Australian Government
Australian Centre for International Agricultural Research

Final report

Small research and development activity

SRA	***A review of the future prospects for the world coconut industry and past research in coconut production and product***
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Summary

This report has been prepared to assist the Australian Centre for International Agricultural Research (ACIAR) as it develops a strategic basis for future research and development investment related to the coconut industry.

ACIAR partner countries account for about 85 per cent of recorded production of coconuts. Three of these countries — India, Indonesia and the Philippines — account for three quarters of world production. In some of the smaller producers in the Pacific, coconuts play a pivotal role in the livelihoods of the quasi-subsistence smallholder who dominate primary production in the region, being a key direct source of cash income, and of nutrition. Coconut palms are important not only because of the direct contribution of coconut products — particularly copra and fresh nuts — to these livelihoods, but also because a significant proportion of the stands are used to provide shade for low input production of other food and cash crops.

Coconut production appears to have been growing at around 2 per cent a year since the early 1960s. However, production of copra and coconut oil has stagnated, as palm oil and soybean oil have grown to dominate world markets for edible oils. If the coconut production data is correct (there are some questions about the reliability of these data), the differences must be explained by growth in coconuts going into domestic food consumption. Certainly the data suggest that for most of the larger producers the bulk of coconuts are consumed domestically for food. For the Philippines and producers in the Pacific, however, most coconuts are processed into copra for further processing into oil.

The declining share of coconut oil in world oil markets primarily reflects the products lack of competitiveness with the other oils. Commercial coconut oil yields are low compared to palm and vegetable oils, and there is a high degree of correlation between world prices of these oils. There is now very little commercial plantation production of coconuts: in many countries colonial era plantations have reverted to smallholder control

under traditional land tenure arrangements and with low or zero input management practices.

Over 50 per cent of harvested palms are thought to be senile, and at the end of their life as viable sources of copra. The low prices of copra, and the strategies that smallholders use to manage risk mean that incentives to replant are limited: while higher yielding varieties have been developed, they are typically more management and input intensive. Moreover, even with precocious hybrids, smallholders appear reluctant to face the loss of production — of coconuts and inter-cropped crops — that replanting entails.

ACIAR has long been a supporter of coconut research, and there are international networks that undertake and support research in the industry. While there have been important developments in developing higher yielding hybrids and some pest and disease control measures, declining productivity and incursions of lethal diseases characterise the industry. The various efforts to summarise research activities and achievements, and to identify priority areas for technical research all acknowledge that uptake of new technologies has been very poor. The ultimate beneficiaries of the technologies face little incentive to adopt.

The underlying economics of smallholder production under customary land tenure, and the competitive position of coconut oil deter growers from incurring the costs of adoption. Unfortunately, some of the arrangements that governments have put in place to regulate the industry exacerbate the problem. Some options, such as the marketing of ‘virgin’ coconut oil and the potential to use coconut oil as a replacement for diesel in internal combustion engines, offer some market opportunities: but they do not seem likely to provide the basis for a large scale revival of world demand for the oil.

Past research for the coconut sector appears to have focussed mainly on issue such as:

- the potential for increase in yields and better pest resistance through genetic selection;
- better control of pests and diseases;
- the development of new products or more appropriately, development of techniques and processes; and
- improving the technical efficiency of coconut processing.

Less attention seems to have been given to research that focused on:

- ways of positively influencing the institutional and policy environment facing coconut growers;
- adoption pathways, increasing the likelihood of uptake of technical research, and identifying technologies that are consistent with the incentives that smallholders face and their risk management strategies; and
- understanding of alternative or complementary uses (such as intercropping) of land planted to coconut palms, and any necessary R&D to support policy change or structural adjustment in the context of the increasing age of most palms.

This report suggests that a research strategy for coconuts should take account of:

- the importance of coconuts to livelihoods in the ACIAR program countries;
- the consequences for smallholder production systems of the ultimate demise of coconut palms, as much with regard to the low-input production of other crops that coconut intercropping allows as for the loss of coconut production;
- alternative uses of land devoted to coconut palms;
- costs of converting land to alternative uses;
- scope for R&D to address impediments or other issues that are limiting profitability of production;
- Australia's capacity to engage in and deliver the require R&D;
- the potential for the R&D to be disseminated to and adopted by growers, processors and other agents of change, including the generally poor performance of government extension agencies with respect to coconuts; and
- the nature of the markets for coconut products, and the incentives that smallholders currently have to invest in adoption of research outputs.

Some of these issues would vary in importance across ACIAR partner countries. Certainly for ACIAR's Pacific partner countries and parts of South East Asia, a sizeable proportion of the population in coastal communities is quite dependent on coconut palm as a direct and indirect avenue for cash and subsistence production.

Given this dependence it would be important to understand the dimensions — in terms of households, localities and production — that is at

risk from the increasing age of coconut stands. This information would help determine the priority to be given to research with respect to alternative uses of land, and alternatives to growing other cash and food crops under coconut palms, and the scope for retrieving some salvage value from coconut timber. While palms are still of value — up to and beyond the age of senility — the obvious risk is that large areas planted during and after the colonial era will start to die. This will then require a systemic replanting or adaptation by smallholders to a different system of farming. Either way there will be a significant impact on smallholders: understanding the status of the stock of palms will help put some perspective on the timing and scale of this impact. Knowledge of how much economic activity of poor smallholders is vulnerable to loss of coconut stands would also provide a basis for considering continued support for 'insurance policy' activities such as germplasm conservation and evaluation.

For many Pacific countries, there may be few economic alternative uses of land planted to coconut palms: coconut production and intercropping systems seem to be fairly robust under the constraints of market access and cash flow that many smallholders face. Circumstances may be different in the Philippines and Sri Lanka, where problems regarding alternative uses may lie more with policy and institutional rather than geographical factors.

It does seem that in principle research targeted at coconut growers could be beneficial and have the potential to bear directly on ACIAR's concern with poverty alleviation. However, given the fairly limited uptake that has occurred of so much of the scientific and agronomic research undertaken in the past, it would seem that an approach that only proposed to do 'more of the same' may not be very helpful to coconut growers.

If ACIAR is to continue supporting coconut related research, it would make sense to consider the needs of smallholders who are currently growing coconut palms, not just the potential for research on coconut production, processing and marketing. That is, the research should recognise the multi-activity livelihoods and the multi-product farm systems of most smallholder enterprises that are involved in coconuts and the way in which research addresses the role of coconut palms, coconuts and coconut products in their overall risk management and production strategies. Research may also be useful in characterising and quantifying the incentive regime that smallholders face when making decisions related to land use and their coconut resource, and the impact of policy and institutional factors in shaping those incentives. On the policy front, there might be value in exploring the economic, policy and institutional factors that could influence agribusiness investment in coconuts, particularly with respect to nucleus estate models.

1 Introduction

Around ninety per cent of total world coconut production occurs in the Asia Pacific region. Coconuts have, for a very long time, been an important crop in these regions and play an important part in the local economy and culture, not only for large producers such as the Philippines, India and Indonesia, but also in the Pacific Islands, where coconut palms are integral to the livelihoods of many smallholders.

Australia is one of very few countries in the world which still funds research and development into coconuts as part of its international development program. A large proportion of this research has been supported by ACIAR which has funded 13 coconut related projects over the last 20 years.

ACIAR's Board has requested that the industry be reviewed and a strategic basis be established for future R&D investments, and ACIAR has commissioned the Centre for International Economics (The CIE) to undertake a study of the industry to assist with this review. The study was to:

- describe the structure of the industry using a supply/demand chain framework;
- review past trends in production, processing, consumption and trade of coconuts and coconut products for the world by regions and countries;
- assess the likely future trends in the industry for each sector;
- identify the importance of coconut production and processing for smallholders and how they fit into the supply chain;
- review briefly past coconut research by ACIAR and other organisations; and
- provide an assessment of the appropriate strategy for ACIAR's future investment options in this area.

This report presents the findings of the study. Chapter 2 discusses recent and longer term trends in the markets for coconuts and coconut products. Chapter 3 discusses the structure of the value chain and the incentives facing growers. Reflecting the important role that governments have played in various aspects of marketing, regulation and support for the industry, chapter 4 discusses the institutional setting for this support and some of its implications for industry development. Chapter 5 presents information on future prospects for coconuts. Chapter 6 briefly describes past coconut research and the perspectives of the research community on the impacts of this work. Finally, chapter 7 lays out issues to be considered in developing a coconut research strategy.

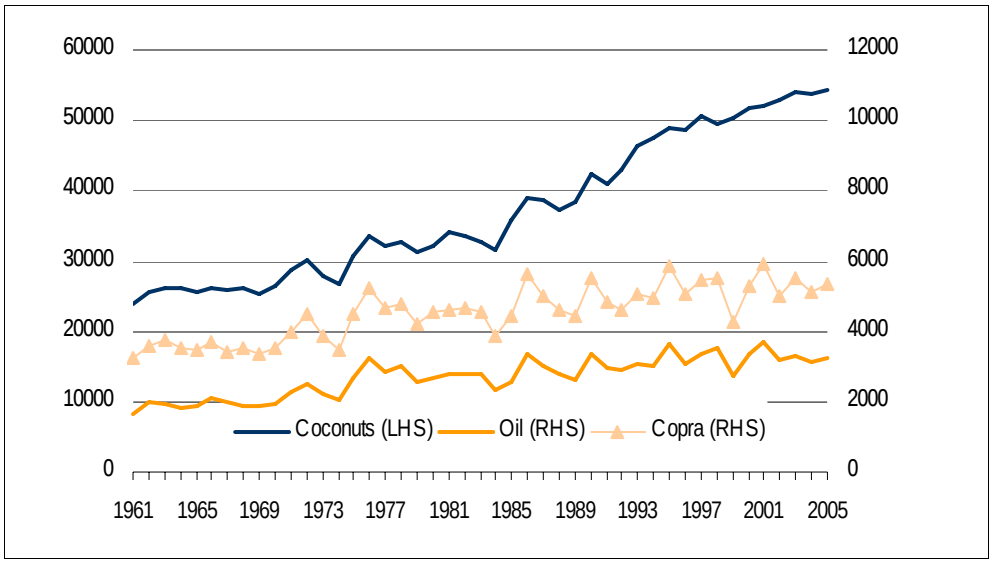
2 *Market trends*

The first step in this study is to provide a brief outline of global developments in the coconut sector, and then to examine in more details what is happening in the coconut sector in ACIAR partner countries.

World production

Chart 2.1 shows the volume of world coconut production since 1961 and of two of the main coconut products — copra and coconut oil. World coconut production has grown steadily over the period, at an estimated annual rate of 2 per cent, with production accelerating in the last twenty years (the trend growth rate from 1985 to 2005 was 2.1 per cent per annum, compared to 1.5 per cent for the period 1961 to 1985).

2.1 **Trends in world production of coconuts and major products (kt)**



Data source: http://faostat.fao.org, accessed on 26 March 2007.

Copra and coconut oil production has fluctuated considerably over the period, and on average grown more slowly than coconut production (with growth rates of 1.1 and 1.5 per cent per annum respectively). Significantly, production of these commodities has not kept pace with coconut

production in the past two decades. Currently global production of coconuts stands at 54 million metric tonnes: production of copra and coconut oil production is around 5 and 3 million tonnes respectively.

The main coconut players in the global market for 2005 are shown in table 2.2. Eight of the ten largest producers are in the Asia Pacific region (the data source identifies 91 coconut producing countries). The three main producers, Indonesia, the Philippines and India account for 75 per cent of world production. A majority of ACIAR partner countries produce coconuts and together they account for about 85 per cent of world production.

2.2 Selected production statistics, 2005

	Production(nuts)		*Area*		*Yield*	
	kt	%	ha	%	kg/ha	%[a]
Top 10 producers						
Indonesia	16 300	30.1	2 670	25.0	6 105	120.3
Philippines	14 797	27.3	3 243	30.4	4 563	89.9
India	9 500	17.5	1 860	17.4	5 108	100.6
Brazil	3 034	5.6	281	2.6	10 802	212.8
Thailand	1 500	2.8	343	3.2	4 373	86.1
Vietnam	972	1.8	110	1.0	8 814	173.6
Mexico	950	1.8	150	1.4	6 333	124.8
Sri Lanka	890	1.6	395	3.7	2 253	44.4
Papua New Guinea	650	1.2	180	1.7	3 611	71.1
Malaysia	642	1.2	179	1.7	3 587	70.7
Other Asia Pacific						
Myanmar	265	0.5	70	0.7	3 786	74.6
Vanuatu	315	0.6	74	0.7	4 257	83.9
China	298	0.5	29	0.3	10 188	200.7
Solomon Islands	276	0.5	37	0.3	7 459	146.9
Fiji Islands	140	0.3	50	0.5	2 800	55.2
Samoa	140	0.3	22	0.2	6 512	128.3
Kiribati	103	0.2	27	0.3	3 815	75.1
Cambodia	71	0.1	13	0.1	5 462	107.6
Tonga	58	0.1	8	0.1	7 160	141.1
Federated States of Micronesia	40	0.1	17	0.2	2 424	47.8
World	54 237	100.0	10 684	100.0	5 076	100.0

[a] Yield as proportion of world average yield

Source: http://faostat.fao.org, accessed on 26 March 2007.

The implied yields shown in table 2.2 suggest considerable variation in productivity across producers. The Philippines has the largest reported area from which coconuts are harvested — representing about 30 per cent of the world's total but its yields are considerably lower than average.

World consumption

A range of products and by-products of the coconut palm are consumed around the world. The kernel of the nut is an important source of nutrition in many tropical countries, and a range of products such as flour, desiccated coconut and coconut milk and cream are made from its flesh. The water in nuts is a source of hydration, the husk of the nut yields a fibre (coir) and pith that are used to make some cottage industry and commercial products, and the shell is made to produce activated charcoal and handicraft objects. The main commercial product however is coconut oil which is used internationally as cooking oil and in the production of, among other things, fats, soaps and detergents. This oil is typically produced from copra (dried coconut kernel/meat), yielding a meal by-product that has a variety of uses, including as an animal feed. Table 2.3 summarises the main uses of copra and coconut oil.

2.3 **Uses of coconut kernel, copra and coconut oil**

Product	***Use***
Copra	▪ Desiccated coconut
	▪ Coconut oil
	▪ Copra meal
Coconut oil (edible uses)	▪ Refined coconut oil for cooking purposes
	▪ Medium Chain Triglycerides (MCT) for medicine and infant foods
	▪ Margarine
Coconut oil (industrial uses)	▪ Coco chemicals such as methyl esters (textiles), rubber, soap and detergent industries, and also in lubricants, jet engine oils, PVC and resins
	▪ Glycerine (in food and beverage industries, resins, emulsifiers & cellophane)
	▪ Soaps and detergents, shampoos, cosmetics, bath oils
	▪ Tooth paste and synthetic perfumes
	▪ Polyurethene, base materials in paint, explosives and propellants
	▪ Biofuels

Source: Landell Mills (2005).

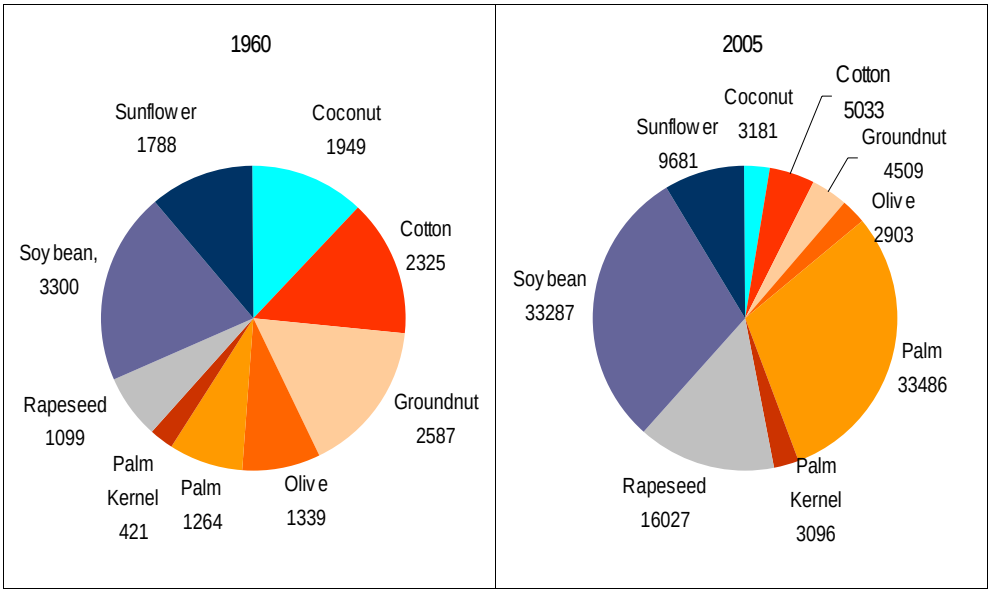
Coconut oil competes with other vegetable oils, and as table 2.4 shows, its position in the world market has declined substantially over the last 45 years. Production has been falling since 1990, and coconut oil's share of the world oil market has fallen from 12 per cent in 1960 to 3 per cent in 2005 (chart 2.5). Palm and soybean oil now dominate the market.

2.4 World production of vegetable oils, 1960-2005

Oil	*1960*	*1970*	*1980*	*1990*	*2000*	*2005*
	mt	mt	mt	mt	mt	mt
Coconut	**1 949**	**2 020**	**2 717**	**3387**	**3281**	**3181**
Cotton	2 325	2 503	2 992	3782	3864	5033
Groundnut	2 587	3 044	2 864	3897	4560	4509
Olive	1 339	1 442	1 701	1855	2540	2903
Palm	1 264	1 742	4 543	11 014	21 874	33 486
Palm Kernel	421	380	547	1450	2691	3096
Rapeseed	1 099	1833	3 478	8160	14 466	16 027
Soybean	3 300	6 777	13 382	16 097	25 541	33 287
Sunflower	1 788	3491	5024	7869	9700	9681
Total	**16 072**	**22 932**	**37 248**	**57 511**	**88 517**	**112 013**

Source: APCC, reported in Coronacion (2006).

2.5 Share of world production of vegetable oils, 1960 and 2005

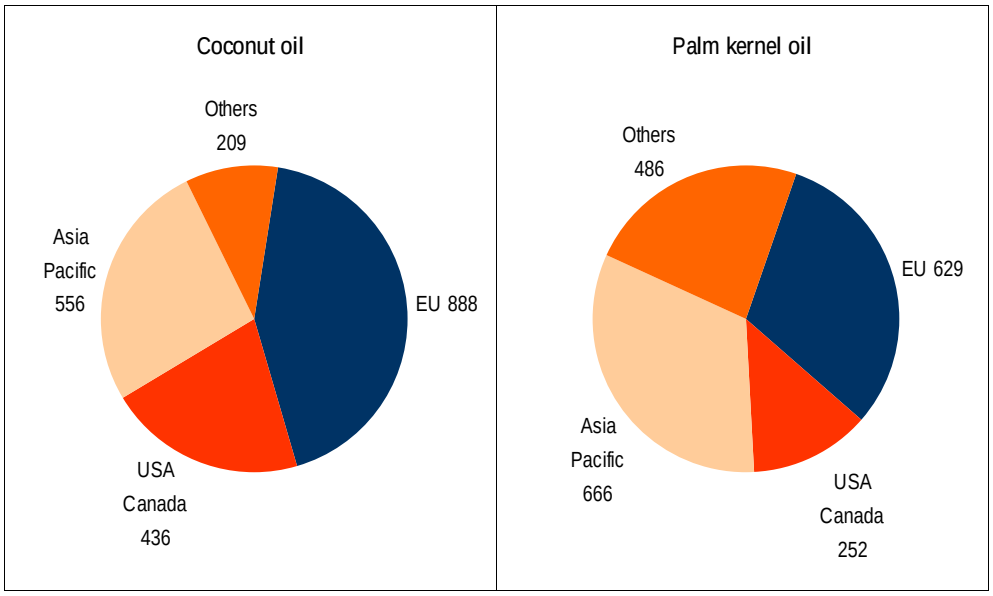


Data source: APCC, reported in Coronacion (2006).

Coconut and palm kernel oil have a different fatty acid composition from other edible oils, being relatively high in medium chain fatty acids, particularly lauric acid (Landell Mills 2005). This underpins the extent of non-food uses of these oils in the oleo-chemical sector, and the price premium that they have commanded over the last couple of decades. However, this market position may be challenged by the development of genetically modified rapeseed and canola oil (Landell Mills 2005).

In 2005 the European Union was the largest destination for coconut oil exports, accounting for 888 million tonnes, or just over 42 per cent of world imports (chart 2.6). The EU and the Asia Pacific region accounted for roughly similar shares of world imports of palm kernel oil.

