>
</table>

Note: The most commonly sold products were live chickens, pig meat and chicken eggs. Other products were sold only occasionally over the survey period. The volume of live chickens has increased greatly since these surveys were conducted and some of these items may no longer be sold in Kainantu market.

Source: Unpublished markets surveys, R.M. Bourke and K. Nema. Surveys conducted every two weeks over a 36-month period (June 1979 to May 1982).
Figure 5.18.1 Locations where sales of crocodiles provided income for rural villagers, 1990–1995. Source: MASP.

Figure 5.18.2 Number of freshwater and saltwater crocodile skins exported, 1997–2005.
of wild freshwater crocodiles caught and exported in 1997, presumably because they were easy to catch when stream levels were low during the major drought in that year, and people needed cash to buy food. Most exports go to Japan (about 70%), Singapore and France.

Wild crocodile numbers are closely monitored by staff from DEC. If this monitoring is not conducted, exports of crocodile skin from PNG will be prohibited under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Monitoring by DEC staff over the period 1982–2006 indicates that the number of saltwater crocodiles is increasing and numbers of the freshwater species are stable in the middle and upper Sepik River region.

The largest crocodile farm in PNG is owned by Mainland Holdings near Lae. It had 51 000 saltwater crocodiles in 2008, which will generate about 10 000 skins per year for export. The crocodiles are fed in part on chicken carcasses from a poultry farm. For the past 20 years this company has sourced about half of its crocodiles from wild juveniles, with the rest from its own eggs and a limited number of eggs from wild animals. Since 2004 however, its stock has come from eggs taken from wild crocodile nests (about half), from farmed eggs (a third) and from wild juveniles (about one sixth). The wild eggs are taken from nests in the upper Sepik River in Ambunti District of East Sepik Province by Mainland Holdings and DEC staff. Villagers are paid K10 per viable egg. The wild juveniles come from a number of lowland provinces, including Oro (Musa Valley), West New Britain, Morobe (Umboi Island, Morobe coast, Watut River), Madang and Bougainville.

Small amounts of crocodile meat are sold to up-market restaurants in PNG and about 40 tonnes/year is exported by Mainland Holdings to Australia.

### Honey

The European honey bee (Apis mellifera) was first introduced to PNG from Australia in the late 1930s by expatriates, for their own use. Swarms from existing hives and further introductions in the 1960s and 1970s has led to this species becoming widespread in PNG. These bees are most productive at 1500–2000 m altitude in PNG and a small honey industry was established in Eastern Highlands Province (EHP) and other highlands provinces in the early 1970s. Honey production in 1975 was about 25 tonnes. Growth continued until 1986 when the number of hives peaked at about 4000, with 500 producers harvesting 120 tonnes of honey in that year. The honey was processed and packed at a plant near Goroka by the Highlands Honey Producers Company. Some was sold on the domestic market and some was exported to Europe where it was marketed as ‘organic’, but exports ceased in the early 1990s. Production per colony declined from 30 kg to 20 kg in the 1990s due to poor management, low prices, the closure of the honey producers cooperative, competition from the invading Asian bee (A. cerana) and changes in nectar sources following the 1997 drought (Figure 5.18.3, Table A5.18.3).

Recently the industry has made a slow recovery. Prices have improved and the Eastern Highlands Provincial Government has supported honey producers with training. Most honey production is concentrated in EHP, with about 370 producers who typically have 5–10 hives each. The New Guinea Fruit Company is the principal buyer, processor and marketer of honey in EHP. There are a limited number of hives in the other four highlands provinces; near Oksapmin in Sandaun Province; and in Bougainville Province. The number of producers is expanding slowly and interest is increasing from potential producers elsewhere in the highlands.

Honey is sold on the domestic market, with about half through informal arrangements and the remainder through New Guinea Fruit Company. Production in 2007 of about 40 tonnes was worth an estimated K500 000 to growers. Domestic consumption is about 200 tonnes/year, so about 160 tonnes of honey is imported each year.

Both the domestic and export market offer potential for expanded production. Eastern Highlands Province has capacity for an estimated 20 000 colonies (from about 3000 currently). There is demand for 500–600 tonnes/year of PNG organically certified honey from a number of overseas buyers. PNG honey is able to be marketed as ‘organic’ because antibiotics, miticides, pesticides
Interest in buying PNG butterflies began in the early 1970s, with trading dominated by a few foreigners. In 1974 the Australian Administration started an Insect Farming and Conservation Project, which became the Insect Farming and Trading Agency (IFTA) in 1978, based in Bulolo. It is currently part of the University of Technology’s commercial arm, University Development Consultancy.

Three other organisations are involved in marketing insects from PNG, but the two organisations that dominate this market (IFTA and Wau Ecology Institute) are both based in Morobe Province. A study over an eight-year period (1995–2002) found that insects were farmed in all provinces except Enga in 1995 but, by 2002, farming was reduced to eight provinces. The number of insect farmers was stable at 120–130, but there was a greater concentration in the Wau and Bulolo areas of Morobe Province. The total amount earned per year from insect farming and collecting was in the range K60 000–K120 000 for the period 1995–2002. Average income per farmer or collector over this period was K350/year. However, income has declined over the period 2002–2008.

An international market exists for dried insect specimens. ‘Farming’ insects provides income to small numbers of people in PNG. Butterflies are the main insect exported, with lesser numbers of beetles, stick insects and other insects. Specimens must be undamaged, so they are produced by ‘farming’ rather than collecting adults from the wild. ‘Butterfly farming’ involves the farmer planting foods that butterflies eat. Butterflies lay eggs on the food plants, which support caterpillars until they form pupae. The farmer collects the pupae and either sells it to traders or hatches the pupae, kills the newly hatched butterfly and sells the butterfly.

### Insect farming

Figure 5.18.3 Estimated honey production in Eastern Highlands Province, 1975–2007. Sources: Hardie et al. (2005) and Tella Loie, Department of Primary Industry, Goroka.
because of shrinking international demand, reduced profitability for traders and problems with obtaining PNG export permits.

### Silk

A small village-level silk industry existed in Southern Highlands and Western Highlands provinces between 1979 and 1983. Cocoons of silk were produced by silkworms fed on mulberry leaves and the cocoons were exported. The fledgling industry collapsed when government funding was withdrawn. Production was greatest in the Lake Kutubu area of Southern Highlands Province.

