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THE COCONUT PALM: PROSPERITY OR POVERTY

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EXECUTIVE SUMMARY

The need for international cooperation on coconut research to bring together a critical mass of expertise and resources to solve some of the pressing problems of the crop and its farmers, has long been recognized amongst producing countries, coconut researchers, and several development agencies. A number of proposals have been prepared for international cooperation, particularly in the area of coconut germplasm collection, evaluation and breeding. These proposals date back to 1972. All have lapsed. The needs of the crop and the millions of people who depend on it for their livelihood have not abated in the meantime.

The key problem has been the lack of follow through to establish a consortium of producing countries, consumers and development agencies, that would design and implement a high quality research program that addresses the major issues facing the crop, and provides the continuity of funding that is essential for a perrenial tree crop such as coconut. The Consultative Group on International Agricultural Research (CGIAR) is ideally placed to sponsor the design and conduct of such a program, and provide the necessary continuity of financial support.

The 1986 CGIAR Priorities paper concluded that coconuts were one of three priority areas requiring international support (the other two being tropical vegetables and aquaculture).

In 1988-89, TAC considered two papers which described: 1) the current status and future trends in coconut production within the context of the world fats and oils market; 2) existing research programs; 3) future research needs; and 4) possible institutional options for an international initiative on coconut research.

The present paper summarises: 1) The importance of coconut as a smallholder crop that is an important component of long-term farming systems in coastal and island regions throughout the world; 2) The needs and opportunities for research; 3) The priority areas for research appropriate for international support. 4) The possible institutional mechanisms for conducting an international coconut research program, either within or outside the auspices of the CGIAR.

The coconut palm is believed to have originated in the Western Pacific. It is now a pan-tropical crop, grown on approximately 11.6 million ha in 82 countries. The main producers are the Philippines, Indonesia, India, Sri Lanka, Papua New Guinea and the Pacific Islands. Total world production in 1985 was 7.5 million metric tons of copra equivalent. Approximately 85% of production comes from Asia (13 countries) and the Pacific (18 countries). Coconut is also a locally important crop in 29 countries in Latin America and the Caribbean, and in 22 countries along the coasts of East and West Africa.

Coconut is predominantly a smallholder crop, with at least 96% of total world production coming from smallholdings of 0.5-4.0 ha. It is an ecologically sound crop. It is able to grow in harsh environments, such as atolls, high salinity, drought, or poor soils. It plays an important role in the sustainability of often fragile ecosystems in island and coastal communities. Coconut is used as a source of food, drink, fuel, stock feed and shelter for village communities, where it is often referred to as the 'Tree of Life'. It is also a cash crop, able to be used to produce many items for sale, at either the local, national, or international level. About 70% of the total crop is consumed in producing countries. Coconut is also an important export crop for some countries. The main internationally-traded products are copra, coconut oil, copra meal, and desiccated coconut.

The rationale for further research on coconut is based on: 1) The importance of coconut as a smallholder crop, produced largely for domestic consumption. There are more than 10 million farm families (about 50 million people) directly involved in its cultivation. A further 30 million people in Asia alone are directly dependent on coconut and its processing for their livelihood; 2) The increasing importance of domestic consumption of coconut in producing countries to meet the growing demand for vegetable oils and fats; 3) The predictions of future decreasing production in the Philippines (the world's major exporter of coconut oil), due to the increasing age of the palms; 4) The continuing price premiums paid for the lauric acid oils (coconut and palm kernel oil), primarily for their industrial uses; 5) The declining competitiveness of coconut, which means it is presently unable to take advantage of the expanding vegetable oil market and is losing ground to other crops; 6) Virtually all the benefits from coconut research accrue to developing countries. Furthermore, the majority of these benefits go to the smallholder producers. The balance go to consumers in developing countries.

Promising research results from only a few programs suggest that a well- organized and adequately funded international research effort could yield high returns on the investments.

Appropriate methods will be required for the transfer of new technologies to smallholders, if these returns on research investments are to be realized. Coconut breeding in several countries over the past 30 years has demonstrated that hybrids are capable of yielding up to 6 tons copra/ha/year, under favourable conditions (cf. world average yield of 500 kg/ha/year). Progress has also been made in the identification of the causal agents of diseases of previously unknown etiology.

Coconut research is presently under-funded. There are several national research programs. With few exceptions, they are not well-supported financially nor do they have sufficient appropriately trained staff and facilities. Most suffer from a lack of continuity in funding, both from national sources, and from external agencies. Many small producing countries are not able to support a coconut research program at all. At present there is no means by which small countries can access new technologies, especially for higher yielding planting material. Yet they could be active participants in an international germplasm evaluation program. The present research efforts are not addressing the needs of the crop internationally, nor capitalizing on the promising results from breeding and other areas of research, for the benefit of smallholders.