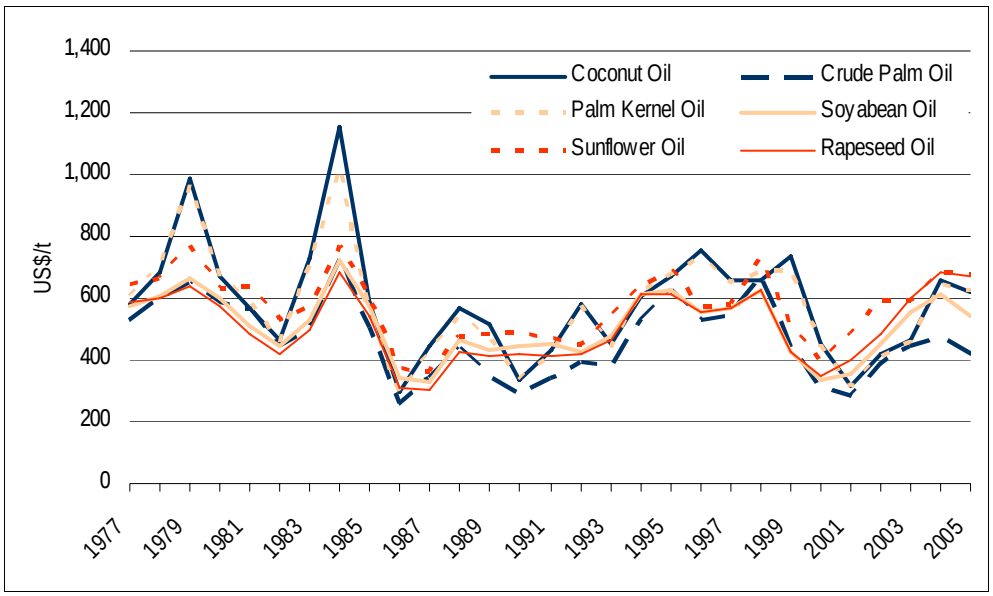
2.6 **Share of world imports of lauric oils, 2005**



Data source: Oil World, report in Coronacion (2006).

Chart 2.7 compares movements in the price (cif Rotterdam) of coconut oil and the other main vegetable oils. It demonstrates the small premium that coconut oil and palm kernel oil typically receive over the other oils, as well as the considerable volatility of prices for these commodities, driven largely by supply fluctuations (Landell Mills 2005). Over the nearly 3 decades covered by the chart, there has been a slight downward trend in coconut oil prices.

2.7 **Vegetable oil prices, 1977-2005**



Data source: http://econ.mpob.gov.my/economy/Price18_05.htm, accessed on 28 March, 2007.

International trade in copra is quite small as a result of the major coconut growing countries processing their own production. However, some of the smaller producers — especially in the Pacific — export copra through a few trading companies that purchase copra around the world for onward sale to the crushing industry. The main markets for copra are in Japan, Germany, Singapore and South Korea (Landell Mills 2005). However, in recent years, some coconut growing countries have begun to import copra. Copra crushers in Bangladesh are importing directly from exporting countries. In the Pacific, Fiji, Samoa and Vanuatu have been importing copra from their neighbours in the face of declines in domestic production. The Philippines routinely imports copra from Papua New Guinea and from the Solomon Islands to maintain throughput in their crushing plants.

The price of copra closely tracks the coconut oil price.

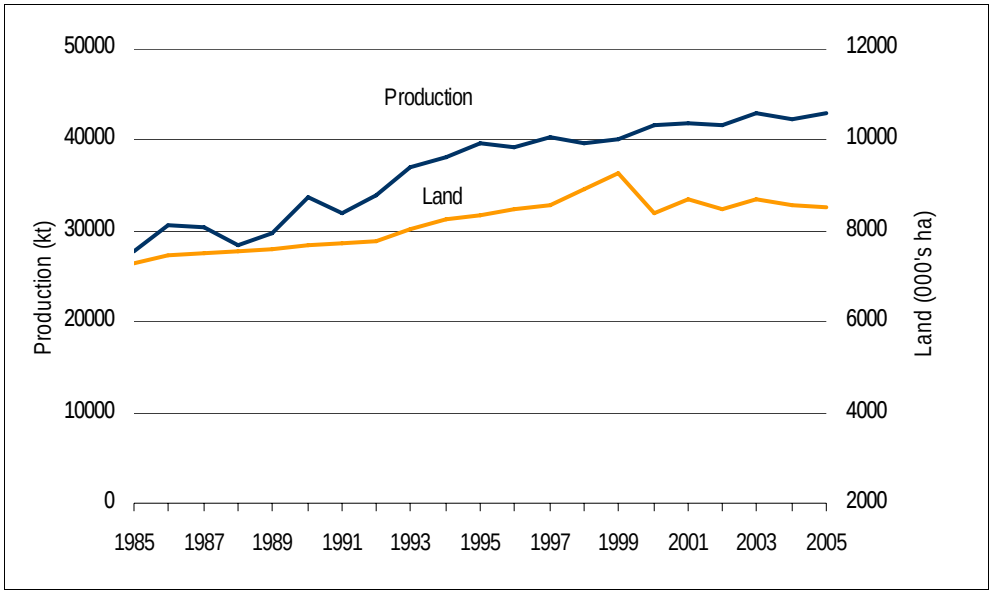
ACIAR partner countries

Coconuts are grown in nearly all of the countries where ACIAR currently has research programs. This section examines some of the characteristics of the coconut sector in the following countries where coconuts play a significant economic role, and where information is available: Fiji Islands; Kiribati; Papua New Guinea; Solomon Islands; Tonga; Vanuatu; India; Indonesia; the Philippines; Sri Lanka; and Vietnam. The analysis draws on the statistical collections of the Food and Agriculture Organization (FAO): it has to be recognised that the quality of the data reported from some

developing countries is variable — however, for commodities like coconuts, FAO is the only consolidated source of information that covers the main producers.

Chart 2.8 shows aggregate coconut production and harvested area for these countries. Since 1988, there has been a clear upward trend in aggregate production from these twelve countries — which is surprising given the declines in world copra and coconut oil production. (If correct, this trend must suggest increased home consumption of coconuts and production of value added products.) Over this period the annual trend rate of growth in production has been 2.4 per cent (the same as the global outcome because these countries dominate global production) while growth in land planted to coconuts has increased at an annual rate of 0.8 per cent.

2.8 **Coconut production and area harvested in selected ACIAR countries** [a]



[a] Includes Fiji Islands, Papua New Guinea, Vanuatu, Solomon Islands, Tonga, Kiribati India, Indonesia, the Philippines Vietnam and Sri Lanka.

Data source: http://faostat.fao.org, accessed on 26 March 2007.

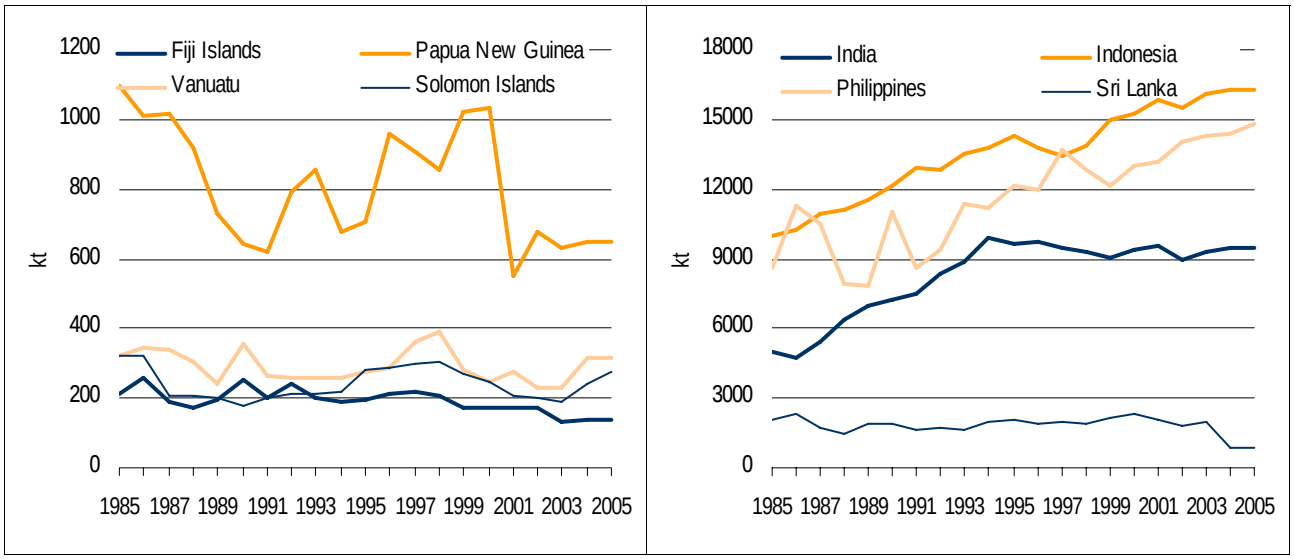
However, there are significant differences in performance between these countries using this broad indicator. Chart 2.9 contrasts the relative performance — as measured by production. Two clear groups emerge:

- the Pacific island countries with comparatively small and variable production base; and
- the larger-scale producers in the sub-continent and South East Asia.

As chart 2.9 shows, nearly all of the growth in production in this set of countries has come from Indonesia and the Philippines. Production expanded in India in the late 1980s to mid-1990s, but has been fairly

stagnant since that time. Production in Sri Lanka, flat for most of the period, has begun to decline quite rapidly, and is now half of the levels achieved in the late 1990s.

2.9 **Coconut production in selected countries** [a]



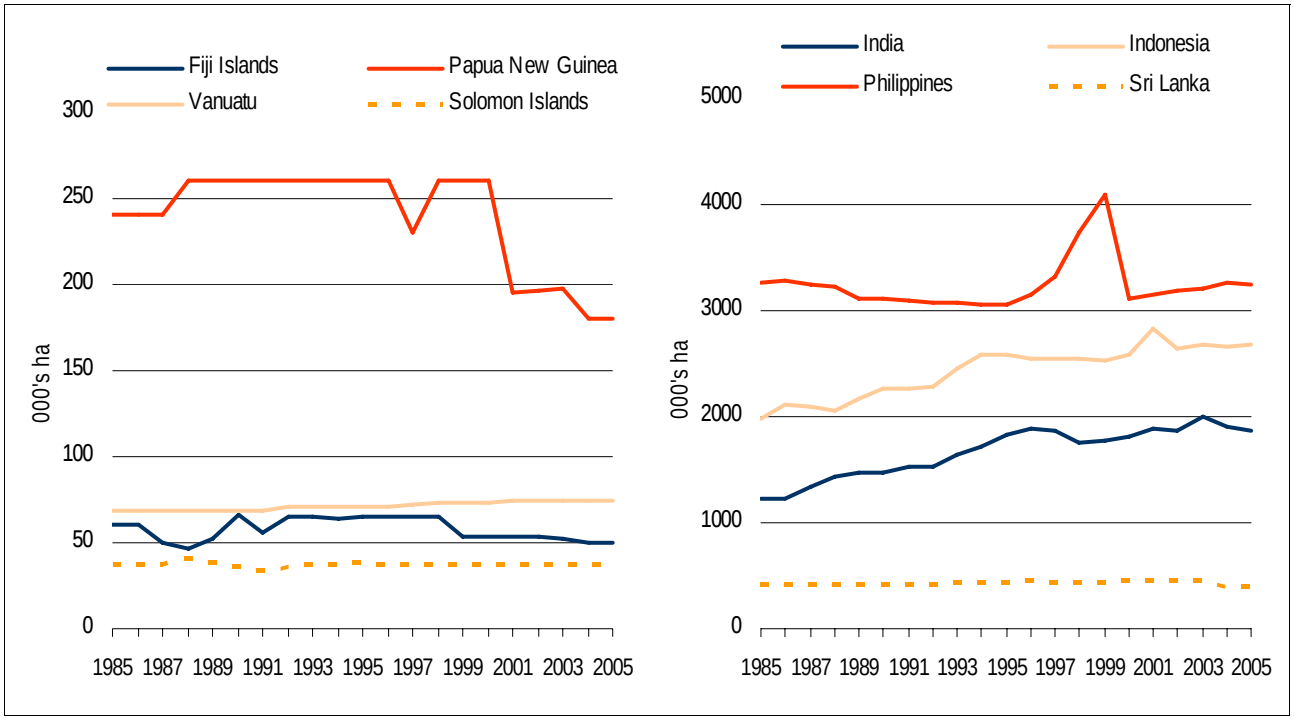
[a] Note difference in scale between graphs.

Data source: http://faostat.fao.org, access 26 March 2007.

Chart 2.10 presents the FAO's estimates of the areas of coconut harvested for the selected countries and suggests that in the Pacific, particularly Papua New Guinea, harvested areas have remained flat or are in decline. For the major producers the area harvested has increased marginally since 1988.

This said, coconuts are much more important to the economies and land use of the Pacific economies. As chart 2.11 shows, the area from which coconuts are harvested represents over 60 per cent of the reported arable and permanent cropland of Kiribati, Vanuatu and Solomon Islands.

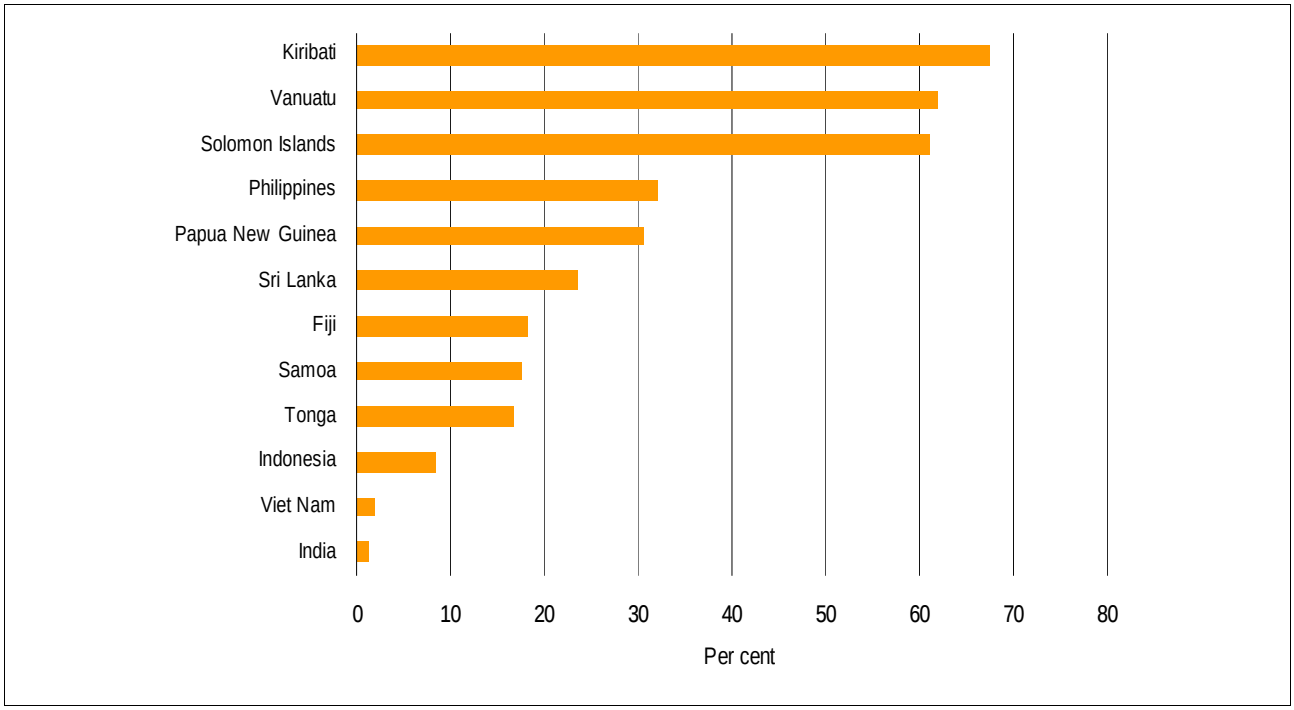
2.10 **Coconut area in selected countries** [a]



[a] Note difference in scale between graphs.

Data source: http://faostat.fao.org, accessed on 26 March 2007.

2.11 **Coconut areas as a proportion of arable and permanent cropland**



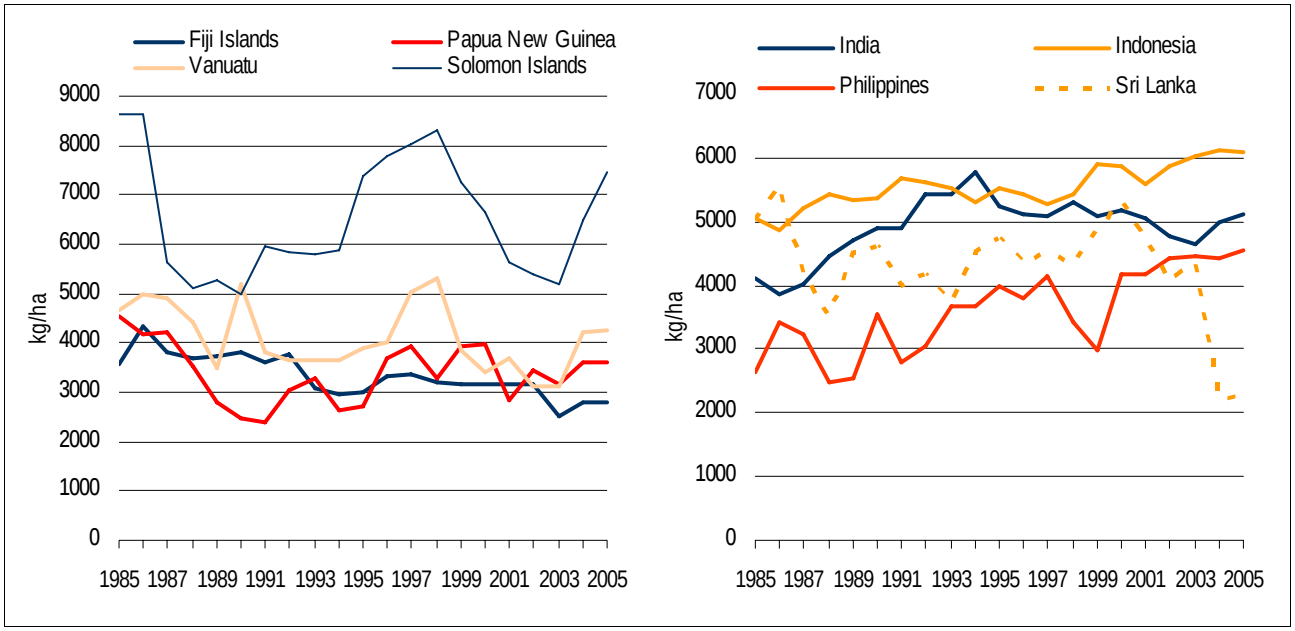
Data source: http://faostat.fao.org, accessed on 26 March 2007, and http://earthtrends.wri.org/country_profiles/index.php?theme=8, accessed on 28 March 2007.

Chart 2.12 shows FAO estimates of yield for selected ACIAR program countries. Two broad trends emerge from this data:

- coconut yields are on a downward trend in the Pacific Islands and are highly variable from year-to-year; and
- the trend for the larger producers is upwards with generally less variability in yields from year-to-year:
  - the exception is Sri Lanka where reported yield per hectare dropped off substantially over the past 3 years — possibly as a result of rapid cost increases and the continuing effects of civil war (K. Chapman, personal communication).

Some of the fluctuations in yields in chart 2.12 are likely to reflect limitations with the data source. These are discussed at the end of this chapter.

2.12 **Coconut yields in selected countries**



Data source: http://faostat.fao.org, accessed on 26 March 2007.

Domestic and export use

Table 2.13 provides information on the volumes of coconut production that are destined for food consumption for selected countries. Across all these countries, around 60 per cent of production goes into domestic food consumption. Coconuts consumed domestically include subsistence consumption for households and cash sale of whole nuts through markets in regional areas and in capital cities.

2.13 **Coconut production and food consumption, 2003**

Country	*Production*	*Food consumption*	
	kt	kt	%
Indonesia	16145	11506	71
Philippines	14294	1932	14
India	9288	9494	102
Sri Lanka	1947	1159	60
Fiji Islands	130	103	79
Kiribati	96	20	21
Papua New Guinea	630	na	na
Solomon Islands	192	60	31
Vanuatu	315	48	21
Vietnam	893	780	87
All countries	43300	25917	58

Source: http://faostat.fao.org, accessed on 26 March 2007.

The table suggests that for the Philippines, Vanuatu and the Solomon Islands, only a small proportion of the coconut produced is consumed for food: most of the remainder is processed for export.

Some caution has to be exercised in using these data. Information from other sources paints a rather different picture for some of these countries. A recent report on Solomon Islands, for example, estimated that around the same number of nuts (107 million per year) went into domestic consumption as was used to produce copra (McGregor 2006). However, the high levels of local consumption in some countries may be consistent with the different movements in production of coconuts and of copra and coconut oil shown in chart 2.1. It may be that an increasing proportion of the coconut harvest is going into domestic consumption and value added products.