### Other animal products

**Plumes and pelts.** The plumes of many birds, especially birds of paradise, parrots, hornbills, hawks and cassowaries, and the pelts of a number of animals, including tree kangaroo and cuscus, are used as ornaments and decoration in customary dress. Such items were important in local trade and gift exchanges in the recent past. They are sometimes sold for cash. The volume sold or traded is probably declining. In the period 1990–1995, sales of plumes and animal skins generated income of almost one million kina per year for rural villagers (Figure 5.1.1, Table 5.1.1). It was estimated that 5% of the rural population lived in locations where these were sold (Figure 5.1.2).

Sales of plumes and pelts are greatest in locations with low population densities, especially on the northern and southern fringes of the central highlands (Figure 5.18.4). The value of sales is very much less than that for fresh food or the main export cash crops, which tend to be grown in areas with better market access.

**Live wild animals.** Some wild animals are occasionally sold live. These include parrots, hornbills, other birds, cuscus and bandicoot. Young cassowary birds raised from wild chicks are sold to highlanders by people who live on the fringe of the highlands where the human population density is low and wild birds can be found. Adult birds are highly priced.

**Game meat.** Small amounts of wildlife meat or animals intended to be killed for meat are sold in markets or directly to consumers. Animals sold include cuscus, wild pig, tree kangaroo, wallaby, bandicoot and birds. Larvae of certain beetles and moths are also sold for food in some places.

**Wildfowl eggs.** Wildfowl eggs are sometimes sold for food, particularly on the Gazelle Peninsula in East New Britain Province and in a number of locations between Talasea and Bialla in West New Britain Province. Eggs were being sold in West New Britain Province for K4 each in 2007.

### Sources


Figure 5.18.4 Locations where sales of plumes and animal skins provided income for rural villagers, 1990–1995. 
Source: MASP.


Land and human labour are the main inputs for most agricultural production in PNG. A minimum use is made of purchased inputs, such as fertilisers and pesticides, except in the plantation sector. Even there, the volumes used are low by world standards. The most common purchased inputs in PNG agricultural production are basic tools, especially spades, machetes ('bush knives') and axes. Coastal- and river-dwelling villagers engaged in subsistence and commercial fishing also buy nets, lines and other fishing equipment.

The use of mechanical tillage for village agriculture is limited. The soil is tilled using tractor-drawn ploughs in the upper Markham and Ramu valleys for peanut crops. Occasionally villagers use tractors or small machines to till the soil for vegetable production in the highlands, but this is uncommon. Boats powered by outboard motors are used for fishing in some locations, but non-motorised canoes are more common. Vehicles and boats are used to transport food and cash crops in many locations, and buffalo-drawn carts in a few places. However, almost all agricultural produce is carried by people or canoe 'on the farm'.

Little seed or other planting materials are purchased for PNG agriculture. The most significant is oil palm seed, which is produced by New Britain Palm Oil Limited (NBPOL) at Dami Oil Palm Research Station, West New Britain Province. Seed from Dami is used throughout PNG oil palm growing areas and is also exported (see Section 5.7).

Coffee seed and seedlings are sold by the Coffee Industry Corporation Coffee Research Station at Aiyura in Eastern Highlands Province. Some coffee growers buy this seed to produce seedlings which they sell to other coffee growers. Improved cocoa seed and seedlings are sold by the Cocoa Coconut Institute (CCI) Research Station at Tavilo in East New Britain Province. Coconut seedlings are sold by the CCI Stewart Research Station in Madang Province. Small quantities of temperate vegetable seed are imported and sold through retail outlets. Seed potato is imported from Victoria in Australia and is multiplied by the Fresh Produce Development Agency and National Agricultural Research Institute before it is sold to commercial potato growers.

Three Lae-based companies produce stockfeed for poultry and pig production from imported grain, particularly sorghum from Australia (see Section 2.6). Other stockfeed ingredients include residues from wheat milling, fish meal and copra meal. One major pig producer in the Markham Valley makes feed from home-grown maize. Locally produced stockfeed totalled 58 000 tonnes in 2005. An additional 37 000 tonnes of fully prepared stockfeed was imported in
2005. Feed grain imports were valued at K18 million in 2004. About 80% of stockfeed is used for poultry production with the rest going to pig production.

The most important purchases of young animals are day-old broiler chickens, with three hatcheries providing more than 400,000 per week. Purchases of other young livestock, including pigs and cattle, are minimal. Fencing materials are an important input for cattle production but attract a high import tariff (see Section 4.1). Very small quantities of chemicals are used in the livestock industry to control parasites.

**Fertilisers**

Most rural villagers engaged in agriculture in PNG do not use inorganic (manufactured) fertiliser. Small quantities are used by some people growing Irish potato and introduced temperate-climate vegetables, but the total quantity used is negligible. Some villagers use organic materials as green manure fertiliser, particularly in the ‘composting zone’ in the western part of the central highlands (Figure 3.11.6). Minor amounts of chicken manure and other organic fertilisers, particularly household waste, are used, especially in the highlands (see Section 3.12). The major oil palm estates compost fruit bunch waste to produce significant quantities of mulch and organic fertiliser for their plantations. For example, Higaturu Oil Palms in Oro Province applied 45,000 tonnes of effluent fruit bunch at a rate of 17.6 t/ha in 2004 while NBPOL applied about 36,000 tonnes.

The oil palm industry uses 83% of the inorganic fertiliser imported into PNG (Table 5.19.1, Figure 5.19.1). The coffee, Irish potato, sugar cane and cocoa industries take most of the rest (13% of the total). The balance is retail sales (4%) to villagers, schools, missions, research institutions and other bodies, most of which is used on introduced vegetables. About 70% of retail sales of inorganic fertiliser were made in Mount Hagen and are used for temperate vegetable and Irish potato production in Western Highlands and Enga provinces.

---

1 Information on fertilisers and pesticides is largely based on that provided by Steve Woodhouse, Farmset Limited, Rabaul.