The long-term nature of coconut research, the history of discontinuity and lack of support in its funding, the prospects of high returns from research investments, and the likely distribution of research benefits to smallholder producers, make coconut a particularly suitable target for an international research initiative.

The priority research areas to be addressed by an international effort are: 1) Coconut germplasm improvement; (collection, conservation, breeding and evaluation); 2) Disease and pest control; 3) Sustainability of coconut-based farming systems; 4) Postharvest handling and utilization

It is proposed that there be a socio-economic component within each of the priority research areas. The issues influencing the participation of farmers in rehabilitation and replanting programs are of particular importance.

After consideration of various options, an international initiative, termed an International Coconut Research Council is proposed as the most appropriate institutional model. It would conduct research on a limited scale, especially in relation to germplasm collection, conservation, and utilization; contract research to national and other research institutes on the identified priority areas; and establish subject-matter and regional research networks, to encourage greater exchange of research results, and technology. A socio-economic component would be included in each research area. A total complement of 14 senior staff was proposed.

The proposed international coconut germplasm improvement programme would require the establishment of an international germplasm research unit under whose auspices coconut germplasm would be collected and conserved and research on techniques for germplasm conservation and breeding would be conducted. The germplasm unit and the headquarters of the Council would be located in Asia (possibly in two different countries, to maintain the decentralised style of the Council).

The proposed initial complement of senior staff would be 14. In addition, the Council would require some support staff. It would also require a significant contractual research budget. The Council would then have the responsibility to commission research of international significance with national programs, other interested research organisations, and advanced laboratories within its identified high priority areas.

The administrative mechanisms by which an international research program on coconut could be established are compared. These options include ones which could be incorporated into the CGIAR system and ones which could be conducted under international auspices but outside the CGIAR system. The critical elements are to establish international auspices for the programme, especially in regard to germplasm conservation, evaluation and improvement, and to provide a mechanism for continuity of funding for coconut research.

A case is presented for establishing an international research initiative on coconut. This subject has been examined since the early 1970's by several bodies interested in improving the productivity of coconut, and increasing the incomes of millions of smallholders dependent on the crop. Although the needs have been demonstrated, and the potential returns from research appreciated, all these efforts have failed.

In the intervening period, research workers have shown the potential for substantial increases in yield, the development of new technologies for pest and disease control, and the improvement in processing of coconut products. The management of the coconut lands to ensure their long-term productivity is also of increasing concern. Investment in research in these priority areas would benefit directly smallholder producers and coconut consumers in many countries. Coconut research is commended to TAC for its consideration as an international research initiative appropriate for support by the CGIAR.

1. INTRODUCTION

The purposes of the present paper are to describe:

1. The current status and future trends for coconut within the context of the world fats and oils market;

2. The importance of coconut as a subsistence crop, as a cash crop, and as a component of long-term farming systems.

3. Future needs and opportunities for research;

4. Current research programs;

5. Possible options for an international research initiative on coconut;

6. Possible institutional mechanisms by which such an initiative might be implemented.

The possibility of an international initiative on coconut research being supported by the Consultative Group on International Agricultural Research (CGIAR) was discussed at the COCOTECH annual meeting, sponsored by the Asian and Pacific Coconut Community (APCC) in Bangkok in May 1989 (APCC 1989). The participants at the meeting welcomed the possibility of such an initiative and the opportunity for continuing consultations during the preparation of documents for the CGIAR Technical Advisory Committee (TAC). The Australian Center for International Agricultural Research (ACIAR) has been assisting TAC in its deliberations on coconut research by organising the preparation of the necessary documents, after consultation with interested parties.

Following the favourable discussion of the proposal by the participants of the APCC meeting, ACIAR convened a small working group in Singapore on 13-14 September 1989. The group was comprised of representatives of some of the major producing countries, some international development agencies active in sponsoring coconut research and the Executive Director and Deputy Director of the APCC. A report of the meeting is available (Persley, 1989).

The purpose of the working group was to assist in the preparation of a document on coconut research priorities to be discussed by the TAC at its meeting in Washington in October 1989. The working group discussed and revised a draft paper on the priority research needs on coconut and how these might be addressed by the establishment of an "International Coconut Research Council" (Persley, 1989).