Table 2.14 presents data on production and export of coconut oil, a major output of the coconut processing chain. The data suggest that the bulk of production in India, Sri Lanka, Vietnam and Solomon Islands is destined for the local market, whereas for the Philippines, the largest producer, nearly 80 per cent of production is exported. For many Pacific Islands the main export product is copra rather than oil. (The data for Papua New Guinea shows exports greater than local production. This is probably an error, although may reflect export of informal imports from nearby locations in Solomon Islands.)

2.14 **Coconut oil production and export, 2003**

Country	*Production*	*Export*	
	kt	kt	%
Indonesia	707	365	52
Philippines	1 524	1 186	78
India	414	6	1
Sri Lanka	21	2	12
Fiji Islands	8	6	80
Kiribati	..	na	na
Papua New Guinea	48	61	127
Solomon Islands	7	1	9
Vanuatu	8	3	41
Vietnam	149	5	3
All countries	2886	1 636	57

Source: http://faostat.fao.org, accessed on 26 March 2007.

Limitations of available statistics

Comprehensive statistics on coconut production and use are currently limited to two sources:

- the FAO; and
- Coconut Statistical Year Book by the Asian and Pacific Coconut Community (APCC) (1996).

This review has relied on the FAO because of the timeframe of the project, but these statistics should be considered as indicative rather than definitive. This is because both of these organisations rely on respective departments of agriculture in each country to supply estimates of production and land usage. As reported by CIE (2006), the collection of accurate information for agricultural production is intrinsically difficult in many of these countries and depends critically on the institutional capacity of government and industry agencies. Often these resources are very limited, so shortcuts are taken and judgements are made.

For the Philippines, it is possible to check the FAO data against information from the Philippines Coconut Authority (PCA). Table 2.15 compares the estimates of production and area harvested from the two sources, and the yields implied by this data. As can be seen, the odd spike in the area of land being harvested that appears in the FAO data is not replicated in the information from the PCA.

2.15 **Comparison of production, area and yield data for the Philippines**

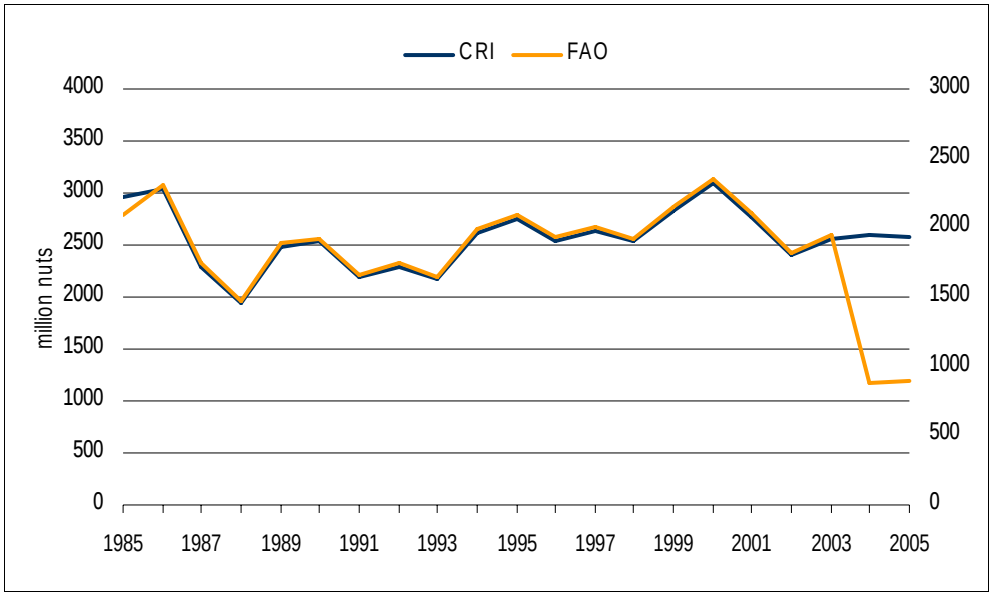
	Production			*Land under coconuts*			*Implied yield*		
	FAO[a]	**PCA**[b]	**Difference**	**FAO**[a]	**PCA**[b]	**Difference**	**FAO**[a]	**PCA**[b]	**Difference**
	kt	kt	%	'000ha	'000ha	%	kg/ha	kg/ha	%
1990	11023	11942	-8.3	3112	3112	0.0	3542	3837	-8.3
1991	8638	11293	-30.7	3093	3093	0.0	2793	3651	-30.7
1992	9384	11580	-23.4	3077	3075	0.1	3050	3766	-23.5
1993	11328	11669	-3.0	3075	3076	0.0	3684	3793	-3.0
1994	11207	11837	-5.6	3062	3083	-0.7	3660	3840	-4.9
1995	12183	12791	-5.0	3064	3095	-1.0	3976	4133	-4.0
1996	11937	11937	0.0	3149	3149	0.0	3791	3791	0.0
1997	13708	13708	0.0	3314	3134	5.4	4136	4373	-5.7
1998	12806	12806	0.0	3731	3116	16.5	3432	4110	-19.7
1999	12142	11589	4.6	4091	3138	23.3	2968	3693	-24.4
2000	12995	12995	0.0	3119	3144	-0.8	4167	4133	0.8
2001	13146	13146	0.0	3149	3149	0.0	4175	4175	0.0
2002	14069	14068	0.0	3182	3182	0.0	4422	4422	0.0
2003	14294	14294	0.0	3214	3217	-0.1	4447	4444	0.1
2004	14366	14366	0.0	3257	3259	0.0	4411	4409	0.0
2005	14797	14825	-0.2	3243	3243	0.0	4563	4571	-0.2
Memo item									
Trend growth rate (% per annum)	2.8	1.6		0.5	0.3		2.3	1.3	

a FAOstat data **b** Data from Philippine Coconut Authority

Source: http://faostat.fao.org, accessed on 26 March 2007, http://www.pca.da.gov.ph/cocostat.html, accessed on 21 May 2007

Table 2.16 compares the FAO production data for Sri Lanka with data from the Sri Lanka Coconut Research Institute (CRI). The latter data is in nut equivalents, but as the data shows, the two data sets track each other perfectly until 2004, when the FAO data suggests a precipitous fall in production which the CRI data does not confirm.

2.16 **Comparison of production data for Sri Lanka**



Data source: http://faostat.fao.org, accessed on 26 March 2007, http://www.cri.lk/pdf/tab6.pdf, accessed on 21 May 2007.

The ease with which reliable data can be collected varies across products. In industries where all of production must be processed quickly with a single point of export, monitoring changes in production is relatively straight forward. Oil palm is a good example: fruit must be picked when ripe and processed within the day. Harvesting is scheduled around a central export oriented processing facility. The presence of plantations and smallholders in concentrated geographical areas supplying centralised processing also permits the collection of accurate data on land use and yields.

The reality for coconuts and coconut products for most countries is that estimates of production and land use are synthesised from a range of data sources. This is especially the case where:

- plantations are geographically dispersed — along the coastline or across a number of islands;
- consumption and export can take place from a number of points; and
- nuts can remain unpicked, and both nuts and copra can be stored over long periods.

In most countries the only hard data available on a regular basis are on export volumes. Using conversion ratios exports for copra, coconut oil and other products implied production is calculated on a nut equivalent basis (number or weight of nuts). This is then combined with assumptions about local consumption — the average number of nuts consumed per household

per week to estimate total production. These calculations are often informed by a range of other data sources including:

- regular collection of processing mills receivals data;
- irregular agricultural surveys which indicate land usage, yields and most importantly harvesting rates; and
- irregular household consumption and expenditure survey data.

Harvesting rate the unknown factor

While estimates of production can be considered reasonably accurate, data on land planted and yields seems to be quite problematic.

As a result of the (generally) low levels of management and other inputs used on coconuts, average yields on a fully harvested coconut plantation will vary from year-to-year primarily as a result of climate — drought and cyclones impact on the number of nuts available or harvest. For example, a cyclone can disturb nuts that would be otherwise very difficult to harvest — and so increase harvesting rates.

Also because of the life span of palms and the smallholder basis of production, the total resource base dedicated to palms in each country should not vary dramatically over time. For example, chart 2.10 shows that since 2000, the estimated area being harvested in Papua New Guinea has fallen by 30 per cent. This is extremely unlikely. The more likely driver behind the apparent fall in production is result is a very low harvest rate — one possibility is that people responsible for reporting the data adjusted the estimated area to maintain a sensible yield estimate. As discussed in chapter 3, harvest rates appear to be quite responsive to prices, and when many producers are predominantly quasi-subsistence households with limited access to markets, harvest rate can be expected to be quite variable.

3 *Structure of the value chain and incentives facing growers*

This chapter looks at the structure and drivers of the value chain for coconut. The coconut industry is predominantly a smallholder industry. As table 3.1 shows, smallholders account for the bulk of the area harvested in most of the larger coconut producing countries. Plantations are relatively more important in Sri Lanka, Vietnam and the Philippines, but even in these countries, smallholders still predominate, and they account for nearly all of the area in the other two large producers, India and Indonesia. In a number of countries, such as Papua New Guinea, Sri Lanka and Solomon Islands, a number of colonial era plantations have reverted to customary ownership and smallholder management.

3.1 **Percentage of coconut area held by smallholders**

Country	*%*
India	98
Indonesia	97
Malaysia	91
Papua New Guinea	84
Sri Lanka	82
Fiji Islands	80
Vanuatu	79
Philippines	71
Vietnam	60

Source: Arancon (1997).

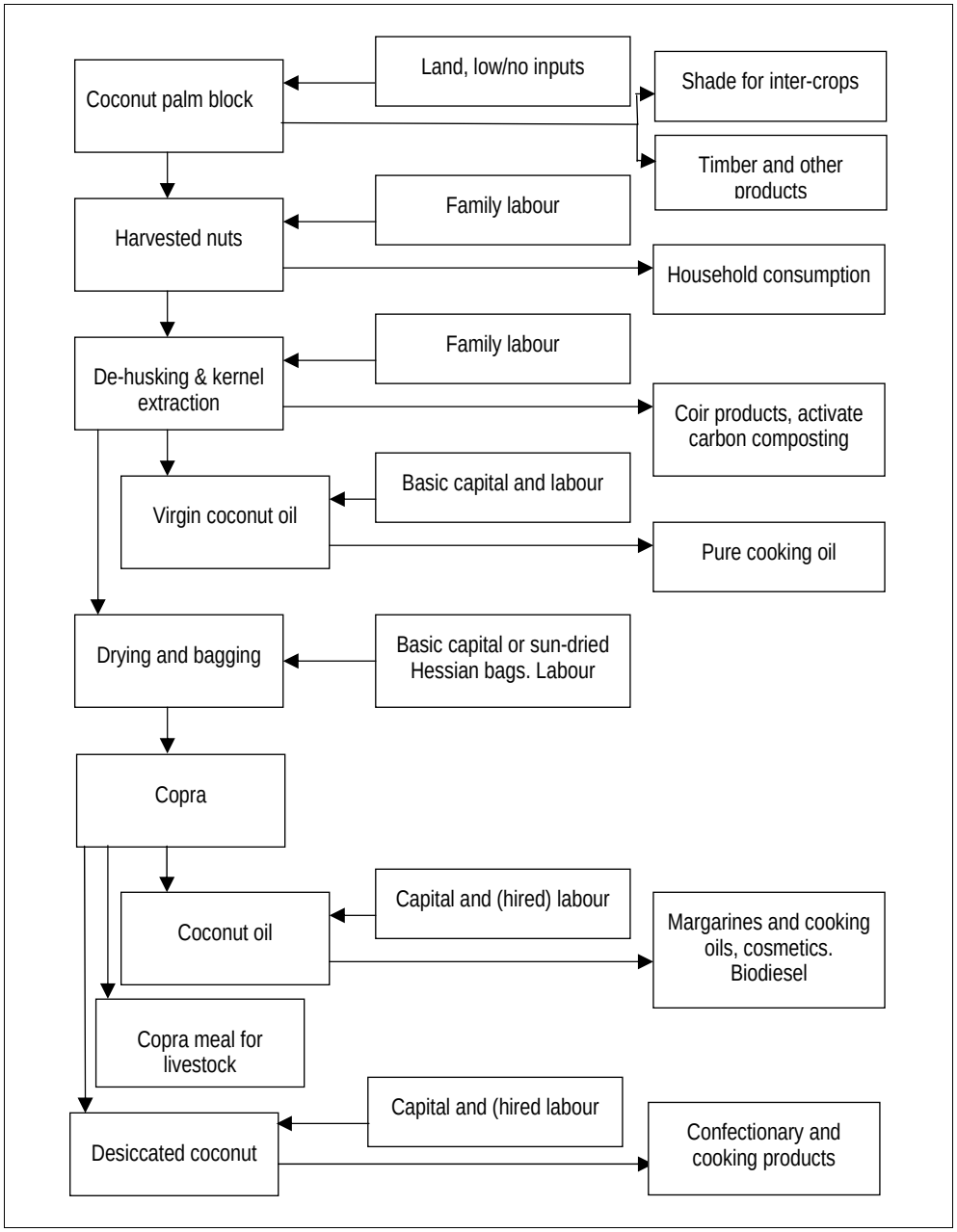
Overview of the value chain

Chart 3.2 shows a stylised representation of the coconut production chain from smallholder blocks through to the final products consumed by households — both in the country in which they are produced and export destinations.

Because this diagram is inclusive of the major processes and products across all producing countries, it does not reflect the fact that the intensity of involvement in some products varies across countries. Typically those

countries with more formal and integrated chains produce a broader range of products — including the use of by-products. Sri Lanka and Thailand are examples of countries producing most of these products, as well as a range of other minor and specialist commodities. For example, coconut water for export is not common because of the quality control required along the chain. Indonesia is another example of a country that produces most coconut products.

3.2 **Production chain for coconuts and products**



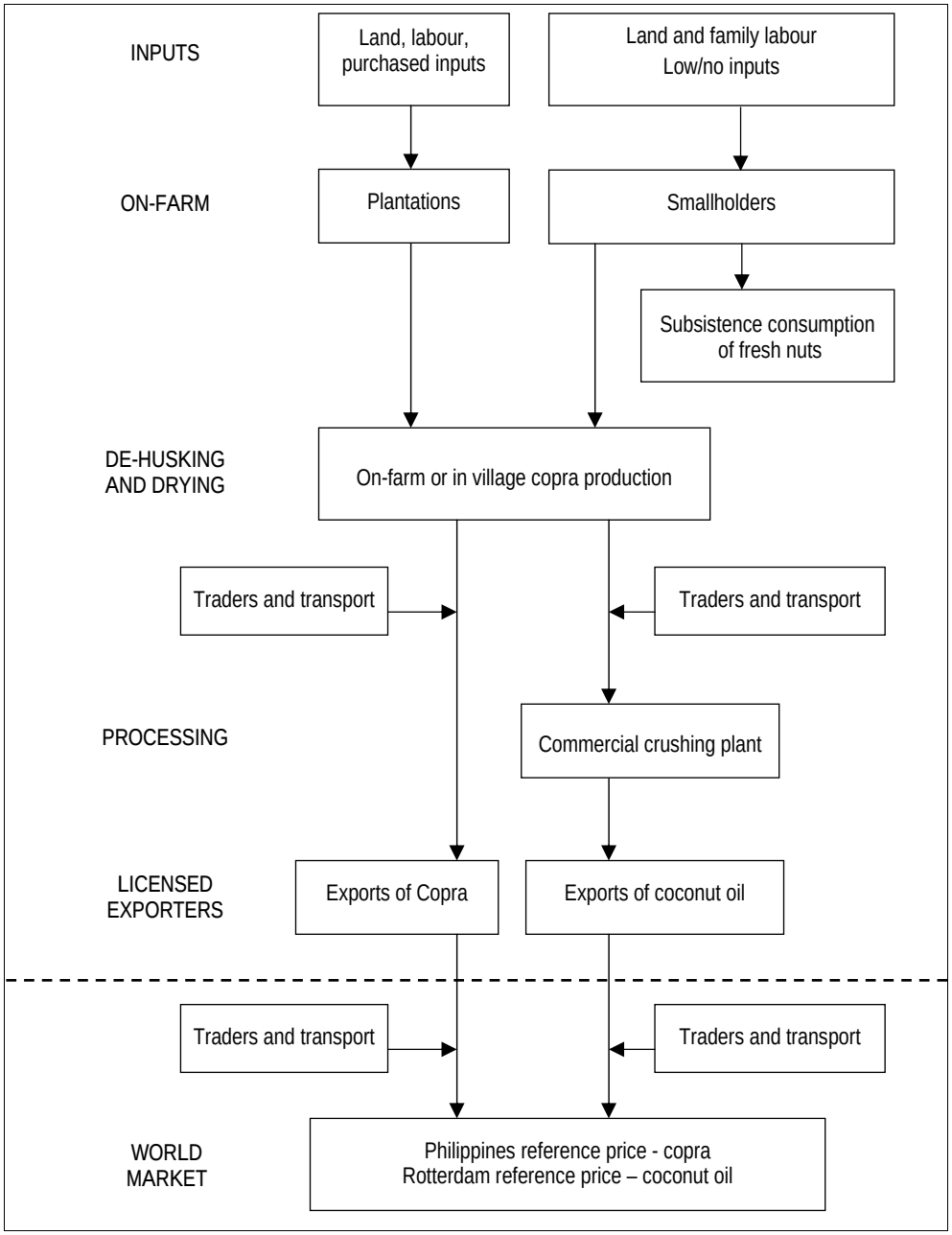
Note: De-husking sometimes occurs at the processing plant when nuts are being used to produce virgin coconut oil or desiccated coconut. There may be by-products from processing nuts for virgin coconut oil, as coconut milk, cream and water s well as desiccated coconut.

Source: The CIE.

Another key feature is the low level of purchased inputs throughout the chain. At grower level, in most countries fertiliser and chemical use is non-existent or minimal. Processing is also low technology often using low-skill labour and basic capital that could be up to 30 years old. Again, the countries most likely to purchase inputs at farm and processing level are those with formal and integrated value chains.

Chart 3.3 shows an equivalent value chain typical of Papua New Guinea and the Pacific Islands such as the Solomon Islands and Vanuatu.

3.3 **Value chain for Papua New Guinea and Pacific Islands**



Source: The CIE.

The key difference is that further processing is very limited. Subsistence consumption of fresh nuts is very important for these countries. Copra for cash-sale is either exported directly — often to countries or regions with under-utilised capital — or crushed locally for export of coconut oil. The reference price for copra is currently set out of the Philippines whereas coconut oil is priced directly off the Rotterdam price and adjusted for transport.

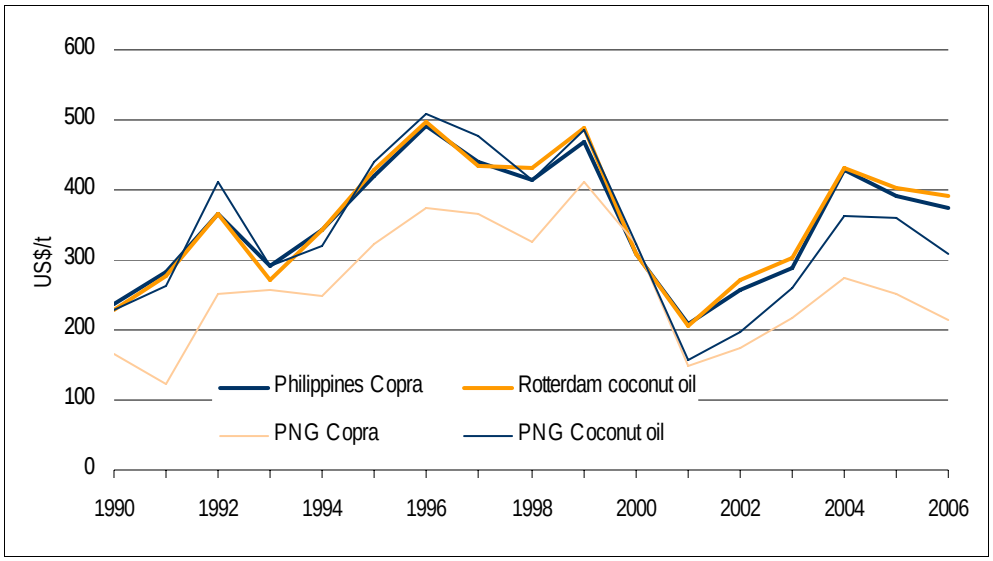
Transport for copra is a binding constraint — especially in the Pacific Islands where production is geographically dispersed and often quite fragmented. In Solomon Islands, shipping services to producers on many of the nine hundred odd islands are very erratic — more so since the collapse of the Commodity Export Marketing Authority (McGregor 2006).

Profitability of the chain

Chart 3.4 compares the world reference prices for copra, on a cif basis in the Philippines, and coconut oil on a cif basis at Rotterdam. Adjusting for the oil yield of copra, the processing margin has been very small over the period when comparing the reference prices. It is noted that the coconut oil price in Sri Lanka and India are usually higher than the reference price.