### Table 5.19.1 Estimated chemical use by crop, 2002

<table>
<thead>
<tr>
<th>Crop</th>
<th>Fertiliser (tonnes)</th>
<th>Herbicide (litres)</th>
<th>Insecticide (litres)</th>
<th>Fungicide (litres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil palm</td>
<td>14,500</td>
<td>396,000</td>
<td>5,000</td>
<td>0</td>
</tr>
<tr>
<td>Sugar cane</td>
<td>500</td>
<td>80,000</td>
<td>1,000</td>
<td>0</td>
</tr>
<tr>
<td>Coffee</td>
<td>800</td>
<td>70,000</td>
<td>0</td>
<td>2,000</td>
</tr>
<tr>
<td>Vegetables</td>
<td>700</td>
<td>0</td>
<td>4,000</td>
<td>0</td>
</tr>
<tr>
<td>Cocoa</td>
<td>300</td>
<td>0</td>
<td>1,000</td>
<td>0</td>
</tr>
<tr>
<td>Irish potato</td>
<td>700</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>17,500</td>
<td>546,000</td>
<td>11,000</td>
<td>2,000</td>
</tr>
</tbody>
</table>

Source: Steve Woodhouse, Farmset Limited, Rabaul.
The most important inorganic fertilisers used in PNG are ammonium chloride and urea. Other fertilisers include potassium chloride, ammonium nitrate, mono ammonium phosphate, mixed fertiliser (the most common being nitrogen–phosphate–potassium (NPK) mixes) and other types, including micronutrients, dolomite, kieserite and sulfur. Many fertiliser mixes now contain 0.3% boron. This follows research in the highlands in the late 1970s and 1980s which showed that application of very small amounts of boron fertiliser increased the yield of many crops in the highlands, including introduced vegetables.

Pesticides

Village production of food and export crops uses negligible amounts of herbicides, insecticides or fungicides. Small amounts of insecticide are applied by a few people to temperate-climate vegetables, particularly brassicas, and very small quantities of herbicide are used by some villagers. Most of the agricultural chemicals imported are applied to oil palm (72%), with most of the balance used on large-scale sugar cane (14%) and coffee (13%). Small quantities are used in vegetable growing (1%) and cocoa production (Figure 5.19.2).

Herbicides make up 98% of non-fertiliser chemicals used in PNG agriculture. Only very small quantities of insecticide and fungicide are used (Table 5.19.1). The oil palm industry is the largest user of herbicides (about 400 000 litres/year or 73% of total herbicide used). New Britain Palm Oil Limited is the biggest user of herbicide in PNG. However, consumption by oil palm estates has dropped significantly in recent years because bunch waste is applied on oil palm plantations as compost, reducing weed growth, and herbicide application methods have improved. Some herbicide is also used against weeds for sugar cane and coffee production. The cocoa industry uses almost no chemicals. The most common herbicide used in PNG is glyphosate (marketed as Roundup® and other trade names) and is about 55% by volume of all herbicide use. Gramoxone® is also commonly used (about 20% by volume). Other herbicides and surfactants make up the remainder.

Some insecticide is used in the production of oil palm, vegetables, cocoa and sugar cane. Small quantities of insecticide are used to control green scale and coffee borer in coffee. Some of the larger agricultural companies import insecticide to control malaria-carrying mosquitoes. The total quantity of insecticide used in PNG agriculture is about 11 000 litres per year. The only significant use of fungicide is for the control of coffee rust in the highlands, but the quantity used is small. About 16 tonnes of copper-based chemicals are used per year to control potato late blight disease in commercial Irish potato production in high-altitude areas, especially in Western Highlands Province.

Source


---

2 A surfactant is a substance that when added to a liquid increases the liquid’s spreading or wetting properties. It is commonly used with herbicides to increase their coverage and therefore effectiveness.
5.20 Fluctuations in village cash crop production

Village production of crops for sale in domestic and export markets varies from year to year, and often the reasons why are not immediately clear. These fluctuations can be observed in the annual exports of coffee (Figure 5.4.3), cocoa (Figure 5.5.1), copra (Figure 5.6.1), copra oil (Figure 5.6.5), oil palm (Figure 5.7.4), rubber (Figure 5.11.2) and vanilla (Figure 5.14.2). Fluctuations in village cash crop production are influenced by a number of factors, which can act alone or in combination, and which may not occur beyond a local area. It is therefore sometimes difficult to understand or predict what production outcomes will be at any particular time. The most important influences on village cash crop production are:

- Returns to labour.
- Changes in access to markets.
- Marketing arrangements.
- Weather conditions.

Returns to labour

‘Returns to labour’ refers to the amount of money growers receive in return for the work they do to produce a commodity for sale. If they believe that their returns to labour are not adequate, they will stop producing a commodity or will switch production to another commodity that they think will provide a higher return. Although this phenomenon is difficult to study among PNG villagers, it is clear that they are very sensitive to returns to labour. Their ability to switch in or out of cash cropping is cushioned by subsistence food crop production. This sustains them and their families even if they do not have a cash income for some time.

Many PNG villagers have an amount of money that they believe they should receive when they sell a cash crop. They will stop production if they cannot obtain an income above that amount. This minimum acceptable return is different from place to place and even from person to person. It depends on what crops can be grown in the local environment, experiences of returns that have been received in the past, the existence of alternative money-earning activities (including off-farm employment)\(^1\) and the need to earn cash, for example, for school fees or medical treatment. A rough guide to the minimum return to labour that many people find acceptable is the

---

\(^1\) Most off-farm wage-earning opportunities are local and limited in time, such as road construction work. Local off-farm employment can affect cash crop production in an area because people may choose wage labour over cash crop production. However, local off-farm employment opportunities are not common. Migration is greatest from areas where cash cropping opportunities are poorest, and only a small proportion of the total population is employed in mines or elsewhere in the formal economy. So the number of people employed off-farm does not have a major influence on year-to-year fluctuations in village cash crop production.
minimum rural wage, that is, the amount of money they could earn if they had wage-earning employ-
ment. This was about K8 per day in 2008.

The main cash crops produced in PNG provide returns to labour that range from K100/person/day to less than K5/person/day (Table 5.20.1). The reasons that the crops that provide the highest returns to labour (Irish potato and oil palm) are not grown by everyone in PNG is because local environ-
ments do not support their production, there is not a local market for them, or other inputs needed are not available. Successful Irish potato production, for example, depends on access to disease-free planting material, fertiliser and fungicide, and a high-altitude location. Oil palm fruit can only be processed in large mills and must be transported to the mill soon after harvest, so production is only by registered growers who live close to a mill. On the other hand, betel nut, which can be grown in most places up to 1000 m above sea level and gives a high return to labour, is produced almost everywhere where transport is available to carry the nuts to a market (see Section 5.17).

Arabica coffee, cocoa and most fresh foods, including sweet potato, provide returns to labour in the accept-
able range of K20–K30/person/day. These commodi-
ties are produced by most families where environ-
mental conditions and access to a market allow. Most sweet potato marketed in PNG is produced in the highlands valleys wherever there is good access to

### Table 5.20.1 Gross returns on labour inputs for selected cash crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>Mean yield(a) (kg/ha)</th>
<th>Price(b) (kina/kg)</th>
<th>Gross return(c) (kina/ha)</th>
<th>Labour inputs(a, d) (days/ha)</th>
<th>Return(e) (kina/person/ day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irish potato (tubers)</td>
<td>20,000</td>
<td>2.00</td>
<td>40,000</td>
<td>400</td>
<td>100(f)</td>
</tr>
<tr>
<td>Oil palm (fresh fruit bunch)</td>
<td>15,000</td>
<td>0.25</td>
<td>3,750</td>
<td>70</td>
<td>54</td>
</tr>
<tr>
<td>Sweet potato (tubers)</td>
<td>14,000</td>
<td>0.80</td>
<td>11,200</td>
<td>350</td>
<td>32</td>
</tr>
<tr>
<td>Cocoa (wet bean)(g)</td>
<td>800</td>
<td>1.00</td>
<td>800</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>Arabica coffee (parchment)</td>
<td>900</td>
<td>4.50</td>
<td>4,050</td>
<td>275</td>
<td>18</td>
</tr>
<tr>
<td>Vanilla (cured bean)</td>
<td>240</td>
<td>15.00</td>
<td>3,600</td>
<td>290</td>
<td>12</td>
</tr>
<tr>
<td>Rubber (cup lump)</td>
<td>650</td>
<td>1.60</td>
<td>1,040</td>
<td>100</td>
<td>10</td>
</tr>
<tr>
<td>Coconut (copra)</td>
<td>500</td>
<td>1.30</td>
<td>650</td>
<td>65</td>
<td>10</td>
</tr>
<tr>
<td>Robusta coffee (parchment)</td>
<td>900</td>
<td>1.60</td>
<td>1,440</td>
<td>275</td>
<td>5</td>
</tr>
<tr>
<td>Rice (paddy)</td>
<td>1,300</td>
<td>0.80</td>
<td>1,040</td>
<td>215</td>
<td>5</td>
</tr>
<tr>
<td>Pyrethrum (dried flowers)(h)</td>
<td>650</td>
<td>1.50</td>
<td>975</td>
<td>430</td>
<td>2</td>
</tr>
</tbody>
</table>

---

(a) Yield and labour input data are from different sections of this book, with some data adapted from Hale (c. 1978).
(b) Price data are farmgate prices for 2007 or an average of 2005–2007.
(c) Mean yields are not precise and prices vary greatly over time. Hence gross returns may differ significantly from these figures. Nevertheless, the broad pattern illustrated here will hold under different yields and prices.
(d) Labour inputs to establish tree crops are not included, but are not large when averaged over the life of the crop.
(e) Land and labour are the main inputs for most smallholder production in PNG, but there are some other inputs that require cash, including tools and sometimes planting material. These have been ignored for this comparison.
(f) Cash outlays for disease-free planting material, fertiliser and fungicide are required to achieve high Irish potato yields, so net returns (after cash expenses) to labour inputs are about K60–K70/person/day.
(g) A cocoa wet bean yield of 800 kg/ha is equivalent to 300 kg/ha of dry bean at a conversion rate of 37.5%.
(h) Yield and labour input data for pyrethrum follow Anderson (c. 1978).
the Highlands Highway. Similarly, Arabica coffee is produced by many highlands families (Figure 5.4.2). Cocoa is produced by many households on the Gazelle Peninsula in East New Britain Province, in Bougainville Province, and by some families in other lowland locations (Figure 5.5.3).

Returns to labour for rubber and copra are only about K10/person/day. These commodities are produced where no alternative sources of cash income are available. Their production is limited because producers harvest and process the crop only until they have earned enough money to satisfy their immediate needs.

Robusta coffee, rice and pyrethrum provide returns to labour around K5 or less per day (Table 5.20.1). Only small quantities of Robusta coffee are harvested and sold (Section 5.4) and production is almost solely to meet immediate cash needs. Rice production is also very low. It fluctuates over time because of bursts of extension activity and subsidies by donors, NGOs and some provincial governments who think it is important that PNG produces its own rice to replace imports (Section 2.5). When growers realise the low levels of returns that rice provides, they cease growing it. Most previous studies of rice growing in PNG have concluded that returns to labour are unacceptably low, even compared to growing root crops for subsistence. These studies concluded that it is more logical for PNG to import rice and to export commodities that provide a higher return to labour, such as coffee or cocoa. Other grain crops also give low returns to labour, including corn (maize) and sorghum sold for stockfeed or

2 Hale (c. 1978: Table 10) compared returns to labour inputs for six lowland cash crops. He showed that returns on rice in 1977 were K0.53/person/day, much less than alternative cash crops, including sweet potato (K7.93), Robusta coffee (K6.24), cocoa (K5.27), copra (K4.82) and rubber (K3.78). He concluded that a major constraint to expanded rice production in PNG was low production at village level and low returns to labour. At the time of writing that paper, Peter Hale was responsible for promoting rice production in PNG. More recently, Mills (2002:69) compared cash returns on growing rice in Japan, Taiwan, Java (Indonesia) and PNG and found that returns in PNG of K2.40/person/day were very low compared with these other countries. Gibson (1994) examined labour inputs for rice and export tree crops. He concluded that increased

industrial use. Likewise pulse crops, such as soya bean, also give poor returns to labour when they are sold for processing.

The sensitivity of people to returns to labour results in two broad patterns of village commodity production. The first pattern is found where a commodity provides low returns to labour and there is no alternative crop. Here villagers work for a ‘target income’, an amount of money that is needed for a particular reason. For example, they might produce enough copra, rubber or bêche-de-mer to earn money to pay their children’s school fees. Once they have this amount of money, they stop production.

The second pattern occurs where returns to labour are high. Here villagers are very responsive to price, and will increase production when prices are higher and reduce production when prices are lower. This behaviour is seen in the production of betel nut, fresh food and oil palm. Consequently, production of these crops fluctuates with price. National export figures do not always reflect a production response to price fluctuations because environmental variation, such as rainfall, can result in an overall decrease or increase in production that hides the returns to labour response. However, the response can be readily observed at the local level.