Processing is more profitable for supply to the domestic market because of the impact of freight costs — which are proportionally higher for copra because of its low density. Margins for coconut oil, on a copra equivalent basis, are higher in PNG (chart 3.4), but were squeezed severely during 2001, when most vegetable oil prices fell to 15-year lows (see chart 2.7).

3.4 **Processing margins are very small** [a]



[a] PNG average fob value s and Rotterdam and Philippines cif prices for coconut oil and copra. Oil yield of copra of 65 per cent.

Data source: Bank of Papua New Guinea (2007).

Table 3.5 shows a value chain corresponding to chart 3.4 for Bougainville and Papua New Guinea. There are several features of the table:

- smallholders receive a large component of the export value of copra and coconuts;
- government charges and transport costs are important; and
- the small margin of 12 per cent between copra and coconut oil.

3.5 **Value chain for copra in Bougainville, April 2004**

Chain component	*Prices*	*% of fob price*	
		Copra	**Coconut oil** [a]
	kina/t	%	%
Copra			
Average price received in Buka	768	82	72
Levy paid to KIK	60	6	6
Research levy to CCI	8	1	1
Transport and trader cost	105	11	10
Average fob price copra	941	100	88
Copra Philippines price cif	1483		
Coconut oil			
Average fob price	1788		100
Rotterdam cif price	2374		

[a] Assuming coconut oil yield from copra is 65 per cent.

Source: Coconut Products Limited, Rabaul (pers. comm. October 2005) and Bank of Papua New Guinea (2007), QEB Statistics.

In the next section we look at how the price received by the smallholder relates to the effort put into the supply of copra.

Smallholder incentives

Although large scale commercial plantations are in decline, smallholder production persists because coconuts play an important role in quasi-subsistence agriculture where the palms are grown. Smallholder coconut stands serve multiple purposes including:

- subsistence consumption;
- cash cropping; and
- providing shade for intercropped subsistence and cash crops.

Subsistence consumption

In many of the coconut producing countries, coconuts form a significant part of the diet and hydration of inhabitants. Green coconut water is an important source of fluids in countries where fresh water and particularly safe surface water may not be readily available. This is especially the case for communities living on coral atolls in the Pacific.

Coconut is a good supply of protein and for many poorer, isolated communities where meat is scarce, the consumption of coconut flesh supplements fishing and allows for a more balanced diet. Table 3.6 shows the estimated number of calories per day per capita provided by the consumption of coconuts in selected coconut producing countries. The table suggests that in some of these countries a large proportion of calories come from the fruit.

3.6 **Average calories from coconuts per day**

Country	*Kcal*
Fiji Islands	376
India	41
Indonesia	120
Kiribati	842
Philippines	76
Samoa	746
Solomon Islands	660
Sri Lanka	336
Thailand	96
Vanuatu	671

Source: http://faostat.fao.org, accessed on 26 March 2007.

The table shows that for some of the Pacific countries, coconuts are a very important source of calories. This is particularly true for Kiribati and Samoa where coconuts contribute 842 and 746 calories a day respectively. This equates to 42 and 37 per cent respectively of the internationally recommended daily caloric intake of 2 000 calories per day.

Apart from nutrition and hydration, coconuts are seen to deliver a range of important health benefits. Coconuts can be an important tool in the treatment of diarrhoea, cholera and de-hydration as the water found in green coconuts has isotonic properties. It contains a wide variety of minerals such as potassium and sodium which are beneficial in treating intestinal disturbances.

It has been suggested (Ontolan 1998) that the coconut industry in the Philippines supports about one-third of the population. In some Pacific countries, the majority of households produce coconuts for subsistence food. According to Opio (1993), over 80 per cent of farm households were

engaged in coconut cultivation in the late 1980s. In the Solomon Islands 1999 census 73 per cent of households reported subsistence production of coconut (Solomon Islands Ministry of Finance 2000).

Coconut as a cash crop

For many smallholders, coconut production is an important source of cash income. In some Pacific Islands, it is nearly the only source. Fresh coconuts are sold in local markets, and are also processed in village operations to produce coconut oil and meal (and in some countries coconut cream for sale in wet markets). However, copra or whole coconuts sold to larger processors is the main income source for most smallholders. In Solomon Islands, around 40 per cent of all households reported producing coconuts for the market in the 1999 census (Solomon Islands Ministry of Finance 2000).

Intercropping

In addition to uses in household consumption at a local level, the coconut resource also provides valuable shading under which other crops can be grown. There is much evidence in coconut growing countries that coconuts are inter-cropped with other crops thus increasing the productivity of the coconut and of the crops grown under it and thereby increasing potential revenue to smallholders with access to the coconut resource.

In a paper delivered to a 1993 ACIAR funded workshop on coconut improvement in the Pacific, Foale and Ashburner argued that while the attraction of coconut as a financial investment had disappeared almost completely, its place in household, local and regional economies remained secure because of its role as a stable perennial component of multi-culture cropping systems (Foale and Ashburner, 1994).

Table 3.7 lists some of the crops that are grown under coconut in Sri Lanka. It is reported that around 80 per cent of all cocoa in Papua New Guinea is grown under coconut (J. Nightingale, Agmark, personal communication, November 2006), and data shows that in Indonesia an average of 35 per cent of coconut plantations are intercropped (Sondakh and Kaligis 1991). In some countries, animals, particularly cattle are grazed in plantations that can be fenced. . In Sri Lanka and Thailand, coconut palms that are between 40 and 60 years old are intercropped with papaya, pineapple and banana, cinnamon, cloves, nutmeg, flowering and ornamental plants and Gliricidia (grown for fuel and cattle feed), as the light penetration is better in these older stands.

3.7 **Crops intercropped with coconuts in Sri Lanka**

Type of crop	*Crop*
Tubers	Cassava, Sweet Potato, Taro, Yams
Cereals	Finger millet, Maize, Sorghum
Legumes	Cowpea, Green gram, Groundnut, Soybean, Winged bean
Fruit crops	Banana, Citrus, Papaya, Passion Fruit, Pineapple, Pomegranate
Spices and condiments	Arecanut, Betel leaves, Chillies, Ginger, Turmeric
Minor export (cash) crops	Black pepper, Cacao, Cinnamon, Clove, Coffee, Nutmeg
Others	Pasture grass, Sesame (oil seed)

Source: Reynolds (1995).

There are four main characteristics of coconut plantations that make them ideal for inter-cropping. These are:

- the spacing between trees in typical stands;
- the morphological features of the coconut that means that older palms occupy less than 30 to 40 per cent of the available air space between canopy and ground;
- the nature of the canopy fronds and the proportion of solar radiation they let through to the ground; and
- the radius and depth of their roots (Reynolds 1995).

Due to the recent low returns for coconut products on world markets, many farmers have found that coconut plantations do not provide sufficient income alone and have to be combined either with animals for pasture or other crops.

There are many examples of coconut plantations being used to grow other plants. In the South Pacific, the shade provided by coconut trees has been used to help grow cocoa, vanilla and pepper among other things. In South East Asia, root crops and citrus are grown in coconut plantations. It is also common practice in many countries to graze cattle under coconut trees.

Findings from experiments have shown that intercropping coconut plantations can actually increase the yields of coconut plantations: many believe this happens through the improved weeding and soil maintenance as a result of other crops and the increased use of fertilisers.

Inter-cropping is an important practice for many farmers as it provides them with a greater degree of income security than cash cropping and also raises the incomes they generate from the same area of land. Coconut farmers are particularly susceptible to fluctuations in the volatile world prices of coconut products and to cyclones and typhoons which have the

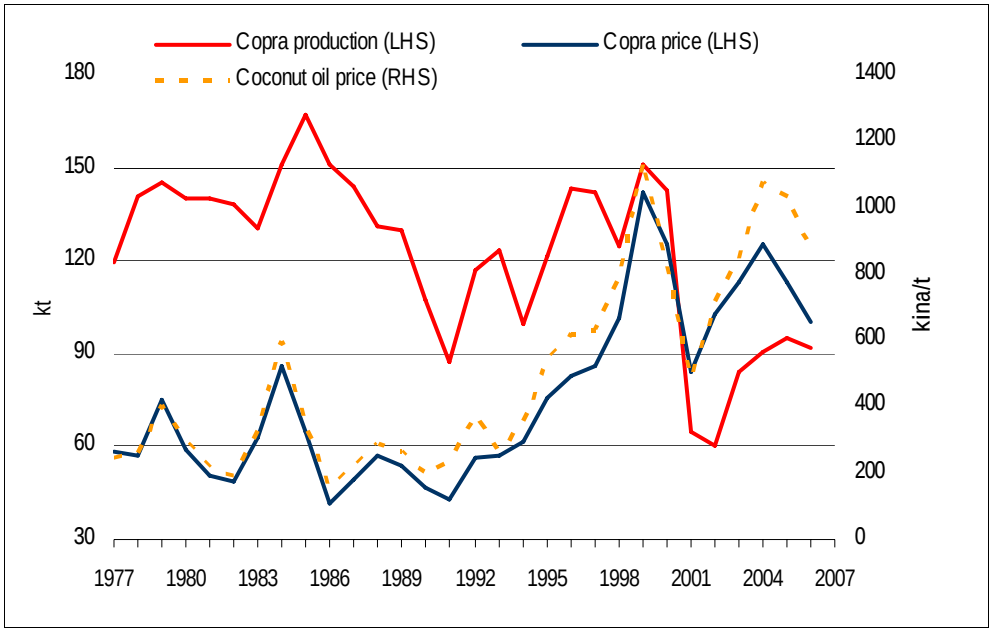
potential to destroy crops. Inter-cropping increases their income security as if the coconut crop fails then they have a secondary source of income. Opio (1993) estimated that mono-cropping of coconuts generated an income of only US$220 per hectare per year, compared with various coconut/cocoa and coconut/coffee systems which would yield US$620 and US$485 respectively.

Price responsiveness

A common view held of quasi-subsistence agriculture is that smallholder coconut supply is relatively price inelastic due to the amount of time it takes to replant areas and change land use. However in practice coconut supply is highly price responsive in many countries. Chart 3.8 illustrates this for the case of Papua New Guinea. This was especially the case in 2001, when the marketing board became insolvent (see chapter 4) and prices paid fell. During 2001, prices paid fell by 60 per cent and production fell by 50 per cent.

Distrust of marketing arrangements and risk aversion of smallholders have combined to ensure that production has not recovered to pre-2001 levels. In fact, in 2002 when the price paid recovered, producers had already made the decision not to supply copra and production fell further.

3.8 **Responsiveness of supply to price – PNG** [a]



[a] Assuming 65 per cent oil yield from copra.

Data source: Bank of Papua New Guinea (2007) and Treasury estimates.

Picking rates the key

Chart 3.8 shows that for Papua New Guinea, copra production has been closely linked to the domestic and world price. (It is probable that a similar relationship holds in other parts of the Pacific.

The main reason that copra production is so responsive to price changes is that farmers are able to change the intensity of harvest activity: changing the area or proportion of nuts harvested. It is uncommon in the Pacific Islands for a farmer to harvest his entire coconut plantation. In most cases, only a small proportion of the total coconuts are picked as the marginal costs of labour required pick, process and carry more copra to transport collection points are too high when prices are low. In some parts of the Pacific, the harvesting effort is quite low — fruit is collected after it has fallen: this contrasts to India, Indonesia and the Philippines where the fruit is harvested off the palms (Foale 2007, personal communication).

Copra production is fairly labour intensive and farmers often have to hire labourers to pick and cut the copra if they want to harvest their entire plantation. When the price of copra is low farmers cannot afford to pay the wages of the labourers and the result is that they leave a proportion of their coconut plantation unharvested and production is reduced. When the price of copra is high farmers can afford to hire labourers and start harvesting larger proportions of their plantation thus increasing production. This is a common scenario across all the Pacific Island countries where large proportions of plantations remain unpicked when prices drop.

In many Pacific Island countries, the reservation price of household labour is quite high. Many households manage a range of subsistence and cash activities, and can reallocate labour between these activities as relative prices change. Where communities are isolated from markets for consumer goods, the demand for cash is often quite limited. Commentators have noted the existence of cash targets: smallholders have a limited set of cash expenditures (often school fees are the major item), and when enough marketable produce has been sold to cover these expenditures, labour is allocated to subsistence activities. An early study (Fowler 1986) concluded that village supply response to prices and earnings in the short term (intensity of harvest) is elastic and long run (planting decisions) is positive but rather low or inelastic.

Return on labour

On the face of table 3.5, the copra value chain provides a reasonable return to smallholders. But to put that return in perspective, table 3.9 estimates the return on effort required by the smallholder. Making a set of realistic assumptions about the size of the holding and copra yields, the average return would be US$77, or around than USc5 per nut collected.

3.9 **Gross revenue to smallholders from copra in Bougainville**

Smallholder production parameter	***Unit***	***Value***
Average smallholding	ha	0.5
Nut yield	kg/ha	3000
Average weigh per nut	kg	1.5
Copra yield per nut	kg/nut	0.24
Copra yield per hectare	kg/ha	480
Total dried copra production	kg	240
Gross revenue	Kina	184
	$US[a]	52
Gross revenue per nut collected	USc/nut	5.2

[a] Assuming an exchange rate of 1 kina -.028 $US.

Source: Table 3.5, CIE assumptions and Foale (2007 pers. comm.).

One point of comparison for the PNG example is the current fresh nut price for local consumption in Sri Lanka which is around 13 000 rupees per thousand nuts (http://www.cda.lk/stats.php, prices for 12 March 2007, date accessed on 3 April 2007). This is roughly equivalent to USc12 per nut but the nuts would be expected to be of higher quality than those that would be used in processing.

For the average smallholder, this return has to cover:

- labour involved in collection off the ground or harvesting from tree bunches — which is dangerous;
- labour involved in de-husking the nut plus removing and sun-drying the endosperm or the use of a drier; and
- transport of the copra to a selling point (in Buka in Bougainville) usually requiring payment for use or rent of a utility or PMV.

Therefore, this process involves labour and time that could be devoted to other income earning and household activities. The return per nut indicates the labour intensity of the process. It is easy to see why:

- production increases when storms or cyclones bring down nuts and they can be simply collected; and
- harvesting is more intensive around selling points where transport costs are lower.

Similar analyses show the return to copra is very low in other parts of the Pacific. McGregor argues that while copra processing is still attractive in Solomon Islands, the activity is declining rapidly in other parts of the Pacific (for example Fiji, Samoa and Tonga) where the opportunity cost of labour is higher (McGregor, 2006). This is illustrated in table 3.10, which presents a comparison of the return to labour from making copra with the prevailing rural wage, at different copra prices paid at the drier in selected Pacific countries. It suggests that it is only in Solomon Islands, where alternative employment opportunities are scarce that copra production is an attractive option.

3.10 **Returns to making copra compared with rural wage rates in the Pacific**

	Return to labour as percentage of rural wage				
Copra price [a]	***Solomon Islands***	*Fiji*	*Tonga*	*Samoa*	*Vanuatu*
US$	%	%	%	%	%
90	173.3	46.8	22.8	60.8	68.5
105	200.0	54.6	26.6	70.9	80.0
120	226.7	62.4	30.5	81.1	91.5
135	253.3	70.2	34.2	91.2	102.9
150	286.7	78.0	38.1	101.3	114.4

[a] Price paid at the drier

Source: McGregor (2006).

Constraints to smallholder production

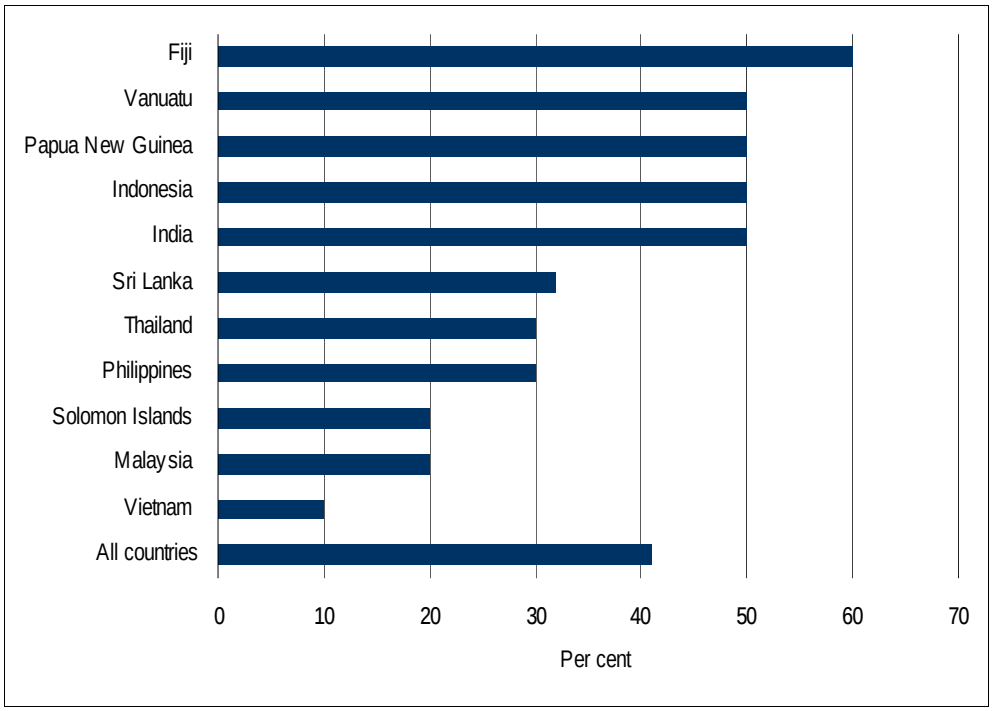
Smallholder farmers producing coconuts operate in an environment which typically discourages greater specialisation and investment in new technology. The key constraints specific to coconuts that face smallholders include:

- declining productivity and aging of trees — in most cases smallholders would not be aware of this process;
- poor market access as the result of lack of infrastructure and poor maintenance of roads, coastal shipping and ports;
- the lack of financial capacity and risk-aversion to make the necessary investment decisions to replace trees and to adopt higher yielding varieties; and
- price volatility and the impact on producer prices of government interventions.

Senility and declining productivity

In many coconut producing countries, a significant proportion of the trees are senile or at an age when production has begun to decline. As chart 3.11 shows, around 50 per cent of the palms in two of the three largest producers, Indonesia and India are estimated to be senile.

3.11 **Proportion of palms that are senile**



Data source: Arancon (1997).

Given harvesting practices, the longevity of trees, the occurrence of self seeding in smallholder stands (which leads to mix of trees of different ages), and the fact that in many cases smallholders families did not plant the palms in the first place (where plantations have reverted to customary ownership) producers may not easily observe declining productivity. As discussed in later chapters, they also face limited incentives to replace trees, with either existing or higher yielding varieties.

Market access

One of the major constraints facing coconut smallholders is the current state of infrastructure in many of the countries. In Vanuatu, for example, there are very few roads leading inland to coconut producing areas which means that a large proportion of coconut is transported in Hessian sacks on the backs of the farmers down to the nearest dock. This is a common method of transportation among the Pacific Islands where roads are scarce.

In the Pacific, many smallholders are affected by the limited reach and reliability of coastal and inter-island shipping. In Solomon Islands, for example, producers on many outlying islands faced a complete breakdown of shipping to the copra consolidators in the main ports of Honiara and Gizo during the recent ethnic tensions. This exacerbated the effects of long periods of neglect of wharves, jetties and navigation aids, and policy interventions that restricted entry into inter-island shipping (Warner and McGregor 2006).

Access to finance

For many smallholders, access to finance and financial services is also a constraint. It is estimated that the equipment required for drying copra costs in the region of US$500 (McGregor 2006) plus maintenance costs. This is a significant outlay in countries where rural cash incomes are very low, but few smallholders have access to credit to finance investments of this size. Many farmers have insecure land tenure, and are unable to use their land as collateral for debt. In the Pacific, this problem arises because most land is under customary tenure, whereas in the Philippines, the problem arises because of the way in which agrarian reform has created uncertainties in tenure.

Price volatility

As charts 3.4 and 3.8 show, world coconut oil prices are quite volatile, and this flows through to copra export prices. The prices received by growers (and in some cases the prices they pay for purchased inputs) are affected by transport and marketing margins, which while not always volatile, can drive prices close to or below smallholders' reservation price (the return below which the smallholder will not engage in an activity, which can be well above zero in quasi-subsistence households). An assessment of marketing margins in the Pacific in 1988 showed marketing costs varying from US$4 per tonne (Fiji) to US$138 per tonne (Vanuatu) (Landell Mills 2005). Some of the institutional causes of these large margins are discussed in the following chapter.

4 Government involvement in the industry

As with most other primary industries, governments in coconut producing countries play a key role in funding and conducting research and extension activities for the industry. However, the industry is also characterised by a high level of government intervention in marketing — using a variety of instruments such as export taxes, price stabilisation schemes and marketing boards, regulation and direct public ownership of plantations and processing facilities. This intervention impacts quite strongly on the incentives for commercial and smallholder investment in the industry, including investment in adoption of the results of research.

The rationale for this kind government involvement has varied between countries and over time. Traditional agricultural exports, such as coconut products, have been subject to taxes and charges with the objective of:

- raising government revenue (with the possibly of influencing the price on world markets);
- directly taxing foreign-owned plantations (export taxes as a de-facto resource rent tax);
- raise funds for promotion and development for the industry; and
- encouraging local processing.

The stated objectives of marketing boards and price stabilisation schemes are most often to increase or smooth producer incomes — particularly smallholder incomes — by attempting to insulate these producers from fluctuations in the world markets. As a comprehensive study of arrangements for managing commodity price risk in developing countries has pointed out (Claessens and Duncan 1993) the attempts to manage commodity price risk through these schemes tend to stifle the operation of market mechanisms.

> Stabilization efforts can lead to domestic prices that do not reflect (worldwide) long-run conditions of supply and demand, and the result over the long run may be a loss of efficiency. Furthermore, taxes and subsidies that are used to implement the stabilization scheme can distort investment and consumption decisions.

Claessens and Duncan (1993) also point out that:

> Even with prices set to reflect long-run world supply and demand, stabilization efforts can still mean that decisions about investment and savings are distorted. Smallholders, for instance, typically save and invest in periods of high prices: therefore price stabilization schemes can reduce their investment. In addition, official stabilization schemes can reduce the incentive to develop private storage, which in itself can be an effective stabilization mechanism.

The experience of such schemes in the coconut sector is consistent with this assessment, and over time many of these schemes have failed due to poor management and poor allocation of resources. (As one of the contributors to the Claessens and Duncan book points out, 'Stabilization agencies may favour special interest groups; indeed, power and high salaries result in the agencies themselves becoming major interest groups' (Gilbert, 1993). Further, as this chapter points out, in some countries, coconut sector policies attempt to inject government control into a much wider range of issues than just price stabilization.

The upshot is that extensive state intervention in the coconut sector can have serious consequences for investment and the willingness/interest of coconut growers to adopt new technologies that results from research. Some of the arrangements increase the uncertainty facing smallholders, making them reluctant to incur current costs involved in adoption of new technologies. Also, where government agencies take on an information transmission role, they may crowd out or actively constrain commercial initiatives to supply information and other services to growers. To give some idea of the extent of the problems, this chapter describes the institutional arrangements surrounding the coconut sector in selected countries.

Sri Lanka

Sri Lanka is the eighth largest coconut producer in the world, and has been a significant exporter of value added products particularly desiccated coconut and coconut oil. Government involvement is pervasive in the Sri Lankan industry encompassing charges, regulation and government ownership of coconut production, processing and further value adding.

Regulation and ownership

At a national government level the Sri Lankan coconut industry is currently administered by the Ministry of Coconut Development. Under its jurisdiction is the control of a number of departments and statutory institutions — the objectives and functions are summarised in table 4.1.

4.1 Institutional structure of Sri Lanka coconut sector

Institution	*Major objectives and functions*
Ministry of Coconut Development	▪ Formulation and implementation of programmes and projects for coconut industries. ▪ Promotion of agro-business relating to coconut products ▪ The promotion of optimum productivity in coconut lands ▪ Training of personnel for the efficient management of coconut plantations. ▪ Matters relating to the development of the coconut industry promotion and research. ▪ Licence and control of fragmentation of coconut estates. ▪ Overall development of coconut plantations, agricultural processing, marketing and industrial activity and research. ▪ Optimum utilization of coconut land through multiple cropping and integrated farming and increasing production and employment.
Coconut Development Authority[a]	▪ Assist the minister in policy formulation and development priorities for the industry, economic utilisation of land and plantations. – Assist in formulation and implementation of projects and schemes in accordance with priorities. ▪ Co-ordinate the activities of the Boards under the Coconut Development Act. ▪ Promotion and regulation of manufactured products and new processing techniques. ▪ The purchase and sale and the regulation of the purchase and sale of coconut products – The formulation and implementation of minimum and maximum price schemes and price stabilization schemes, for coconut products in general and for small holders coconut products. – The promotion of co-operative and collective forms of management and ownership of coconut plantations and establishments manufacturing or trading in coconut products.
Coconut Research Board	▪ Conduct and furthering research into growth and cultivation of coconut palms and growing of other crops and animal husbandry in coconut plantations and prevention of disease and pests. – In addition, processing and utilisation of coconut products including pilot plants. ▪ The establishment/maintenance of research institutes, experimental stations and nurseries, ▪ Training of advisory and extension workers
Coconut Cultivation Board	▪ Development of productivity and regulation of lands in coconut plantations. ▪ Identification and promotion of land suitable for inter-planting and animal-husbandry. ▪ Promotion of correct cultivation practices through advisory and extension workers.
British Ceylon Corporation (Co.) Ltd	▪ Miller and trader of coconut oil. Government sole shareholder.
Chilaw Plantation Ltd	▪ Coconut plantation. Government sole shareholder.
Kurunegala Plantation Ltd	▪ Coconut plantation. Government sole shareholder.

[a] The objectives of the Authority are wide-ranging with many functions omitted.

Source: http://www.treasury.gov.lk/FPPFM/ped/statutoryah.htm, accessed on 13 March 2007.

A key feature of table 4.1 is that the government is heavily involved in the entire value chain of the coconut sector as a producer, processor and also regulator of the sector. This is a characteristic of many coconut producing countries.

Price stabilisation scheme

While provision has been made in legislation for some time, it is unclear how much the price stabilisation scheme for coconut oil has been utilised in recent years. At the end of 2002, the total funds available for use by the scheme stood at Rs 165 million or US$1.7 million. Treasury and other government reports suggest little use of the scheme over the past 3 years.

Export duties and levies

Export duties on all plantation crops (defined traditional exports) were abolished in December 1992 as part of the country's liberalisation process. But the structure of the industry today has been shaped by these taxes which were designed to as a default resource-rent tax on foreign-owned plantations to ensure that some of the benefits of the traditional industries were kept in Sri Lanka.

In 1992, export duties on coconut products (coconut oil, copra, desiccated coconut and fresh coconuts) were levied on a sliding scale based on the estimated free-on-board value per metric tonne of coconut oil. If this value was not greater than a threshold value (Rs 20 000 per tonne), no export duties are payable on coconut oil or fresh coconuts, while the duty on copra is Rs 2 000 per tonne and that on desiccated coconut is Rs 2 500 per tonne. There is always the risk of these duties being reinstated.

> According to the authorities, export duties have been phased out in all sectors, although they may be restored if the Government feels that there is a need to promote further processing of local materials (WTO 2004).

Traditional exports are still subject to export cess; which are revenues earmarked to finance specific activities are used in the plantation sector through selective incentives, replanting subsidies, start-up subsidies for new exporters, and expenditure on research, extension and product promotion. These revenues from cess complement direct funding allocation from the budget to constitute the revenue of the Coconut Development Authority.

Currently, the rate of cess collection for coconut is less than 2 per cent of the free-on-board value of exports; and is levied on a wide-range of other

coconut-derived products as shown in table 4.2. The imposition and rationale for the cess is strongly linked to the extremely high level of government involvement in the sector. In 2002, the total cess collection was Rs 135 million or US$1.4 million.

Table 4.2 also identifies the diversity of coconut-related products routinely exported by Sri Lanka and also that many of the products derived from the shell or husk of the coconut — such as coir and fibre products — but these are very low value adding products.

4.2 **Cess levied on coconut products Sri Lanka, 2007**

Fresh Coconut	*Units*	*CESS*	
		Rupees	*US$*
Fresh Coconut	Per 1000 nuts	750	6.85
Coconut Oil	Per metric ton	400	3.66
Desiccated Coconut	Per metric ton	2000	18.28
Copra	Per metric ton	900	8.23
Poonac	Per metric ton	200	1.83
Defatted Coconut	Per metric ton	250	2.28
Coconut Cream	Per metric ton	450	4.11
Coconut Milk Powder	Per metric ton	450	4.11
Coconut Based Liquor	Per litre	3	0.03
Coconut Shell Charcoal	Per metric ton	250	2.28
Coconut shell Flour/Pieces	Per metric ton	200	1.83
Coconut Shell Activated carbon	Per metric ton	450	4.11
Coconut ekels	Per metric ton	100	0.91
Mattress fibre	Per metric ton	250	2.28
Bristle fibre	Per metric ton	250	2.28
Coir yarn and rope	Per metric ton	100	0.91
Coir twine	Per metric ton	200	1.83
Twisted fibre	Per metric ton	250	2.28
Tawashi brushes	Per 1000 pieces	50	0.46
Brooms & Brushes	Per 1000 pieces	100	0.91
Coir Mats / Rugs	Per 1000 pieces	250	2.28
Coir mattings	Per 1000 sq.	50	0.46
Rubberized coir pads	Per sq. meter	0.5	0.00
Pads and mattresses for bedding	Per piece	5	0.05

[a] Exchange rate Rs. 109.42 = 1 US$

Source: Export Development Board (2007).

Papua New Guinea

In 2001, copra production fell to 65kt or less than 40 per cent of that production recorded in 1985 total. The collapse of the Copra Marketing Board (CMB) during 2001 was well documented through the media. Contributing factors were:

- low international prices;

- higher costs of coastal shipping; and
- the virtual closure of production on Bougainville due to civil unrest.

The CMB was established at independence for the marketing of copra. Its establishment reflected a view that was prevalent at that time, which could be summarised as follows:

- copra, unlike coffee and cocoa, is a homogenous product that is sold to a few buyers on the world market;
- the marketing board would protect smallholders from fluctuations in the world prices;
- there can be substantial economies of scale in marketing and processing; and
- many copra growers are located on relatively isolated islands that needed to be serviced: the cost of which could be cross-subsidised from the earnings of better located growers.

The backbone of the CMB was compulsory acquisition and exporting powers over copra. Most copra from the farm level was sold through a network of middlemen, cooperatives and ship-owners who on-sold to the CMB.

The CMB appears to have performed satisfactorily through the 1980s, however during the late 1990s became insolvent due to a combination of the adverse market developments identified above plus the impacts of poor management and political interference at a board level. The bottom line was that insolvency lead to producers not being paid in full. Many smallholders acted rationally and chose not to actively harvest for cash sale to traders and the CMB. Production fell dramatically and still remains low.

Institutional structures

In response to this collapse, the government privatised the Board in 2002 with the *Indastri Koporesen Act 2002*. The Kokonas Industri Koporasen (KIK) expected to play a policy formulation and regulatory role with the private sector playing the marketing role — up to 20 export licences were issued to private traders.

A major role of the KIK was ‘to ensure the integrity of the deregulated buying and export process so that producers, and the nation, achieve the maximum benefit’ (Gomez 2002).

Funding of the KIK is through an export levy in addition to transfers from taxpayers through consolidated revenue of the national budget. In 2005, growers paid levies of 60 kina per tonne which amounted to a levy of between 7 and 8 per cent in ad-valorem terms of the average export fob value.

Since privatisation, high levels of debt and poor governance have plagued the KIK. Proceeds from the sale of the (then) CMB's assets including offices in Port Moresby and a coconut oil mill in Madang were used to partially pay off debts totalling about K10 million (US$2.4 million).

The Cocoa Coconut Institute of Papua New Guinea (CCI) was formed in August 2003 out of the merger of the PNG Cocoa and Coconut Research Institute (CCRI) and PNG Cocoa and Coconut Extension Agency (CCEA). The CCI is owned jointly by two statutory bodies, the Cocoa Board of Papua New Guinea and KIK, and is responsible for all cocoa and coconut research and development in PNG.

Institutional weakness remains a problem

Since its creation, the Cocoa Board of PNG has been under significant public scrutiny in relation to claims of corruption and nepotism.

In 2005, there was controversy about the diversion of nearly K3 million collected from growers for research levies' away from the intended target, the Coconut and Cocoa Institute, to the KIK. The protest was led by producers from East New Britain who contribute around 80 per cent of levy funds.

> A sum of K53 is being deducted from farmers for every tonne of copra exported. From that amount, only K8 goes as levies for research and extension purposes. The remaining K45 goes to the KIK board as management fees. (Post Courier, 'Growers angry', 25 November 2005)

In late 2005 the Public Accounts Committee (PAC) opened investigations into the KIK in response to complaints from industry and the subsequent media coverage (The National, 'KIK to come under microscope', 29 November 2005). As of March 2006, the inquiry into the board's finances was still in progress. This scrutiny has been mainly in relation to the disappearance of industry levy revenues and the exorbitant travel expenses claimed by board members.

If the industry continues to decline, maintaining the overhead structure of the KIK will become even more burdensome for growers. While corruption remains a significant problem, many industry stakeholders believe that the

regulatory burden of the KIK remains high. Three examples are given below.

- The involvement of a third party regulator adds unnecessary costs and provides scope for corruption. The KIK issues licences to export to 'maintain quality' —the most significant issue being smoke damage.
- Issues of poor quality relating primarily to smoke damage are handled well through the market — with poor quality product discounted appropriately.
- In late 2005, there was a KIK requirement that all copra exports should be processed, checked and exit PNG through Madang.
  - In the case where there were exports of copra to Philippines (or any other destination) from East New Britain and New Ireland, where it would be logistically sensible to send the product direct - additional transport costs and port charges had to be incurred to send it via Madang.

The Philippines

Recent reports on the policy and institutional environment for agricultural development in the Philippines, and in particular for the development of the tree crop sector have identified a range of constraints affecting the coconut industry. Among these are:

- Land tenure and the impact of the incomplete Comprehensive Agrarian Reform Program (CARP), which has created uncertainty with respect to the future tenure of commercial tree crop plantations. Land tenure. Where landholders have received title to their land under CARP the 25-year lease limits long term investment in on-farm infrastructure and tree crops. The program limits the size land holdings and limit the capacity of farmers to expand their holdings contiguously. The CARP has had many revisions, and its acquisition programs have been continuously under-funded, adding to the uncertainty about its implementation. The uncertainty that this creates, combined with titling irregularities and the confusion on transfer of leases, prevents the land market from operating effectively. Aragon (2000) refers to reports that many landlords prohibit coconut farmers from intercropping for fear that this would make their land more easily subject to land reform: apparently in 1998 some 70 per cent of coconut land was not intercropped.
- Restrictive financial sector regulations which lead to bias against long-gestation investments, (such as restrictions on the length of the grace

period that banks can offer on loans), combined with inappropriate measures to force lending to agriculture (the Agri-Agra Law) which serve mainly to raise costs of intermediation or direct financial resources in favour of real estate development .

- Regulations whereby farmers must pay a fee to and receive permission from, the Department of Agriculture, to fell coconut palms for replanting, conversion to another crop, timber or other purpose; this regulation is instrumental in deterring replanting with higher-value coconuts or other crops and leads to about 25 per cent of agricultural land being permanently under low productivity and usually very old, palms. Aragon (2000) reports that the regulation was introduced in part because some landlords were cutting their coconut trees in an effort to evade land reform under the CARP. Aragon also refers to reports that many landlords prohibit coconut farmers from intercropping for fear that will make their land more susceptible to land reform.
- The legacy of the past levies on the coconut sector, including those to fund a coconut investment fund, a coconut consumer stabilisation fund, a coconut industry development fund, a coconut industry stabilisation fund and a coconut reserve fund (World Bank, 1999). The Bank estimates that the levy accounted for close to 41 per cent of the farm price of coconut products in the mid 1970s. Ownership and control of the bank that was created using levy funds fell into the hands of big planters, processors and middlemen, and delivered limited benefits to the bulk of growers. Nor did many growers benefit from the subsidies for replanting and vertical integration. (World Bank, 1999).
  - Although these levies have been terminated, there has been a long standing legal dispute over the ownership of the considerable funds raised by the levy system. Dy and Reyes (2006) estimate that the assets of the fund could now be worth around 100 billion pesos, or some A$3 billion.

Vanuatu

Vanuatu provides another example of how small country governments heavily regulate the marketing of traditional exports particularly coconut products.

The Vanuatu Commodities Marketing Board Act of 1986 provides for the establishment of the Vanuatu Commodities Marketing Board (VCMB) for the control and regulation of ‘prescribed’ commodities. The functions of the Board were:

- to secure the most favourable arrangements for the purchase, sale, grading and export of prescribed commodities;
- to purchase prescribed commodities or products thereof and to sell or export the same;
- to develop or to assist in the development of the various prescribed commodity industries in the Republic of Vanuatu, including the manufacture and processing of prescribed commodities and related products, for the benefit and prosperity of those industries; and
- to stabilise prices paid for prescribed commodities.

Key traditional exports such copra, cocoa and kava were declared to be 'prescribed commodities' under the Act, and came under the control of the VCMB. The powers of the board were wide-ranging:

- to purchase prescribed commodities produced in the Republic of Vanuatu which may be offered and delivered to the Board, after such commodities have been graded as suitable for export;
- to control and fix prices from time to time payable to producers for prescribed commodities and to notify such prices;
- to purchase prescribed commodities directly or through an agent and to do all things necessary for, and in connection with, the purchase of such commodities;
- to sell prescribed commodities and to do all things necessary for, and in connection with their marketing, cleaning, storing for export and shipping;
- to appoint agents for the purchase, storage and export of prescribed commodities for such periods and on such terms and conditions as the Board may require; and
- to grant, withhold or cancel any written authority provided for by section 2 and to impose conditions upon the grant of such authority.

The copra related regulations in the Act are very prescriptive as to the standards suitable for export:

- in terms of specification of moisture, dust and acidic characteristics of copra,
- the size and materials of the bags for export; and
- regulations on grades and quality designed to restrict export of smoke damaged copra.

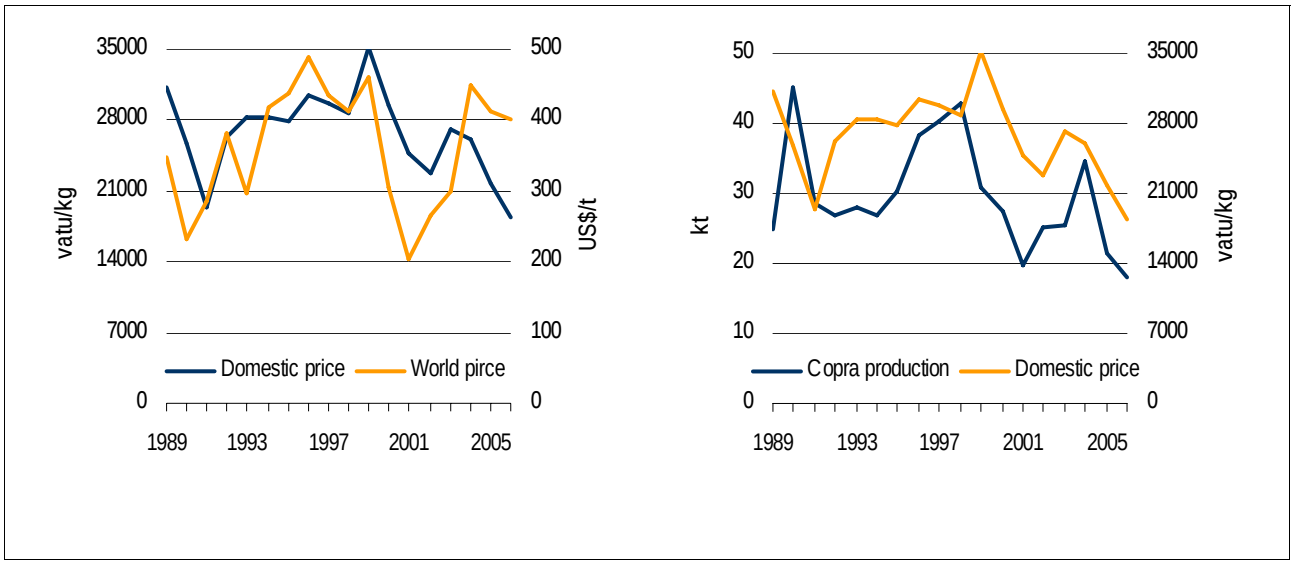
The cost of price stabilisation activities, the costs of overheads and corruption resulted in the board becoming insolvent during 2003. The Reserve Bank of Vanuatu (2003) noted that the activities of the VCMB had dramatically affected the confidence of producers.

The decline in the production and exports of copra and coconut oil was mainly attributed to the financial difficulties of VCMB, which resulted from unsustainably high subsidy prices on copra in 2001 and 2002 (Reserve Bank of Vanuatu, 2003).

Chart 4.3 shows the impact of the marketing board's activities on production. On the left hand side of the diagram, the impact of the price stabilisation can be seen from the year 2000 onwards. In 2001, the scheme indeed resulted in higher domestic prices — but couldn't be sustained in following years — when the insolvency of the board was passed onto producers through a significantly lower price. The right-hand side shows the supply response of producers to the declining price — for many in outlying islands it simply was not worth harvesting coconuts and processing the copra.

In July 2006, the council of ministers restructured the VCMB and removed its capacity to be the sole exporter of any commodity but retains a reduced capacity as the regulator (The Independent, 'Vanuatu Commodities Marketing Board on the skids', 10 July 2006).