Returns to labour do not always prevent people from adopting a cash crop, largely because the amount of labour involved to produce a crop is not known during the adoption phase. So people frequently enthusiastically adopt a new crop that has been introduced by an extension program, or which is reported to earn high prices. However, it is not until they have actually experienced how much work is required to produce the crop that they decide whether to continue production. It is very common to hear people say, in answer to the question ‘Why are you growing this crop?’: ‘Mipela traim tasol’

2 Hale (c. 1978: Table 10) compared returns to labour inputs for six lowland cash crops. He showed that returns on rice in 1977 were K0.53/person/day, much less than alternative cash crops, including sweet potato (K7.93), Robusta coffee (K6.24), cocoa (K5.27), copra (K4.82) and rubber (K3.78). He concluded that a major constraint to expanded rice production in PNG was low production at village level and low returns to labour. At the time of writing that paper, Peter Hale was responsible for promoting rice production in PNG. More recently, Mills (2002:69) compared cash returns on growing rice in Japan, Taiwan, Java (Indonesia) and PNG and found that returns in PNG of K2.40/person/day were very low compared with these other countries. Gibson (1994) examined labour inputs for rice and export tree crops. He concluded that increased

rice production would result in reduced production of tree crops and would reduce employment rather than increasing it.

3 Corn sold as a fresh food has a much higher price and gives a high return to labour. The same applies to coconut. When sold in food markets to be used for cooking, coconut commands a high price and hence a good return to labour, but when sold as copra for industrial uses, returns to labour are low.
(we are just trying it). If they find that the labour required to produce the crop is high relative to the income received, they are likely to lose interest and either cease production or only produce the commodity when they need cash for a particular reason. Plants of former cash crops that are no longer harvested and sold can be seen in many villages. These include cardamom, chilli, kapok, purple passionfruit, Robusta coffee, rubber and sisal.

A moderate amount of information exists on villagers’ labour inputs for a number of important export and food crops (Table 5.20.2). However, much more information is needed for some crops so that informed decisions can be made about what crops are likely to be adopted by villagers.

It has recently been recognised that the amount of labour required to produce a crop can alter over time. This can change the returns to labour and result in lower production or even cessation of production. Crop yields can decline significantly over time because of disease, the ageing of trees or lack of crop maintenance. Furthermore, if regrowth is not kept clear, harvesting becomes heavier work. As the amount of labour required to harvest the crop increases, people will harvest less or will stop harvesting altogether. This has been observed for a number of cash crops, including oil palm, cocoa, coffee and coconut. A similar pattern occurs in food gardens, with less and less food being harvested from old gardens as weeds and regrowth make harvesting more difficult and labour-demanding.

### Changes in access to markets

Access to markets is an important influence on cash crop production (see Section 1.14). When road access is good, it is less work and cheaper for producers to market their goods. An example of how production improves with better road access is provided by the road repair program that followed the civil war in Bougainville Province. Cocoa production increased steeply in 2002 following 11 years of much lower production caused by the fighting (Figure 5.5.5). During the war, road maintenance stopped and the ring road around Bougainville Island became almost impassable. However, after the road had been repaired (with AusAID funding), cocoa growers responded with a big increase in production, especially in the main cocoa-growing areas of Wakunai and Tinputz.

The opposite is also true, that is, poor roads reduce growers’ access to markets. Unfortunately, there are many examples of this over the past 15 years, especially in the highlands where lack of road maintenance means that places once easily accessible from the Highlands Highway are now isolated.

### Marketing arrangements

Changes in the arrangements for marketing produce can have a positive or negative influence on the amount of produce sold. For example, prior to 2002, organisational and financial problems within the Copra Marketing Board, the only buying agency in Bougainville, resulted in low copra production there. In late 2002, Coconut Products began buying copra in Buka. This company processes copra into copra oil at its factory near Rabaul, East New Britain Province (see Section 5.6). Coconut growers on Buka Island and the northern tip of Bougainville Island, the main producing areas, immediately responded. Villagers started making copra again because they could sell it to agents of Coconut Products.

The closure of a number of copra-purchasing depots in recent years has led to a loss of market access for copra producers in some more remote locations in PNG. For example, 22 depots existed in 11 provinces in 2001 but this had become 10 depots in 9 provinces by 2005 (Table 5.6.2). Recently, the closure of depots has been offset to some extent by copra purchases by the ship MV Coconut Trade operated by Coconut Oil Production Madang Limited.

---

4. There is a reasonable amount of information on labour inputs for sago starch extraction, which is in the range 2–4 kg dry starch per hour for New Guinea mainland locations (Table 2.4.4).