4.3 **Impact of the VCMB on Vanuatu copra prices and production**



Data source: Reserve Bank of Vanuatu (2003).

The operations of the VCMB are not the only policy and institutional constraint on development of the coconut sector. Burnett and Kenneth listed a range of following factors in their paper presented at a 2005 International Coconut Forum that ACIAR supported. These factors are summarised in box 4.4:

4.4 Constraint to development of the Vanuatu coconut sector

In the paper they presented at the 2005 International Coconut Forum held in Cairns in 2005, Burnett and Kenneth presented a list of constraints hindering development of the coconut industry in Vanuatu. These included:

- a wide variety of taxes, policies and regulations, including high trade taxes
- lack of competition in markets for credit, shipping, utilities and other inputs
- inefficient and loss-making state farming and marketing bodies, e.g. VCMB
- traditional land tenure that has been a barrier to commercial investment
- land air and sea transport that are both unreliable and expensive
- excessive utility charges
- an exchange rate that tends to be overvalued by capital inflows from aid donor and trade taxes
- investors who are discouraged by uncertain government policies and excessive bureaucracy
- labour that is relatively high cost and has generally low productivity
- high age profile and low productivity of existing coconut stands, and a lack of a comprehensive and extensive replanting program
- Melanesian garden farming systems that discourage smallholder specialisation in commercial agriculture.

Source: Burnett and Kenneth (2006).

Other Pacific countries

Other Pacific Countries have had government marketing arrangements for copra, but a number of these have been closed. An FAO report on agricultural marketing in the Pacific (FAO 1999) observed that the Tonga Commodities Board and the Cocoa, Copra and Banana Board in Samoa had been closed. The Commodities Export Marketing Authority in Solomon Islands ceased all trading functions when it effectively became insolvent in the early 2000s after the ethnic tensions. McGregor (2006) reports that copra production recovered quickly after deregulation of copra marketing. In Fiji, however, all coconut development was transferred in 2002 to a newly formed Coconut Industry Development Authority, which has purchased the country's copra mill and is regulating copra buying: as a report to the COGENT Steering Committee commented 'it is not clear if this will enhance coconut industry development (SPC 2002).

Conclusion

In many coconut producing countries, governments have long played a role in many aspects of marketing, finance, regulation, research and extension of the sector. Unfortunately, as with most government commodity marketing interventions, original good intentions have not been realised, and arrangements have often served as little more than a tax on growers. More troublesome for bodies interested in supporting technical research in the sector is that the interventions have frequently served to distort incentives for growers to invest in new technologies. As discussed in chapter 6, there is an almost universal concern from researchers that there is very little uptake of coconut research findings. One important factor driving this is that government policies have too often reduced expected returns from adoption of new varieties and government involvement in production and processing has crowded out commercial initiatives.

5 *Prospects for coconut products*

A number of factors are likely to shape the prospects for the coconut sector in the coming decade. The most important are likely to be:

- global demand for vegetable oils, which in turn will be driven by the effect of population and income changes on demand for food and (largely policy) driven demands for biofuels;
- competition from other vegetable oils in world market;
- development of, and consumer acceptance of newer coconut products, in domestic and world markets, such as 'virgin' or cold pressed coconut oil or organic coconut cream;
- domestic demands for coconut products in producing countries, including biofuel demand; and
- development of coconut timber technology and markets.

Oils

World vegetable oil demand

A key driver of world demand for vegetable oils in the past has been growth in world population and per capita incomes. As the data in table 2.4 in chapter 2 shows, total world production of vegetable oils has grown on average by 4.4 per cent per annum in the 45 years 1960 to 2005. The shift in favour of processed foods that underpinned this growth in the past is likely to continue, as incomes and population grow in the larger developing countries, offsetting slower income and population growth elsewhere.

On top of this food related demand for oils, a strong policy push in favour of biofuels is likely to add a significant additional demand for vegetable oils. While the main thrust in the United States has been to expand ethanol production from corn as an alternative to petrol, the European Union has been placing greater emphasis on substituting biodiesel for diesel.

The European Union support for biofuel production can be traced back at least to 1985, with a European Commission directive proposing reduction of dependence on imported oil through substitution, including with biofuels. This support was substantially expanded with new directives setting targets for biofuels to account for 2 per cent of the transport fuels market in 2005, and 5.75 per cent of the market in 2010. In March 2007, European Union leaders agreed to increase the share of biofuels used in transport to 10 per cent in 2020 (BBC News 2007).

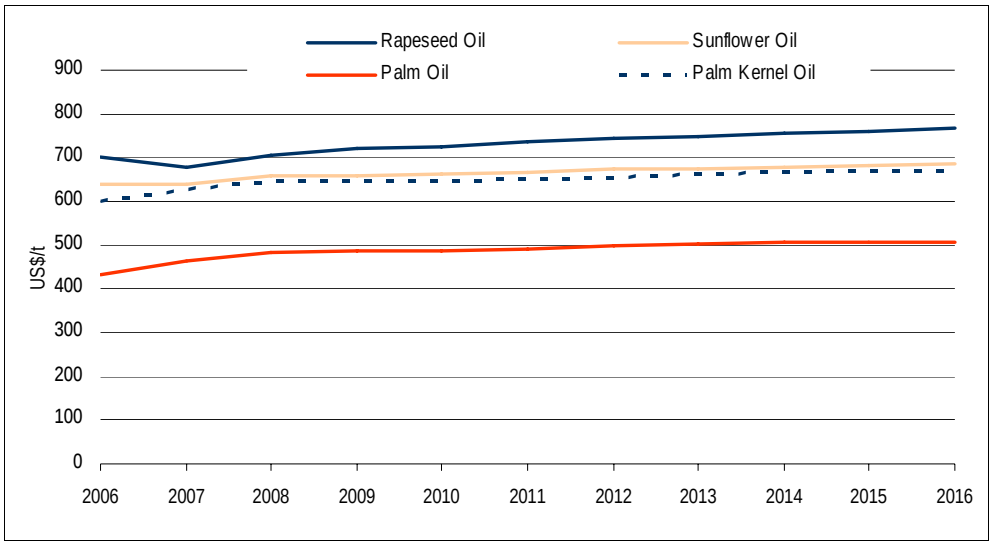
The rapid expansion in biodiesel capacity has started to outstrip production of feedstocks and Europe has been importing significant amounts of oilseeds and palm oil to meet production targets. In 2005, EU members imported 2.27 million tonnes of palm oil from Malaysia alone — about 28 per cent of the country's exports. There have also been imports of canola from Australia (as well as biodiesel).

The prospect of rapid, policy-driven expansion in biodiesel consumption in Europe is prompting significant investments in the production of feedstocks and biodiesel around the world. The Government of Malaysia is supporting investment in biodiesel production using palm oil, and the country is reported to be bringing on stream capacity to produce 100 000 tonnes of biodiesel targeting markets in Europe. Estimated palm oil production in Malaysia and Indonesia is projected to grow by 30 per cent between 2005 and 2010, responding to growing fuel and food related demands.

In its 2006 outlook for world agriculture, the Food and Agricultural Policy Research Institute (FAPRI) projected that world per capita vegetable oil consumption would increase by an average of 0.3kg a year between 2006 and 2016. Consumption of palm oil and palm kernel oil (the closest substitute for coconut oil) are projected to grow by 3.9 and 3.6 per cent consumption a year over the period. Within this framework, FAPRI projects a steady increase in world vegetable oil prices (chart 5.1).

These projections, however, may understate the impact of biofuel policies around the world. The expansion in aggregate demand for vegetable oils should, all other things being equal, translate into demand increase for coconut oil. This assumes no changes in preferences for different types of oil.

5.1 **Projected vegetable oil prices, 2006 to 2015**



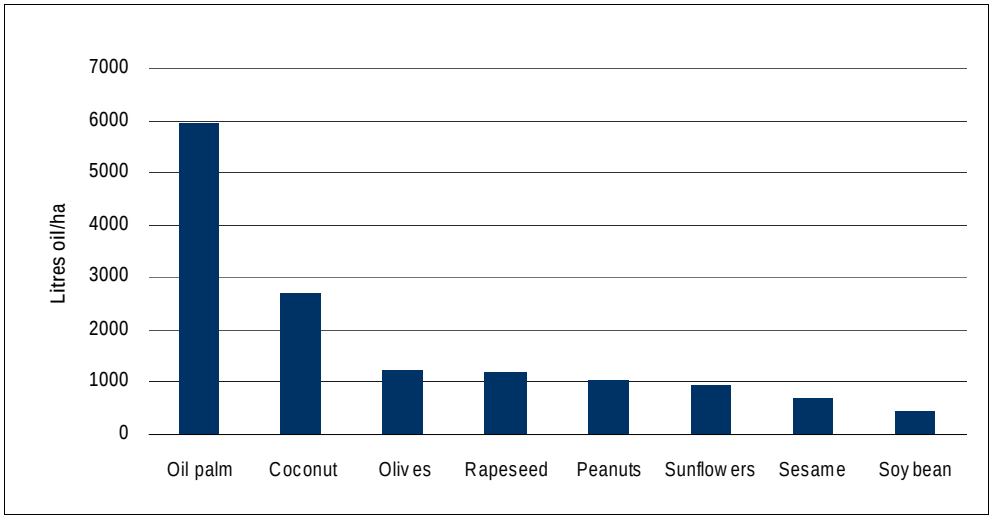
Data source: FAPRI (2006)

Competition from other oils

The substitutability of coconut oil for other oils varies between market segments. For production of biodiesel, coconut oil is not competitive with other oils, especially palm oil, given that the key characteristic is energy content. Oil palm oil is a far more productive generator of oil in volume terms per hectare than other oils (see chart 5.2), and most expansion of tropical oil production to meet biofuel demand is likely to be met by palm oil. As Foale (2003) points out:

> …it is now recognised that coconut has a substantially lower potential yield of oil than oil palm, mainly because of the coconut's high proportion of non-fatty fruit components (Foale 2003).

5.2 **Potential productivity of vegetable oils**



Data source: Butler (2005).

The story on food related demands is a bit more complex. One reason for the displacement of tropical oils by soybean and sunflower oils was the success of campaigns promoting consumption of poly-unsaturated oils as a healthier alternative. Recent studies have provided some counterbalance to the lobbying maintained by the US edible oils industry. Foale (2003) discusses at some length the health benefits of consuming coconut oil, including the antiobiotic effects of the lauric fatty acids in which coconut oil is rich. He further reports that 'derivatives of lauric and capric oil suppress bacterial, fungal and viral pathogens of humans, including HIV' (Foale, 2003, pp. 130).

Foale also pointed out that:

> The second major cause of deteriorating health in industrialised countries has been the increase in consumption of trans fats—the fats produced by the process of partial hydrogenation of unsaturated oil. The very thin, or runny, polyunsaturated fats are converted by partial hydrogenation into firm, artificially saturated fats, in order to make margarine and shortening. Such trans fats, which are derived from soy, cotton, sunflower, canola and maize oils, do not occur naturally in any food consumed by humans (except for very small amounts of related but not identical forms in dairy fat), and therefore are 'foreign' molecules entering into the chemistry of the body. There is accumulating evidence that they are seriously harmful to health when consumed in excess of a safe daily amount (set at 12 grams per day for adults in the United Kingdom), and are linked to increased incidence of stroke, carcinoma (cancer) and obesity.

In January 2006 the United States introduced trans fats labelling legislation. This legislation requires companies to declare the trans fat content on the label of their products. Such developments may shift food related demand back towards tropical oils.

Virgin coconut oil

Industrial processing of copra to produce coconut oil involves a process of pressing heated copra. Because of the variable quality of the copra, the oil contains a high level of free fatty acids and range of undesirable flavours colours and aromas which are removed by further processing involving refining, bleaching, and deodorising to make it usable as an edible oil. Virgin coconut oil is obtained directly from the fresh kernel, without prolonged heating and is suitable for human consumption without further processing, provided the extraction process is carefully controlled. It is stable, has a very low content of free fatty acids, is a good source of Vitamin E and is claimed to have an indefinite shelf life at ambient temperatures.

Virgin coconut oil is currently produced using a variety of methods. Some start with dried grated, chopped or granulated meat and others start from coconut milk or milk residue (Bawalan and Chapman 2006). The methods using coconut meat employ high or low pressure expellers: the coconut milk starting points involve natural fermentation, heating or centrifuging.

Low pressure expeller methods are proliferating throughout the Pacific, where there is also some production using small scale mills traditionally developed and used to produce non-edible oil from copra (Warner, McGregor, Wore and Pelomo 2006). The fermentation method is used in cottage industry production in the Philippines, and is reported to produce high quality oil (Bawala and Chapman, op cit).

Warner, McGregor, Wore and Pelomo (2006) note that:

> Virgin coconut oil products are often organically certified, giving them additional appeal to the type of consumer they attract. Organic products are defined as those grown and processed in a sustainable manner without artificial chemicals. On these criteria, virgin coconut oil is in direct contrast to conventionally processed edible coconut oil, which is processed using chemical solvents. Organic certification offers price premiums, but more importantly it offers access to a wider range of marketing channels. For small virgin oil producers … organic certification is becoming a marketing tool of necessity rather than choice. Some producers are also taking on 'alternative or fair trade' certification, which further expands their marketing options and attractiveness.

Organically certified virgin coconut oil currently commands a significant price premium over industrial coconut oil. It is being marketed for its medicinal properties as a nutraceutical, for processing into high quality soaps, shampoos and body lotions and as a premium cooking and salad oil. It is not clear that the premium that the oil attracts as a niche product would persist if there were significant increases in supply. However, there may well be scope for expanded production as a substitute for other edible oils in the Pacific, where a significant transport cost advantage may apply.

One of the appeals of virgin coconut oil production is that the technologies involved are quite simple and do not seem to exhibit economies of scale. For this reason, there has been significant work devoted to fostering production in the Pacific, where the coconut resource is relatively large, alternative income generating opportunities are small and transport costs eat into the returns from producing low value copra. However, performance to date has been has been at best marginally successful. This reflects a number of the constraints facing development of commercial operations in these locations (see box 5.3). More success has been achieved

where a more commercially oriented entity has taken the lead in marketing and providing technical, financial and logistical support to household based producers (Warner, McGregor, Wore and Pelomo 2006).

5.3 Recent Pacific experience with virgin coconut oil

Over the past decade, there has been a proliferation of small DME virgin coconut oil operations throughout the Pacific Islands — notably in Samoa, Fiji, Kiribati and, more recently, Solomon Islands. The equipment has often been provided as a grant to communities by donors. The general performance of DMEs has been disappointing. There are several reasons for this:

- Many DMEs were established as community operations. This was the result of the naïve assumption of many donors that village enterprises are community based. The reality is that when it comes to income-earning activities, rural households are often individualistic in their approach. All the DMEs operated under the auspices KPSI are operated by individual households.
- Interested individual households and enterprises have faced barriers to establishing DME businesses. This has been due to the relatively high capital cost of the equipment, the absence of rural finance, and the unwillingness of donors to assist individually owned enterprises.
- Many DMEs have not been able meet the quality specifications of the market, particularly with respect to critical moisture requirements.
- DMEs have tended to operate in isolation, with weak marketing links and little backup.
- Difficulties in obtaining and maintaining organic certification has been a problem for some DME operations. The nature of virgin coconut consumers is such that organic certification has become essential requirement for market access. Enterprises that have not been able to acquire certification have been at a considerable disadvantage. The overhead cost of organic certification is high and the requirements are administratively demanding.
- The marketers of virgin coconut oil, as with many small enterprises targeting export markets, have tended to underestimate the working capital requirements to develop markets and to cover the lags in payments for sales to overseas buyers.

Source Warner, McGregor, Wore and Pelomo (2006).

Analysis of returns to DME enterprises suggests that the returns to labour from producing virgin coconut oil are not much different from the return to producing copra. However, the work is less physically demanding, and there is more scope for increasing prices of coconut oil. Overall, however, it seems that such operations will not be terribly successful where people have alternative sources of income. An analysis of returns to family labour working in a DME mill in Solomon Islands (McGregor 2006) suggests that the average daily return would be rather less than that derived from making copra: but, as the author points out, the work is rather more congenial, and typically provides opportunities for female labour.

McGregor's analysis suggests that it may be more financially rewarding to use the more capital intensive cold press copra methods, providing that producers can obtain the same prices as DME operators (McGregor, op cit, pp. 23). These results are summarised in table 5.4 (where the analysis for a DME operation is based on the hire of contract labour, rather than using family labour, to provide comparability).

5.4 **Comparative rates of return producing coconut oil**

		DME [a]	*Cold press* [b]	*Cold press* [c]	*Cold press* [d]
	Unit				
Oil price	$Si/litre	8	3	3.45	8
Capital cost	$SI	85 600	125 000	125 000	125 000
Annual operating cost	$SI	39 130	191 180	191 180	191 180
Annual labour cost	$SI	33 960	26 100	26 100	26 100
Average annual gross margin	$SI	17 608	-19 233	33 171	408 567
Internal rate of return	%	27	-ve	47	infinite

[a] Assumes contract labour hired on a rate of $2.83/litre, shared among 6 people, plus a supervisor at $SI 15 a day
[b] Cold press operation, with returns based on oil prices equal to those obtained for non-edible oil
[c] Cold press operation, with returns based on oil prices 15 per cent higher than those obtained for non-edible oil
[d] Cold press operation, with returns based on oil prices equal to those obtained for virgin oil
Source: McGregor (2006).

Bawalan and Chapman (2006) present a more encouraging scenario for the less expensive 'modified natural fermentation' method used by smallholders in the Philippines and more recently in Thailand.

Biofuel

Coconut oil is unlikely to face significant demand in world markets as a feedstock for biodiesel production, since it is not competitive with palm oil (even though the high level of carotene in crude palm leads to higher refinery investment requirements than is the case for coconut oil).

However, there is scope for the oil to be used as a diesel substitute or for small scale biodiesel production in some areas of the main coconut growing countries. High oil prices and high transport costs of diesel may create opportunities for this kind of substitution. In Solomon Islands in May 2006, diesel prices in Honiara stood at around $6.16 per litre and between $7.5 to $12 per litre outside of Honiara, making coconut oil, available from a cold press mill or a copra mill at less than $4 per litre, a very viable option, especially in more remote locations (Warner, McGregor, Wore and Pelomo, 2006).

Coconut oil can be used in diesel engines in a number of ways. Straight coconut oil can be used in modified or unmodified engines; coconut oil can

be used along with diesel in duel systems in modified engines; and the oil can be processed into biodiesel by methylation, or mixed with kerosene.

The advantages and disadvantages of these various biofuel options are listed in table 5.5.

Biofuel development utilising coconut oil can be expected to occur on two fronts.

- In remote locations using high quality coconut oil produced on site as a direct substitute for diesel, either as a blend or in pure form.
- Using crude copra derived coconut oil to produce bio-diesel at a centralised location which is in close proximity to the market.

5.5 The advantages and disadvantages of various options to use coconut oil in compression (diesel) engines

Biofuel option	*Advantages*	*Disadvantages*	*Example of option application*
Straight coconut oil in unmodified engines	▪ Low cost of fuel ▪ No modification costs	▪ Works only in certain types of engines ▪ hIgh quality oil required	▪ Commonly used by vehicles on Buka in Bougainville ▪ Used by Rabaul shipping in PNG ▪ Tropical Products in Honiara uses coconut oil mixed with simple additives to run several diesel engines.
As part of a duel system in a modified engine	• Lowest cost fuel can be chosen • Flexible	▪ Continued diesel imports ▪ Extra components risk extra failure ▪ Possible contamination of fuels	Village electrification system at Welagi, Taveuni, Fiji Islands
Pure coconut oil in modified engine	• 100% Renewable • Low cost of fuel • Small island communities can produce own fuel for electricity	▪ Dependence on local oil production ▪ Non-standard components ▪ Requires heating under ambient temperatures of 25OC	
Bio-diesel	• Standardised and guaranteed	▪ Chemical Facility required ▪ No transportation cost savings to isolated locations	

Source: Cloin (2005).

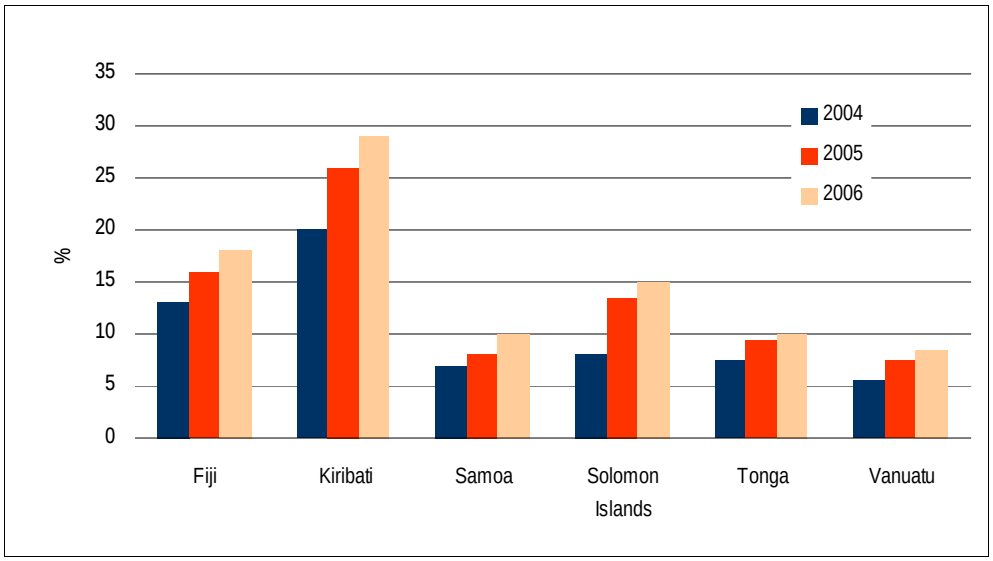
These options seem most promising in the Pacific. The main reasons for this conclusion are:

- Remoteness: large distances from oil refineries and small volumes lead to high landed costs of diesel in the main ports of many Pacific island

countries. For many of these countries, fuel imports account for a large share of national income (chart 5.6). The archipelagic nature of some of these countries makes internal distribution very expensive also.

- Coconut resource: most Pacific island nations have adequate coconut resources to sustain use of coconut oil as a diesel substitute.

5.6 **Fuel imports as a percentage of GDP**



Data source: Central Bank bulletins for each country.

There has already been some progress in using coconut oil as a diesel substitute in the Pacific. Unelco, the monopoly power generating company in Vanuatu, is already trialling a 5 per cent coconut oil/diesel mix in its main generator in the capital Port Vila. The electricity power corporation in Samoa is currently running its generators with a 20 per cent mix of coconut oil. In Papua New Guinea, some shipping companies are using coconut oil in their vessels (Leah Sharp, Star Ships, personal communication, March 2007) and the oil has been used in transport vehicles in Bougainville for some time.

Other products

Coir

Coir is the fibre obtained from the coconut husk. It can be used to make matting, rugs, ropes and fibreboard, among other things, and a by-product of its production process is coir dust which is used as a soil conditioner in the horticulture industry. The only two significant coir producers are India and Sri Lanka — it is estimated that only 10 per cent of all coconut husks are used with the remainder either returned to mulch the coconut palms or

wasted. This may suggest that there is significant potential for this industry. Exports of coir textiles from India grew on average 53 per cent per year between 1995 and 2000. Despite being the largest producer India and this export growth, Sri Lanka is the largest exporter of coir products.

The coir industry has not been a priority for development in many coconut growing countries so little is known about its potential for development. Increasing restrictions on the extraction of peat moss make coir dust an attractive alternative as a potting mix base for many horticulturalists.

Constraints

India and Sri Lanka are dominant in coir processing because they have a more formalised processing sector and exceptionally low cost of labour (although labour costs in Sri Lanka are reported to be increasing rapidly (K. Chapman, 2007, personal communication). While coir processing can potentially be mechanised, the coir industries in both countries are highly labour intensive. Recovering the fibre from the husk, and spinning and weaving the fibre is difficult work without machines.

> The economics of coir fibre production are based upon a multi-linked chain in which much of production is dependent on cheap and abundantly available manual labour. Because of socio-economic conditions prevailing at the village level, mechanising the fibre extraction plant may not the most obvious way forward. (van Dam 2002)

This industry is made possible by access to a segment of workers, within a narrow age and ethnic profile, whose wage rates reflect a low reservation price for labour. A substantial risk to these industries is that as economic development and education change labour force attitudes over time, processing costs will increase dramatically as labour becomes scarce. (Producers in Sri Lanka are reported to be looking to mechanise production in the face of rapidly rising labour costs (K. Chapman, 2007, personal communication).

This factor is already the case in the Pacific Islands, where smallholders have a high reservation price for their own labour —and no attempt is made to recover coconut by-products from the husk. In fact, the effort put into recovery of the copra by many smallholders is very sensitive to the price received (see the chapter on smallholders incentives).

Desiccated coconut

Desiccated coconut is the white dehydrated meat of coconut, used mainly in a variety of food processing processes, including production of confectionery and bakery products, canned and frozen foods, and as a domestic and commercial cooking ingredient. World exports have averaged around 250-300 thousand tonnes in recent years, with the Philippines, Sri Lanka, Malaysia and Indonesia accounting for around 70 per cent of this trade (Landell Mills, 2005).

The market establishes stringent quality standards to meet food safety requirements in the main importers (the United States and the United Kingdom are the two largest importers, followed by Germany and the Netherlands). These standards, which are influenced in particular by the risk of salmonella contamination, require that processing be a continuous operation, which in turn requires a guaranteed supply of coconuts. While scale of processing is not a key determinant of profitability (Landell Mills, 2005), there are some economies of scope in that larger operations allow for production of a wider range of products such as organic virgin coconut oil, and organic cream and water (Chapman, 2007, personal communication.).

Timber

A 1997 report by the FAO (Arancon, 1997) sheds some light on the potential for senile coconut palms to be logged and traded as timber. The report estimates that there are 371 million senile trees in the Asia Pacific region which could be made into 111 million cubic metres of sawn coconut wood. They estimate that this would be enough to construct 7 million housing units. The following table shows the distribution of senile trees across key countries and shows that the Pacific Islands have the highest incidence of senile palms. Overall, 40 per cent of all palms could be ranked as senile. Many of the palms today were planted in the pre-war colonial era.

Ranked on the basis of size, Indonesia, the Philippines and India have the largest potential resource.

The high proportion of senile trees explains apparent low productivity of the coconut industry over the last decade. It also indicates that replanting programs are urgently needed if coconut production is to remain stable in the future —if the economics of the industry proves sustainable.

5.7 **Percentage of senile trees, 1995**

Country	*Percentage of senile trees*	*Coconut area planted*	*Coconut timber resource*
	%	000's ha	000's ha
Fiji	60	64	38
Vanuatu	50	96	48
Papua New Guinea	50	260	130
Indonesia	50	3710	1855
India	50	1600	800
Sri Lanka	32	419	134
Thailand	30	412	124
Philippines	30	3164	949
Solomon Islands	20	59	12
Malaysia	20	290	58
Vietnam	10	186	19
All countries	41	10260	4167

Source: Arancon (1997).

This resource presents an opportunity to extract coconut timber for export and local use and provide some revenue without reducing the productivity of their coconut industry. Timber from coconut palms can be used in a number of different ways including firewood, housing components such as walls, joists, doors and flooring, and furniture. It can also be made into charcoal or activated carbon.

Currently construction provides the largest share of demand for coconut wood and this demand is increasing as reflected by the price of timber. Arancon (1997) explains that in the Philippines, coconut trees had been given away, but were now being sold and there has been a corresponding increase in the number of coconut lumber producers and dealers. Demand has been influenced by declines in the availability of traditional tropical hardwood.

Constraints

The scope for exploitation of coconut timber will largely depend on a range of economic factors outside of the coconut sector. While the technology of cutting down and milling coconut timber is readily available, the key factors that will determine possible success will be:

- property rights to land in many countries remain unresolved making the ownership and right-to-harvest of individual trees very unclear;
- access to markets which then depends on the distance from potential consumers — most likely in urban areas — which in turn depends on availability of roads and shipping networks;
- access to sufficient capital to purchase the portable mills most likely used on-site in coconut plantations;

- addressing environmental concerns arising from felling palms and loss of ground cover and carbon sinks; and
- the ability of smallholders to find alternative income sources until replacement palms come into production.

Particularly in the Pacific Islands, these problems remain pervasive. Those areas where copra production is least economic and which are most in need of rehabilitation, and are therefore most logically targeted for logging would also be the less feasible. In these areas, the incentives for rehabilitation of coconut blocks are very poor. (McGregor demonstrates that replanting coconuts in Solomon Islands is a very marginal proposition.)

The most likely regions for a timber industry will be those where opportunistic logging can take place as coconut plantations succumb to competing land uses — especially housing developments through population pressure and increased urbanisation. This seems to be more likely for coconut stands in more rapidly developing areas of South and South East Asia, and less so in the Pacific.

6 ACIAR and coconut research

Since 1984 ACIAR has had some 13 projects that are directly involved with the coconut industry (they are summarised in table 6.1). Two of these projects are currently ongoing:

- HORT/2006/006, Development of an embryo culture manual and an embryo transplantation technique for coconut germplasm movement and seedling production of elite coconut types; and
- ASEM/2002/014: Improving productivity and the participation of youth and women in the Papua New Guinea cocoa, coconut and oil palm industries.

Of the completed projects, one, CS1/1990/025, Coconut improvement, has been the subject of an ACIAR impact evaluation (Bates 1999). The project was a follow on from an earlier ACIAR project established to address declining coconut productivity in large and small plantations in Papua New Guinea (CS1/1984/042). Its findings were discussed with South Pacific coconut researchers in a workshop held in Tauveni, Fiji Islands in 1993 (Foale and Lynch, 1994).

The general objective of the project was to develop improved coconut germplasm as a basis for breeding and evaluation of new coconut material. The assessment observed that researchers were unable to achieve all of the aims of the project. It concluded that the project had had significant impact on research capacity in Papua New Guinea, but had had small community impact through commercialisation and farmer/regulator uptake and no noticeable impact on consumers and community/environmental welfare. (Reviewers contacted during the assessment suggested that the project would increase production, but noted that such benefits would only appear in the long term). The impacts on Australia and third countries were judged to be small.

Of the ongoing projects, HORT/2006/006 is concerned with preparing a manual on embryo culture and transplantation techniques developed in an earlier project, while FST/2004/054 is exploring the use of coconut timber

for flooring in Australia. The other ongoing project, ASEM/2002/014, appears to be concentrating its efforts on the cocoa and oil palm sectors.

ACIAR published a monograph on coconuts in 2003 (Foale, 2003), and in 2005 it co-sponsored an International Coconut Forum in Cairns. The purpose of the forum was to discuss Australian and other international support for coconut R&D in the Asia-Pacific Region, identify strategic issues in the development of regional coconut industries and discuss the potential benefits to Australia of increased interest in coconut as a health food (Adkins, Foale and Samosir, 2006). The summary of the Forum's proceedings observed that:

> …despite the various technologies, including high-yielding varieties, that have been developed through past R&D investment in various countries, coconut farmers are still faced with many problems. (Adkins, Foale and Samosir, 2006)

It also pointed out that particular importance needed to be given to the enhancement of technology transfer, quality control and marketing.

One of the contributed papers for the Forum discussed Australian involvement in coconut R&D (Samosir, Foale and Adkins, 2006). It stated that ACIAR has been an important contributor to the Asia-Pacific region's coconut R&D effort, but concluded ACIAR-funded projects had not yet had a major impact at the community level because of the slow growth of the palm and the time taken to maturity. It observed that benefits from germplasm work would take decades to impact at the farmer level, and that this would only come after extensive breeding programs had been put in place and propagation systems had been established. The paper pointed to the poor capacity of coconut farmers to adopt new technologies, and suggested that this implied a need to develop technology transfer schemes to aid the uptake of new technologies.

6.1 **Coconut research projects funded by ACIAR**

Project code	*Project/activity title*	*Discipline*	*Date*	*Commissioned institution*	*Countries involved*	*Budget A$*
HORT/2006/006	Development of an embryo culture manual and an embryo transplantation technique for coconut germplasm movement and seedling production of elite coconut types	Horticulture	2006-07	University of Queensland	The Philippines	67 800
FST/2004/054	Improving value and marketability of coconut wood	Forestry	2007-10	Queensland Department of Primary Industries and Fisheries	Fiji, Samoa	520 522
ASEM/2002/014	Improving productivity and the participation of youth and women in the Papua New Guinea cocoa, coconut and oil palm industries	Socioeconomic	2003-07	Curtin University of Technology	PNG	647 736 (% for coconut unclear)
AGB/2000/072	Improving resource use efficiency in the coconut industry of North Sulawesi and its national implications	Agribusiness	2004-06	University of Sydney	Indonesia	396 158
ADP/2001/068	Technical support for regional plant genetic resources development in the Pacific	Agricultural development policy	2002-06	International Plant Genetic Resources Institute, Malaysia	Fiji, Kiribati, Malaysia, PNG, Samoa, Tuvalu, Solomon Islands, Vanuatu	585 000 (% for coconut unclear)
HORT/1998/061	Coconut tissue culture for clonal propagation and safe germplasm exchange	Horticulture	2002-05	University of Queensland	Indonesia, The Philippines, PNG, Vietnam	711 309
ASEM/1998/068	Socioeconomic evaluation of supervised cattle distribution under coconuts in the Philippines	Socioeconomic	1999-2002	University of Queensland	The Philippines	151 158 (% for coconut unclear)
ASEM/1997/118	Socioeconomic monitoring and evaluation of research and development of the PNG cocoa and coconut smallholder sector	Socioeconomic	1998-2000	University of Western Australia	PNG	149 886 (only 20% for coconut)
CS1/1992/021	Nucleotide sequence determination of cadang-cadang-like viroids in the Pacific area	Crop improvement	1993-95	University of Adelaide	The Philippines, Vanuatu	244 707
CS1/1990/025	Coconut improvement	Crop improvement	1991-94	Victorian Department of Agriculture and Rural Affairs	Papua New Guinea	645 407
CS1/1998/031	Virus-like diseases of coconut palm	Crop improvement	1989-92	University of Adelaide	The Philippines, Solomon Islands, Vanuatu	734 769
CS1/1984/042	Coconut improvement	Crop improvement	1986-90	Victorian Department of Agriculture	Papua New Guinea	504 939
CS1/1984/002	Studies on cadang-cadang disease of coconut in the Philippines and Micronesia	Crop improvement	1984-87	University of Adelaide	Federated States of Micronesia, The Philippines	176 348
CS1/1984/003	Etiology, distribution and control of virus-like diseases of coconut palm in the South Pacific	Crop improvement	1984-87	University of Adelaide	Vanuatu	221 197

Source: Samosir, Foale and Adkins (2006), and ACIAR.

Some issues related to coconut research

Befitting the important role that coconuts have played in the livelihoods of many poor people around the world, and the significant resource that the stock of coconut palms represents in some countries, there have been considerable programs of government and internationally funded research in the industry. Two networks and alliances play an important role in supporting research efforts and transmitting information and promoting communication amongst players in the coconut industry globally and in the Asia Pacific region.

The International Coconut Genetic Resources Network (COGENT), which has 38 member countries, was established in 1992 by the International Plant Genetics Resources Institute when the Consultative Group on International Agricultural Research (CGIAR) decided to become involved in coconut research. Its objectives are to (Batugal, 2006):

- establish an international database on existing and future coconut germplasm collections;
- encourage the protection and use of existing germplasm collections;
- identify and secure additional threatened diversity by developing and adopting suitable conservation technologies and strategies;
- promote greater collaboration among research groups in producer countries and advanced technology sources in the exchange of germplasm and the development of new conservation techniques;
- secure necessary funding for network activities; and
- conduct appropriate training and information dissemination.

The Asian and Pacific Coconut Community is an intergovernmental organisation with 15 member countries formed with the objective of assisting members to develop, provide and exchange technologies that will benefit their producers and processors. It organises meetings, seminars, workshops and training programs, executes projects and studies, support transfer of technology and facilitates networking.

The development of higher yielding varieties

A significant focus of coconut research over the years has been the development of higher yielding varieties, particularly by developing hybrids between dwarf and tall coconuts. Tall varieties, which remain the most common in commercial production, are slow to mature and first flower six to ten years after planting. They produce medium-to-large size

nuts and have a life span of sixty to seventy years. The dwarf varieties are thought to have resulted from domestication (Harries 1991). They may grow to a height of twenty-five to thirty feet and begin flower after three years, when the trunk height is about one metre. Their life span is only about thirty years. Although difficult to grow, the dwarf varieties are valued because they bear early and are resistant to lethal yellowing disease. Table 6.2 compares the main characteristics of tall and dwarf coconut varieties.

Despite considerable success in developing higher yielding hybrids, it appears that there has been little replanting to take advantage of the potential they offer. Samosir, Foale and Adkins (2006) observe that:

> The productivity potential of coconut has not increased, and it is estimated that more than half of the existing plantations are becoming too old for continued copra production. Several high-yielding hybrids of Tall by Tall and Dwarf by Tall have been available for many years but farmers are reluctant to replant with these materials due to a lack of confidence and knowledge of this kind of germplasm. In addition, hybrid seedlings are not easily available to the farmer and, when available, the seedlings are too expensive for the average farmer to buy.
>
> Thus the typical coconut farmer continues a zero or low input management practice and, under such conditions, the palms are performing well below their potential.

The longevity of the predominant tall varieties, and the incentives that shape most smallholders' decision making also would seem to work against adoption of new varieties, or, as the World Bank pointed out in 1991, replanting with the same variety:

> Coconut smallholdings tend often to be self-perpetuating: with a high population density and a spread of ages within the stand of fifty years or more, the yield remains very stable and it is difficult for the farmer to decide the point at which it becomes financially worthwhile to sacrifice his existing palms and replace them with material of higher yield potential. (World Bank 1991)

Even given the precocity of the dwarf hybrids, for many smallholders the absence of production while new palms mature may be difficult to manage, especially in locations where copra is the main source of cash income (as is the case in parts of the Pacific). And given limited cash flows, and the limited reach of financial services, smallholders may be even more reluctant to plant palms that require purchased inputs.

6.2 Comparison of characteristics between tall and dwarf coconuts

Characteristic	*Units*	*Broad coconut variety*	
		Talls	***Dwarfs***
Commercial distribution		Wide	Limited
Use by smallholders		Wide	Very limited
Pollination		Cross-pollinating	Self-pollinating
Nut size		Very small to large	Very small to medium
Planting density	metre grid	7-10	5.5
	palms/ha	160 (8 metre grid)	330
Time to first bearing after planting	years	5-7	3-4
Bearing intervals		Each year	Can be irregular
Mature height	metres	15-22	Less than 8
Commercial productive life (high yielding)	years	Up to 50	Up to 30
Senile age (tree ceases production)	years	Between 60-70	Between 30-40
Expected life span (at death of tree)	years	Between 80-100	Up to 50
Drought tolerance		Variable	Variable
Susceptibility to storms		Low	High
Average plantation yield[a]	number nuts/ha	9 700	11 000
	tons copra/ha	2.8	2.9
	copra grams/nut	greater than150	90-120
Potential plantation yield[a]	number nuts/ha	16 974	18 635
	tons copra/ha	4	5
Smallholder yield[b]	tons copra/ha	0.8-0.9	not used
Oil content	%	66-70	65
Harvesting without mechanisation		Difficult	Very easy
Potential for inter-cropping		High	Lower
Inter-cropping activities		Cocoa, vanilla and vegetables	Grazing cattle
Inputs required for good growth		Low to medium	High
Palm productivity without applied inputs		Low to medium	Very low
Suitability for logging		High	Low

[a] In the Philippines. [b.] Yields in no input systems in Papua New Guinea and the Solomon Islands.

Source: http://www.ipgri.cgiar.org/publications/HTMLPublications/362/ch2.htm and pcaagribiz.da.gov.ph/bukdtips/cocovarcultivars.pdf.

Table 6.3 presents an analysis of the returns from replanting aging palms in Solomon Islands where the old palms are assumed to have half the yield of the new ones. Because of the costs of acquiring and planting new seedlings, and the assumed 9 year period until the new palms hit full yield, persisting with the old palms yields a higher net present value per day of labour,

using a discount rate of 10 per cent. The net present values of the two activities roughly coincide with a discount rate of 4 per cent: but the returns to labour are still better for the old palms, because no effort is to replant palms.

6.3 **Relative returns from replanting senile palms, Solomon Islands**

Item	*Unit*	*Old trees*	*Replanting*
Total production over 16 years	kg	9600	10760
Total gross margin over 16 years (@ $SI1 per kg return at the dryer	$SI(2006)	4160.0	5700.0
Total labour input over 16 years	days	297	422
Average annual gross margin/ha	$SI2006	130.0	178.1
Average return per person-day of labour	$SI2006	14.0	13.5
NPV @ r(i)10%	$SI2006	2347.1	1030.3
Average annual NPV/ha	$SI2006	1173.6	515.2
NPV/person-day of labour	$SI2006	126.6	39.0
NPV @ r(i)4%	$SI2006	3029.6	3078.4
Average annual NPV/ha	$SI2006	1514.8	1539.2
NPV/person-day of labour	$SI2006	163.4	116.7

Note: The table compares the returns over a 16 year period of producing copra from 2 ha of old palms yielding 300 kg/ha with the returns from replanting with palms that yield nothing in the first 4 years, and then 80,100, 200, 300, 500 kg/ha for the next 5 years, and then yielding 600 kg/ha for the remainder of the period. Seedlings are estimated to cost $SI5.00 at the plantation site, and are planted at 130 palms/ha. In both scenarios it is assumed that the smallholder has already constructed a drier, and maintains it by replacing parts over the period. It is assumed that in the case of the new plantings, the dryer does not need reconstruction, nor is expenditure on replacement materials required during the period of no production.