5. See Curry et al. (2007:68, 126) for discussion on the influence of the quantity of accessible crop on cocoa harvesting levels.
<table>
<thead>
<tr>
<th>Crop</th>
<th>Location</th>
<th>Labour input (days/ha)</th>
<th>Source</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cocoa</td>
<td>Gazelle Peninsula Bougainville Karkar Island Madang Province</td>
<td>68</td>
<td>Godyn (1974: Part 3, Table 8)</td>
<td>Inputs were for maintenance (32 days/ha), harvesting (31), and bagging and carrying wet bean (5). Time for waiting (6 days) and walking (1) are not included in the total.</td>
</tr>
<tr>
<td>Cocoa</td>
<td>Gazelle Peninsula East Sepik North coast road, Madang Karkar Island Popondetta area</td>
<td>39</td>
<td>Yarbro and Noble (1989)</td>
<td>Labour inputs were for clearing land (32 days/ha), planting shade (17), planting cocoa (31), planting coconut (3), pruning cocoa and shade (5), weeding (20), applying fertiliser and chemicals (2), and harvesting (12). Comparable data not given for processing. The total of 39 days is to produce wet bean from established cocoa.</td>
</tr>
<tr>
<td>Coffee</td>
<td>Eastern Highlands Simbu Western Highlands</td>
<td>274</td>
<td>Anderson (1977: Table 24)</td>
<td>Anderson surveyed coffee producers in 13 villages in 3 provinces in 1976. Inputs were harvesting (174 days/ha), weeding (21), pulping (37), washing/drying (26) and marketing (16). He presented data for each activity for adult men, adult women and children. In total, 45% of labour inputs were by men, 42% by women and 13% by children (Table 25).</td>
</tr>
<tr>
<td>Coffee</td>
<td>Benabena area, Eastern Highlands</td>
<td>324</td>
<td>Overfield (1994: Table 3)</td>
<td>Overfield surveyed 18 households over a two-year period. Data were originally presented as days/tonne. Inputs were for harvesting (196 days/ha), weeding/spraying (26), pruning/maintenance (62), processing (33) and marketing (7).</td>
</tr>
<tr>
<td>Mixed root crops</td>
<td>Simbai Valley, Madang Province</td>
<td>363</td>
<td>Clarke (1971:17.3)</td>
<td>Soil was tilled mechanically; all other operations were by hand.</td>
</tr>
<tr>
<td>Peanuts</td>
<td>Keravat Research Station</td>
<td>175</td>
<td>Bourke (1977: Table 2)</td>
<td>Soil was tilled mechanically; all other operations were by hand.</td>
</tr>
<tr>
<td>Rice</td>
<td>Lowlands</td>
<td>214</td>
<td>Mills (2002:69)</td>
<td>Inputs are for land preparation (78 days), transplanting (10), weeding (40), harvesting and thrashing (80), and other (6).</td>
</tr>
<tr>
<td>Sweet potato</td>
<td>Aiyura Research Station</td>
<td>244</td>
<td>Kimber (1976: Table 1)</td>
<td>Labour inputs are for mounding (80), planting (30), maintenance (46) and harvesting (88). Also 12.7 tractor hours/ha for soil tillage.</td>
</tr>
<tr>
<td>Sweet potato</td>
<td>Goroka area</td>
<td>240</td>
<td>Anderson (1976)</td>
<td>Inputs are for commercial vegetable growers. This figure does not include initial opening of land after fallow.</td>
</tr>
<tr>
<td>Sweet potato</td>
<td>Keravat Research Station</td>
<td>280</td>
<td>Bourke (1977: Table 2)</td>
<td>Soil was tilled mechanically; all other operations were by hand.</td>
</tr>
<tr>
<td>Taro</td>
<td>Popondetta area</td>
<td>300</td>
<td>Waddell and Kinnis (1968-42, 57, 85)</td>
<td>Labour input figure generated from data from two years’ survey (1962–1964) in two villages. Data converted from hours to days by dividing by 8.</td>
</tr>
<tr>
<td>Taro</td>
<td>Paniai Lakes, Papua (Indonesia)</td>
<td>338</td>
<td>Bayliss-Smith (1982: Appendix 2)</td>
<td>Data extracted by Bayliss-Smith who summarises labour input data for tao production from 12 Pacific Island studies. Data converted from hours to days by dividing by 8.</td>
</tr>
<tr>
<td>Vegetables</td>
<td>Goroka area</td>
<td>233</td>
<td>Anderson (1976)</td>
<td>Labour inputs for commercial vegetable growers are given for pumpkin, cabbage, radish, marrow, tomato, Irish potato, beans, carrots, lettuce, pak choi, silverbeet and sweet potato. The figure here is for beans and carrots for plantings that follow previous crops (‘medium re-establishment’). Inputs for other crops are similar.</td>
</tr>
</tbody>
</table>
The involvement of provincial governments or their business arms in marketing agricultural produce has generally had poor outcomes in PNG. One example is the involvement of the Simbu Provincial Government in buying cardamom from the Karimui area. After the collapse of the producing company there, the provincial government took over marketing. However, cardamom production at Karimui ceased partly because the government financial system did not allow cash advances to be made to public servants to buy cardamom. Another example is the collapse of chilli growing and marketing when a number of provincial governments became involved in marketing in the early 1980s (see Section 5.15). There is a long history of government-run fresh food marketing operations, going back to the mid 1970s (see Section 6.3). Almost without exception, these operations have lost money and have closed down after a few years, leaving producers with unsold produce.

Villagers expect a cash payment for their produce – receiving cash in the hand can be more important to them than the price they receive. Small, wholesale businesses and government agencies in PNG often face cash-flow problems when purchasing produce from villagers. Small marketing organisations do not have access to overdraft facilities from banks. Any delay in payments reduces the confidence of villagers, who may choose to supply to somebody else or not to supply at all. If the villagers do not sell, buyers cannot sell to the wholesalers, and so do not have cash to pay villagers for the produce, a vicious cycle that undermines development of fresh produce marketing in many places.

### Weather conditions

Changes in weather conditions, especially rainfall, influence crop yields (see Sections 1.6, 1.13). Because the influence of weather is felt over a wide area, adverse or favourable conditions can influence regional or national production. However, knowledge of how rainfall influences crop production is poor. For example, it was widely assumed that the severe drought in 1997 would adversely affect coffee production and exports. But the opposite happened and the drought conditions in 1997 actually resulted in increased production in the following year (Figure 5.4.3). In contrast, it appears that the 1997 drought reduced cocoa production, which was low in 1997 and 1998, but increased by about 50% in 1999 and subsequent years, even though prices did not vary greatly between 1997 and 2001 (Figure 5.5.1).

For some crops there is better knowledge about their response to water stresses. A minor or moderate drought results in increased production of mango and breadfruit, but reduced production of other fruit, such as pawpaw. Similarly, sweet potato and cassava are tolerant of minor drought, whereas the same drought can negatively affect taro production. Conversely, sweet potato production is often badly affected by very wet periods, while taro is not.

Other environmental conditions can interact with rainfall to affect crop yield. For example, the 1997 drought had a more severe impact on oil palm production on the well-drained limestone soils on New Ireland than it did on the volcanic ash soils of West New Britain Province.

### Other local factors

Factors that operate at a local level commonly influence production from a particular area, but generally do not influence national-level output. Localised unrest and fighting in the highlands can cause people to take refuge some distance from their villages, or result in road blocks. For example, in 2005 fresh food producers near Porgera mine in Enga Province were prevented from travelling to the mine site to sell food because of a dispute with local groups. However, people from Mount Hagen in Western Highlands Province were allowed to use the road and were able to sell their produce at the goldmine.

Other things that operate at a very local level and influence production and sale of cash crops include feasts, funerals and other rituals. The need for

---

6 See Hombunaka and von Enden (2001) for a detailed explanation as to why this happened.
Fluctuations in village cash crop production with the existing supply of sweet potato. If sweet potato is abundant now the average area planted per day per family now will fall below the average long-term planting rate. Conversely, if sweet potato supply now is below that which is considered satisfactory, the rate of planting now will increase above the average rate (Figure 5.20.1). This pattern has been found to hold true in a number of areas in Eastern Highlands and Southern Highlands provinces.