Source: Data supplied by A McGregor, (pers comm.)

Clearly other strategies have to be examined to allow for replanting. One is to interplant old palms with new ones on part of the farm, so that some returns are coming in as the new palms grow to cropping age. Another supporting strategy is to try to make use of carbon credits to partially offset the costs of such inter-plantings.

It has been suggested (K. Chapman, 2007, personal communication and Foale, 2007, personal communication) that the development of nucleus estate processing and planting of palms in areas with sufficient suitable land, to link with existing smallholders could facilitate replanting and provide a market for their coconuts. Where there are contiguous areas of palms that could readily be organically certified, the inter-row areas may be leased out to produce high value organic and health food fruits, spices or alternatively become a supplier to such larger processors. Both of these models are now operative in Sri Lanka, and an integrated processing centre has just started operation in northern Mindanao in the Philippines.

Pests and diseases

Research has also been targeted at the management of pests and diseases that affect coconuts. Coconuts are subject to many diseases, bacterial,

fungal, viral, viroidal and phytoplasmic. Some of these diseases are lethal and others are debilitating. Of particular concern are cadang-cadang (a viroid disease, lethal yellowing (caused by mycoplasma-like organisms and bud rot (caused by the fungus Phytophthora palmivora) (Adkins, Foale and Samosir, 2006). ACIAR supported work on viroids during the 1980s and early 1990s, prompted in part by concerns over the possible effects of viroid-like entities found in Vanuatu after research in the Philippines linked the cadang-cadang disease to a viroid. Among other things, the research made inputs into the development of protocols for the movement of coconut germplasm.

Foale (2003) identifies some of the main pests affecting coconuts. They include the rhinoceros beetles (*Oryctes spp.*), the black palm weevil (*Rhyncophorus bilineatus*) and the coconut leaf beetle (*Brontispa spp.*). The red ring nematode, which can fatally attack palms in the Caribbean, does not seem to be a threat in the Asia Pacific. Foale points out that in Papua New Guinea and Indonesia, a grasshopper (*Sexava spp.*) can from time to time completely defoliate palms. He also indicates that leaf-eating caterpillars, scale insects and other creatures (termites in a seasonally dry climate, and root caterpillars on peat soils) can sometimes pose a severe or even fatal threat. Some types of sucking bugs (*Hemiptera*) feed on the coconut inflorescence, while the others, known as the nut-fall bug target young fruits and can remove so much sap that the fruits drop off.

Chapman reports that the coconut leaf beetle (*Brontispa longissima*) is currently a very serious threat in South East Asia and FAO has in recent times supported successful biological control initiatives in Lao PDR, Cambodia, Thailand, Viet Nam and the Maldives. The Philippines is now under threat, and spread of this pest to India, Sri Lanka and parts of Indonesia, where no natural parasites exist would be devastating. Other effective parasitoids or alternate controls need to be identified urgently for the devastating Brontispa coconut leaf beetle. These leaf and fruit mites pose serious problems in some drier areas of Sri Lanka (K. Chapman 2007 personal communication).

Classic biological control mechanisms are available for some of these pests, as well as integrated pest management protocols. An important measure for some pests is the clearing of weeds and dead palms, an activity which may be prompted by the extent of intercropping undertaken in coconut stands. Development of pest and disease resistant varieties will suffer the same uptake problems as development for increased productivity.

Intercropping

Research on intercropping in coconut stands has long been identified as a priority (World Bank 1991, for example, identifies palm spacing, nutrition, and pest and disease control as fruitful areas for research with respect to intercropping). ACIAR has supported research on grazing cattle under coconuts, but it is not easy to find evidence of research on smallholder systems of growing the wide range of crops that are known to benefit from the shade provided by coconut palms (see chapter 3). CIRAD however, reports recent research on the productivity of intercropping systems in Vanuatu (CIRAD 2005). A 1995 FAO review of pasture-coconut cattle systems indicated that the economics of intercropping has only recently been the subject of much research (Reynolds 1995). Ontolan (1998) reports that despite the evidence of considerable improvement in household returns from intercropping in the Philippines, 'large areas of coconut are still underlain by land covered with unproductive weeds and bushes' (Reynolds 1995). Ontolan (1998) suggests a range of socio-economic constraints on adoption of systematic intercropping: a similar set of constraints have been identified for smallholders in Sri Lanka (Reynolds 1995). Chapman also reports that there have been a many trials on intercropping in India, Thailand and Sri Lanka (K. Chapman, 2007, personal communication).

7 *Issues in developing a coconut research strategy*

The objective of this chapter is to offer some suggestions regarding an appropriate strategy for ACIAR's future investment in the coconut area. ACIAR's partners in Asia and the Pacific produce a large proportion of the world's coconut products, and coconuts play a key role in the livelihoods of many of the poorest people in these countries. This alone would suggest that ACIAR should give careful consideration to continuing to support coconut related research.

Ideally, development of a research strategy for ACIAR should be embedded in a strategic planning process for the coconut industry. At the broadest level, a strategic plan for the global coconut industry would look at the following broad areas:

- research and development;
- promotion and marketing;
- quality assurance and product development and innovation; and
- channels for transmission of research results, including the effectiveness of extension services, the incentives for uptake and for commercial delivery of technology and support services.

Such a process would usually involve participation of stakeholder groups and industry experts through input of ideas and feedback to strategic priorities and specific project proposals. It would also encompass a comprehensive stock-take of activities that are already been undertaken by the range of government, international institutions and donor agencies already involved in the coconut sector in each country.

A number of attempts were made in the late 1980s and early 1990s to develop a coconut research agenda, using, with varying degrees of thoroughness, the above approach. According to Batugal, in 1989 the Technical Advisory Committee of the CGIAR commissioned studies to identify priority problems that could affect coconut production, including those that could be addressed through research and those of an

international character that would be beyond the capacity of any one country to resolve. Based on these studies, the CGIAR identified a set of problems suitable for international research support (see box 7.1).

7.1 International coconut research agenda — suggestions from the CGIAR and the World Bank

CGIAR

On the basis of a series of studies commissioned in 1989, the CGIAR identified a set of problems as suitable for international research support. They were:

- germplasm collecting, conservation, evaluation and enhancement
- pest and disease control, especially lethal diseases
- improving the productivity and sustainability of coconut-based farming systems
- increasing efficiency and added value in post-harvest handling and utilisation, and
- addressing socio-economic issues such as the factors that influence farmers' varietal choices in replanting coconut land.

World Bank

A World Bank technical report which presented a collection of papers from scientists and agronomists working on coconuts suggested areas for future research. They included:

- development of new varieties which will perform well in less favoured environments, and broadening the genetic base of existing collections
- developing micro-propagation techniques to improve the diffusion of improved hybrids
- defining the nutritional requirements of new hybrids
- studying the interactions between crops and coconuts to improve the performance of inter-cropping in coconut stands
- developing integrated and environmentally sound techniques for controlling pests and diseases
- develop ways of mechanising copra production so that expected heavier crops can be harvested and processed more economically, and
- develop non-food uses of coconut oil and coconut by-products such as timber.

Source: Batugal (2006), World Bank (1991).

In 1991, the World Bank commissioned a series of papers from the scientific staff of the vegetable oils and oilseeds research department of the French Centre de Cooperation Internationale en Recherche Agronomique pour le Developpement (CIRAD) and individual scientists working in coconut issues. The purpose of the papers was to 'review important biological factors influencing coconut production, and to identify means by which the necessary improvements may be realised in the world's major coconut producing areas' (World Bank 1991). It aimed to proved insights into the

recent objectives and achievements of research and describe many of the best cultural techniques then current, and suggested areas where future research would be desirable. Box 7.1 summarises the report's proposed areas for further research.

It seems that a considerable quantum of resources has been devoted to work on the technical components of the research agenda identified by these and other efforts. But, as reported in chapter 6, a recurring theme on assessments of this research is the very poor uptake of new technologies, and, in the words of the editors of the report of the 2005 International Coconut Forum, coconut is a 'crop in crisis' (Samosir, Foale and Adkins, 2006) —see box 7.2.

7.2 **A crop in crisis — a view from the International Coconut Forum**

A paper by the editors of the 2005 International Coconut Forum that was supported by ACIAR descriebed coconut as a crop in crisis. In support of this diagnosis it observed that:

- The decline in the industry has been observed for a long time, but little significant effort has been made to reverse the decline.
- The productivity potential of coconut has not been increased, and now more than half of the existing plantations are too old for continued copra production.
- Farmers are reluctant to plant high-yielding hybrids that have been developed, because of lack of confidence and knowledge, and because the seedlings are too expensive or not easily available: so most growers continue with a zero or low input management practice, with palms performing well below potential.
- Devastating diseases are affecting the industry in many locations , and there is no economic measure to control some of the worst of these (such as cadang cadang and lethal yellowing and resistant varieties are yet to be developed.
- Prices for coconut oil are low and fluctuating, and the product faces growing competition from other oils, and other products from coconut have yet to be popularised and marketed on a large scale.

Source: Samosir, Foale and Adkins (2006).

This may suggest that not enough attention has been devoted to the socio-economic elements of the agenda — in particular, as identified by the CGIAR, addressing socio-economic issues such as the factors that influence farmers' varietal choices in replanting coconut land. In turn this may reflect the difficulty of giving the smallholders who are the ultimate beneficiaries of the research a sufficient voice in shaping the agenda. One of the key observations emerging from this study is that most growers operate in an environment which is not conducive to undertaking investments with long gestation periods, or to adopt technologies that require additional use of purchased inputs. Development of a technical research agenda for coconuts

must either accept that environment as a given, and target research into technologies that are appropriate to it, or identify links to work that addresses those policy, institutional and infrastructural constraints that underpin the environment. (It must also recognise the underlying economics of coconut markets and the alternative uses of the land on which coconuts are grown.)

The following sections summarise some of the key findings of this study, and their implications for developing a strategic basis for future ACIAR investments in coconut research.

Key lessons from this study

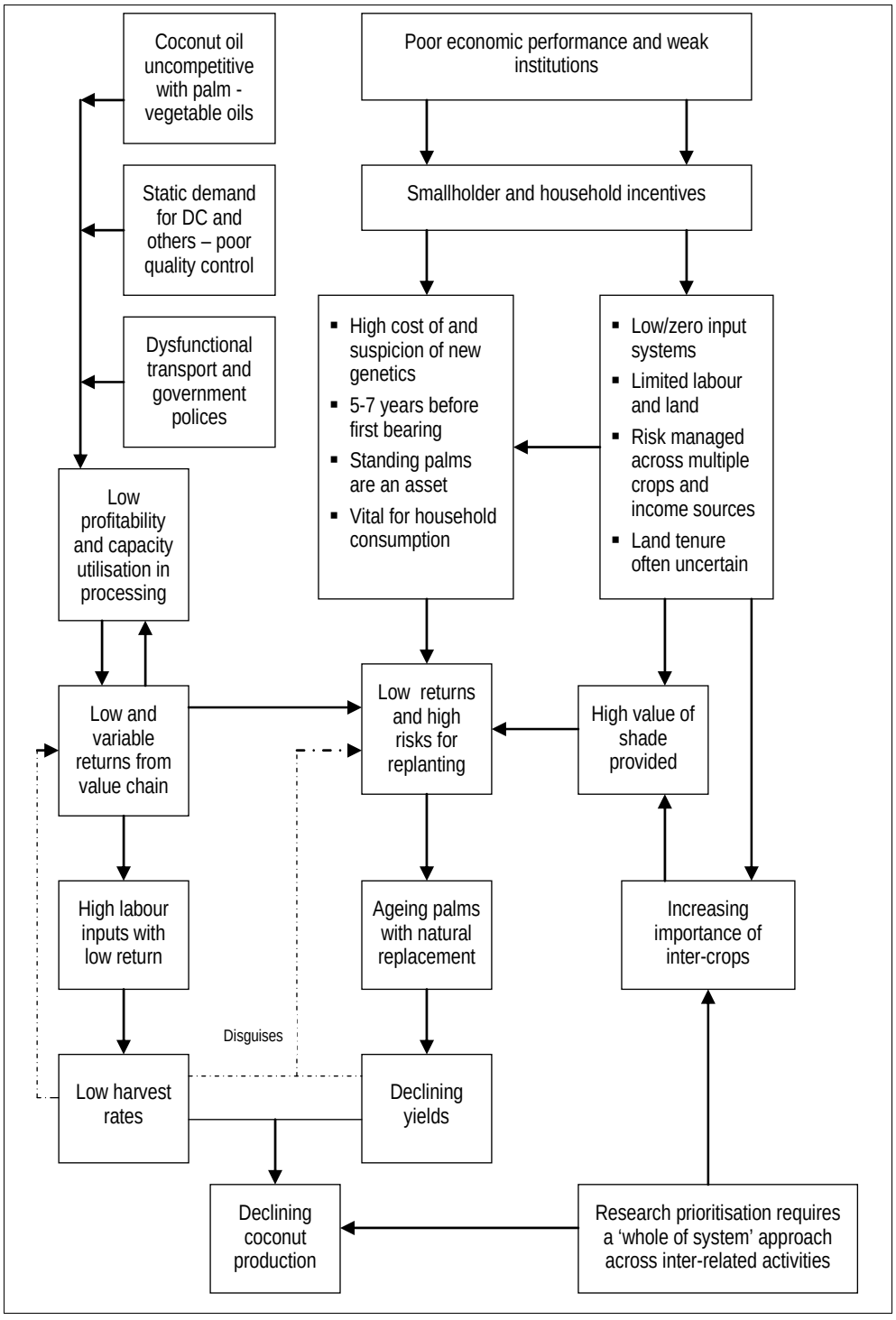
The majority of coconut production is by smallholders, many of whom engage in quasi-subsistence agriculture in which coconuts are just one activity in the family enterprise. Often the coconuts were planted in colonial era plantations, which have reverted to smallholder control as the economics of plantation production has declined. Many palms are close to senility. Very often, the contribution that coconuts make in providing shade for other crops is as significant, if not more so, than the contribution from coconut products. Many growers are relatively isolated from markets (physically or economically as a result of poor transport and communication infrastructure).

In these circumstances it seems clear that it is not wise to develop a research strategy for coconuts without considering the value-chain for coconut products, the other activities that compete for smallholders' land and labour, and the incentives that shape smallholder's resource allocation decisions. Chart 7.3 summarises the issues that have to be considered. Key points are as follows.

- Production systems are no or low input systems, and the production of copra especially is a very labour intensive activity.
- There is no or little incentive to 'specialise' in a single activity such as a coconut plantation and sale of copra:
  - with average blocks of 0.5 hectares or less, specialisation is simply not possible, nor is mechanisation economically viable.
- Smallholders will continue to spread risk across a number of activities including subsistence and cash crops and other income earning opportunities:
  - coconut palms are important to these diversified activities because they provide shade and thus enable low input production of other crops; and

– because returns from coconut products are low relative to the returns from intercropping, and because replanting involves loss of income from both sources, there is little incentive to adopt new more productive varieties as long as the palms stand.

7.3 **The coconut paradox**



Source: The CIE.

- The coconut block acts as part of an insurance policy for smallholders that can be called on in times of shortage — of food or income.
- Coconut oil prices are set in relation to prices of palm and vegetable oils in commercial applications, so the lower productivity in production systems translates into low producer returns. There seems to be little commercial interest in developing large scale markets for alternative products.

What emerges from all of this is that there appear to be limited incentives for smallholders to adopt new technologies that might deliver greater productivity if they involve replanting or greater inputs of labour or purchased materials. Smallholders have been unwilling to replace trees that are bearing — even with low and falling yields. Given the costs and returns from gathering and processing nuts, many smallholders rarely harvest all of the nuts that reach maturity on their stands. This means that declines in productivity have yet to reach a stage where they impact on household incomes or welfare. The unwillingness to replant also reflects the difficulty they face in managing the loss of income while new palms mature. It seems that some of the research in the sector, and the frequent expectation that channelling results through traditional extension systems would lead to uptake, occurred without full consideration of the range of constraints that shape smallholders' decision making.

How can R&D help coconut growers?

As discussed in chapter 6, a lot of past research in the coconut sector has focused on issues such as:

- the potential for increase in yields and better pest resistance through genetic selection;
- better control of pests and diseases;
- the development of new products or more appropriately, development of techniques and processes; and
- improving the technical efficiency of coconut processing.

Less attention seems to have been given to research that focused on:

- ways of positively influencing the institutional and policy environment facing coconut growers;
- adoption pathways, increasing the likelihood of uptake of technical research, and identifying technologies that are consistent with the

incentives that smallholders face and their risk management strategies; and

- understanding of alternative or complementary uses (such as intercropping) of land planted to coconuts, and any necessary R&D to support policy change or structural adjustment (although work on coconut timber is relevant to this adjustment question, since it may help address the problem of the costs that smallholders face when removing senile palms).

The assessments presented in the 2005 International Coconut Symposium seems to reflect recognition that a broader approach to research may be required: but the proposed research priorities still seem to take for granted that the incentive issues are somehow being addressed elsewhere. The main suggestions are presented in box 7.4.

7.4 Research priorities: one set of proposals

The 2005 International Coconut Forum identified the following research priorities:

- clinical research on HIV/AIDS and effects of virgin coconut oil
- raising farmers' real incomes from coconut production
- market research for coconut products
- value adding possibilities for virgin coconut oil
- scaling up development of elite coconut types
- germplasm collection
- research on phytoplasmas
- pheromones for rhinoceros beetles and other pests
- biocontrol agents for Brontispa spp
- virgin coconut oil quality control
- somatic embryogenesis — looking for breakthrough for clonal propagation
- organic farming technology
- refinement of biofuel technology
- emerging coconut pests.

Source: Adkins, Foale and Samosir (2006)

Developing a research strategy for coconuts would have to consider issues such as:

- the importance of coconuts to livelihoods in the ACIAR program countries;
  - information about the age profile of palms in those countries;

- the consequences for smallholder production systems of the ultimate demise of coconut palms, as much with regard to the low-input production of other crops that coconut intercropping allows as for the loss of coconut production;
- alternative uses of land devoted to coconuts;
- costs of converting land to alternative uses;
- scope for R&D to address impediments or other issues that are limiting profitability of production;
- Australia's capacity to engage in and deliver the require R&D; and
- the potential for the R&D to be disseminated to and adopted by growers, processors and other agents of change.

Some of these issues would be of different importance in different ACIAR partner countries. Certainly for ACIAR's Pacific partner countries and parts of South East Asia, a sizeable proportion of the population is quite dependent on coconut as an avenue for cash and subsistence production.

As discussed above, given this dependence, it would be important to understand the dimensions — in terms of households, localities and production — that is at risk from the demise of coconuts. This information would help determine the priority to be given to research with respect to alternative uses of land, and alternatives to growing other cash and food crops under coconuts. While palms are still of value — up to and beyond the age of senility — the obvious risk is that large areas planted during and after the colonial era will start to die. This will then require a systemic replanting or adaptation by smallholders to a different system of farming. Either way there will be a significant impact on smallholders: understanding the status of the stock of palms will help put some perspective on the timing and scale of this impact. This may not require a detailed census, but rather drawing on the knowledge within the research and agricultural community. Knowledge of how much economic activity of poor smallholders is vulnerable to loss of coconut stands would also provide a basis for considering continued support for 'insurance policy' activities such as germplasm conservation and evaluation.

For many Pacific countries, there may be limited economic alternative uses of land planted to coconuts: coconut production and its value chain seem to be fairly robust under the constraints of market access and cash flow that many smallholders face. Circumstances may be different in the Philippines and Sri Lanka, where the problems may lay more with policy and institutional rather than geographical factors. However, it does seem that in

principle research targeted at coconut growers could be beneficial and have the potential to bear directly on ACIAR's concern with poverty alleviation.

Given the fairly limited uptake that has occurred of so much of the scientific and agronomic research undertaken in the past, it would seem however, that an approach that proposed only to do 'more of the same' may not be very helpful to coconut growers.

If ACIAR is to continue supporting coconut related research, it would make sense to consider the needs of smallholders who are currently growing coconuts, not just the potential for research on coconut production, processing and marketing. That is, the research should recognise the multi-activity livelihoods of most small-holder enterprises that are involved in coconuts and the way in which research addresses the role of coconut and coconut products in their overall risk management and production strategies. Research may also be useful in characterising and quantifying the incentive regime that smallholders face when making decisions related to land use and their coconut resource, and the impact of policy and institutional factors in shaping those incentives.

Developing a coconut related research strategy would also have to consider:

- the level of funding required to bring about substantive change;
- the activities of other organisations already funding programs — including government departments and other donors that may be helping address policy and institutional constraints; - and if there are any gaps ACIAR could fill;
- any scope for leverage of existing programs and industry activities; and
- the capacity in coconut growing countries to collaborate with Australian researchers.

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