Sweet potato yield is influenced by rainfall in the period after planting and in the period before harvesting. Tuber formation is reduced if rainfall is particularly heavy during the first 10 weeks after planting. Periods of low rainfall during the tuber bulking phase (when tubers grow large), some five to six months after planting, can reduce tuber size. This combination of particularly high rainfall early in a year followed by a period of low rainfall later in the year is common during El Niño climatic events (see Section 1.6).

The combination of these two rainfall extremes severely reduces sweet potato supply and can result in food shortages. This is reflected by both a

**Fluctuations in sweet potato supply in the highlands**

The supply of sweet potato from the highlands to local urban markets (and to Lae, Madang and Port Moresby) can fluctuate significantly from time to time. The cause is a complicated relationship between three factors: (1) the supply of sweet potato influenced by rainfall; (2) the area planted; and (3) the way in which families assess how much sweet potato to plant on the basis of present sweet potato supply.

Total sweet potato supply is determined by the area planted and the yield. The yield is in turn influenced by rainfall. The area planted depends on the rate at which sweet potato is planted (that is, the average area planted per day) and this is inversely associated

![Figure 5.20.1](image-url)  
**Figure 5.20.1** Model of paired food shortages in highland sweet potato agricultural systems. Source: Bourke (1988).
reduction in sweet potato marketed and an increased demand for sweet potato in markets by rural people. This combination of reduced supply plus increased demand results in a marked increase in the price of sweet potato in food markets.

However, this is not the end of the fluctuations in supply. As a result of a reduction in supply, families immediately increase the area planted per day. Planting rates continue to be higher than normal for up to six months and fallow land may be brought into cultivation. After six months sweet potato supply is high again. In response to this oversupply of sweet potato, families plant less and the planting rate falls sharply (and in local markets the price also falls sharply). Over the next 10 months or so, sweet potato supply remains more than adequate and so the planting rate remains well below average. This results in a second, more severe, food shortage. This event is about two-and-a-half years removed from the initial high rainfall episode and two years after the first food shortage. It is usually blamed on a number of more immediate possible causes, all of which are merely coincidental. This second food shortage causes sweet potato prices to increase once again in response to a significantly reduced supply.

Sources


Summary

Many things influence the production of commodities for sale in PNG. The most important influence is the returns to labour. A clear association exists between high returns to labour and high levels of participation in production of a commodity for marketing. Where returns to labour for a commodity are below about K10 per person per day, participation in production of that commodity for marketing takes the form of ‘target’ earning, that is, when a certain amount of cash has been earned, production of the commodity stops. In order to participate in commodity production, access to markets is necessary and changes in access, due to road conditions or the closure of buying points, will influence production. The direct influence of weather on the crop, particularly excessive or inadequate rainfall, also causes fluctuations in production. The most interesting cause of fluctuations in a commodity is the way in which rainfall and villagers’ planting choices combine to cause significant fluctuations in sweet potato supply in the highlands.

7 These have included the demands of the annual coffee harvest, temporary absences from gardening to harvest karuka pandanus nuts, temporary migration to towns, labour migration, cattle projects, large ceremonies, and too much card playing or ‘laziness’ on the part of villagers, none of which are the actual cause (Bourke 1988). In a number of places in the highlands, these food shortages have been associated with significant falls in birthweight and weight loss in children.


5.21 Marketing agricultural exports

Agricultural marketing in PNG ranges from the well-organised structures for marketing oil palm, tea and rubber to the informal, dispersed and disorderly marketing of fresh food, betel nut and vanilla. Coffee and cocoa marketing are very competitive with a high degree of self-regulation. A common feature of all these industries is that marketing functions are carried out entirely by the private sector. This contrasts markedly with the situation in a number of other Pacific island countries where government agencies have been actively involved in agricultural marketing, usually to the detriment of industry development.

This section reviews PNG’s agricultural marketing of the major tree crop commodities. Marketing of domestic fresh foods is discussed in Section 5.3. Marketing for minor export crops is discussed in the relevant sections.

Tree crop commodity marketing

Markets

PNG’s tree crop industries are entirely export-oriented. The small domestic PNG market restricts the opportunities to add value by processing a primary product into a marketable product such as, for example, making chocolate for local sales from cocoa. Despite the importance of the tree crop industries to the national economy, PNG has a very small share of world markets and so has no influence over price. PNG produces around 3% of the world’s palm oil, less than 2% of coffee and cocoa, 0.1% of rubber and 2–5% of copra oil.

Marketing systems

In the mid 1960s the World Bank advised the Australian administration on the importance of competitive marketing for coffee and cocoa. This advice was heeded, and the newly formed Coffee Marketing Board and Cocoa Marketing Board did not become directly involved in marketing. Rather, they focused on improving quality standards, price stabilisation, funding, and directing research and development. Competitive and efficient marketing systems developed, to the benefit of growers. However, more centralised and less competitive marketing systems evolved for other commodities.

Coffee

Coffee is the second largest agricultural export by value in PNG (see Section 5.4). Although quality and productivity have declined, the coffee industry has maintained a reasonable degree of international competitiveness. This is because of the low level of purchased inputs used (see Section 5.19) and a fairly efficient marketing system.

The coffee industry’s marketing structure has remained virtually unchanged since the Coffee Marketing Board, now replaced by the Coffee Industry Corporation (CIC), was established in 1964 (see Section 6.4). Coffee production has been dominated by the smallholder sector since the early
1960s. Smallholder coffee beans move through a marketing chain of itinerant buyers, dried bean factories and exporters. Virtually all of PNG’s coffee is exported as dried green bean. All parts of the marketing chain are competitive to some degree. However, growers have not been offered financial rewards for producing better-quality product, and the result is generally poor quality of smallholder coffee. If the industry is to remain viable in the longer term, the quality of the coffee produced must be improved.

Buying is highly competitive, with several thousand itinerant buyers competing to purchase parchment coffee from village producers at the ‘farm gate’. Marketing at this level is unregulated and sometimes chaotic. Buyers provide an important marketing service, particularly for growers who do not have ready access to a processing factory. But the price paid is usually significantly lower than what growers would receive at the ‘factory door’. The more remote the grower is from the factory and the poorer the access, the greater the price differential between the ‘farm gate’ price and the ‘factory door’ price. Most roadside buyers pay the same price per kilogram regardless of bean quality and keep very poor or no records of their purchases.

Because financial viability depends on the volume of throughput, many of the wet bean factories accept whatever coffee is offered to them, and also pay no price incentives for quality. Under CIC rules, all processors buying coffee at the factory door are required to display prices for different grades. In some locations it has become common practice to offer just one price. Grades are ignored to increase throughput to achieve short-term viability, despite the dry bean processors being registered and more closely regulated. Some processing factories are owned wholly or partly by exporters, although most are owned by small local companies and individuals.

Coffee exporting from PNG is dominated by a small number of large companies. Exporter competitiveness is restricted by the way the industry is financed, with the larger exporters being owned partly or wholly by the larger international coffee trade houses, or tied to them through financing arrangements.

The share of export earnings that goes to PNG coffee growers is comparable to what growers in other countries producing a similar type of coffee receive. However, PNG growers receive considerably lower prices (Figure 5.21.1). This occurs because PNG exporters receive lower returns as PNG coffee exports are dominated by Y-grade coffee (57% of exports in 2006). The average price received in 2006 by PNG exporters for Y-grade coffee was K5.90/ kg, compared with K7.10/kg received for premium smallholder grade.

The failure to offer price incentives for quality coffee is to some extent the outcome of the way coffee buying is financed. Commercial banks will not lend working capital to buy coffee without secure guarantees or collateral, so many processors are forced to seek advances from exporters. In turn, exporters have difficulties raising funds locally and so look to their overseas buyers or parent companies to provide bank guarantees or offshore lines of credit. This lack of easily accessible credit creates a substantial barrier to entry into coffee exporting and, as a result, the sector is dominated by a handful of exporters. Exporters must sell to the international buyer that provides their finance and are not in a position to sell to the highest bidder.

**Cocoa**

Cocoa is the third largest agricultural export earner in PNG (see Section 5.5). The cocoa marketing system has competitive pricing at each stage of the marketing chain. Growers sell wet bean to dealers or directly to fermentaries. Cocoa Board regulations make it mandatory for fermentaries and exporters to display wet and dry bean prices respectively. The PNG competitive marketing system has resulted in low marketing margins and relatively high returns to growers. This contrasts with the situation in other Pacific island countries, where state-owned or controlled monopolies have dominated cocoa marketing and growers receive a lower proportion of the export price. The impact of competition on marketing margins is seen in the differences between Fiji and PNG grower prices during the 1980s cocoa price boom (Table 5.21.1).

---

1 The marketing margin is the share of the export price that goes to those involved in marketing and production.
Copra provides a low income for many people living in coastal mainland and island areas (see Section 5.6). Low yields mean that the PNG copra industry is barely internationally competitive.

The Copra Marketing Board (CMB) was established in the 1950s (see Section 6.4). There were good economic and social reasons for creating a monopolistic marketing body for copra. Unlike coffee and cocoa, copra is consistent in quality and sold to few buyers worldwide and substantial economies of scale can accrue in marketing. In the 1950s many copra growers were located in isolated places and transport costs were cross-subsidised from the earnings of better-located buyers. Most copra was sold by village producers to a network of middlemen, cooperatives, or ship owners, who on-sold to the CMB.

In the past, PNG cocoa had a quality and fine flavour reputation in international markets that earned significant market premiums. This quality advantage has been eroded with the decline of the plantation sector and increasing problems of smoke contamination in drying and under-fermentation in smallholder cocoa. However, some buyers still seek out better-quality PNG cocoa as part of their blends and are prepared to pay higher prices for it.

The Cocoa Board’s efficiency and performance as a regulator has declined (see Section 6.4), but the competitive marketing structure that has served cocoa growers well for more than three decades remains largely intact. Despite relatively low yields, the PNG industry has remained internationally competitive due to a low level of purchased inputs and a competitive marketing system. There is scope to increase yields and to raise farm gate prices by improving quality.

Figure 5.21.1 Average grower prices for Arabica coffee by country, 2006. Source: International Coffee Organization (2006).
5.21 Marketing agricultural exports

Central processing facilities and purchase fruit from hundreds of surrounding smallholders, whose leases require them to grow oil palm. All marketing functions are carried out by the estates. The nucleus plantation companies purchase smallholder fruit at prices determined by a formula (see footnote 5, Section 5.7). Although this structure brings considerable benefits to smallholder growers in the form of extension services and supply of inputs, they argue that the formula should be modified so that it is more favourable to them.

The CMB performed satisfactorily for a number of years, but it became insolvent in the 1990s due to a combination of low international prices, deterioration in inter-island shipping, poor management and political interference. In response, the board was privatised in 2002 with the formation of the Kokonas Industri Koporesen (KIK). The KIK was to form policy and regulate the industry, with marketing to be managed by the private sector. One result is that copra is no longer purchased in uneconomic, isolated places.

Growers continue to pay the same levies to the KIK as they did to the CMB, but the KIK does not provide the same services. The levies are high relative to the prices received, making the few services offered by the KIK very expensive. Copra does not have the same regulatory needs as more complex commodities such as coffee and cocoa and the involvement of a third party regulator adds unnecessary cost. There are no major research issues for copra that require the imposition of industry levies, and extension requirements are minimal.

**Oil palm**

Oil palm represents PNG’s newest tree crop industry and is now the most important agricultural export earner (see Section 5.7). Oil palm is PNG’s most successful agricultural industry in terms of efficiency and international competitiveness.

In contrast to coffee and cocoa, the oil palm industry is limited in both location and the number of processors and exporters. The industry is characterised by a few large companies that grow oil palm on nucleus plantations (‘estates’). These companies operate

<table>
<thead>
<tr>
<th>Year</th>
<th>Fiji grower price (F$/tonne)</th>
<th>Fiji grower price (kina equivalent/tonne)</th>
<th>PNG grower price (kina/tonne)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984</td>
<td>1,500</td>
<td>1,269</td>
<td>1,804</td>
</tr>
<tr>
<td>1985</td>
<td>1,500</td>
<td>1,364</td>
<td>1,890</td>
</tr>
<tr>
<td>1986</td>
<td>1,700</td>
<td>1,556</td>
<td>2,010</td>
</tr>
</tbody>
</table>


**Sources**