It was agreed by the working group that an international effort was needed to bring a critical mass of expertise and resources to solve some of the pressing problems of the crop. The need for international cooperation on coconut research has long been recognized amongst producing countries, coconut researchers, and several development agencies. A number of proposals have been prepared for international cooperation, particularly in the area of coconut germplasm collection, evaluation and breeding. These proposals date back to 1972. All have lapsed. The needs of the crop, and the smallholders who cultivate it have not abated in the meantime. The key problem has been the lack of follow through to establish a consortium of producing countries, industry sources and development agencies that would design and implement a high quality research program that addresses the major issues facing the crop, and provides the continuity of funding that is essential for a perennial tree species such as coconut. The CGIAR is ideally placed to sponsor the design and conduct of such a program, and provide the necessary continuity of financial support.

2. TAC ASSESSMENT OF OILSEED RESEARCH PRIORITY

Consideration of coconut research by TAC originated in the 1986 Report on "CGIAR Priorities and Future Strategies" (CGIAR 1988). TAC identified the oilseed crops as a high priority area for research. The following extract from the report give the rationale for the priority accorded to oilseeds in general and coconuts in particular by TAC at that time:

> "Oilseeds are important sources of fat and protein, they enjoy a growing demand, they are a viable cash crop for small-scale farmers, and growing deficits have been projected for developing country regions. This priority was reflected in TAC's recommendation to increase resources to soybean and groundnut research. It also underlies TAC's recommendation of coconut as a possible new venture within the CGIAR. The oilseed crops are a large and diverse group. The two most important are soybean and groundnut. Other important sources of edible vegetable oils are two perennial crops, coconut and oil palm, and a number of annual crops with different regional significance, (sunflower, safflower, rapeseed, sesame and mustard). Cottonseed is also a major source of edible oil, although cotton is grown primarily for its value as a source of natural fiber.
>
> The group is an excellent source of protein and fat and make an ideal complement to root crops, which are predominantly carbohydrate. They are used as whole seed, vegetable oil and animal feed (in the form of oil cake after oil extraction), and their by-products are used for fuelwood, mulch and industrial purposes. Soybean, groundnut and coconut are important foods in their primary growing areas, are major cash crops in developing countries, provide employment in farm and processing industries, and earn valuable foreign exchange. Their processing has often been a first step to industrialization.
>
> Increases in the developing-world production of oilseeds matched demand in the 1970's, but at very different rates for different crops. Oil palm production increased by 11% annually; sunflower, safflower and rapeseed by 5-7%; coconut by 2%; and sesame remained virtually stagnant. Trends indicate that total oilseed production will have to increase an average of 3.3% annually to meet demand to the year 2000. Although crops can substitute for one another, this is small comfort in regions such as Equatorial and Humid-West Africa where, based on recent trends, oilseed production will not meet demand.
>
> The oilseeds which do not earn foreign exchange are of a lesser and largely local importance. Sunflower, safflower and rapeseed make relatively low contributions to the food supplies and economies of developing countries and are of much less national importance. In developing countries, sunflower is harvested from 3 m ha, safflower from 1.2 m ha; and rapeseed from 7.4 m ha. Sesame is widely grown in a variety of conditions in the tropics and sub-tropics, mostly for domestic consumption; about 6.3 m ha are harvested in developing countries; and India, Mexico and Venezuela have strong national research programs for sesame.

TAC considers that none of the annual oilseed crops, soybean and groundnut excepted, is of sufficient global importance to justify the allocation of CG System resources at present.

Oil palm, a perennial, is a major world oil crop, usually grown on plantations in rain forest areas of Southeast Asia, West Africa and Central and South America. Oil palm production is dynamic and highly competitive; in response to the demand for vegetable oil, production increased by 150% in the 1970s. Intensive private and public-sector research has led to considerable increases in yield per hectare and improved oil quality. Recently developed techniques for the vegetative propagation of the oil palm through tissue culture opens the way to cheap methods of raising large numbers of plantlets from elite clones. Internationally, research is done by IRHO and commercial interests. Colombia, Ecuador, Malaysia and Nigeria also have strong national programs. TAC therefore considers that the needs for production and post-harvest research are well addressed and do not require support from the CG System.

Coconut, also a perennial, is not only a primary source of edible oil, but also of livestock feed and fiber and can be processed into a variety of end-products. Its contribution to food supplies is substantial. Cultivated widely in littoral regions of the world, it is especially important in Southeast Asia, India and the Pacific and Caribbean islands, but standards of husbandry and yields are generally low. The IRHO does research on the crop internationally and there are a number of significant national coconut research institutes and programs - in India, Indonesia, Jamaica, Philippines, Sri Lanka and the South Pacific. Utilization research is done in developing countries and at specialized institutes in the developed countries.

TAC considers that the establishment of an international coconut research network would provide a focal point for collaboration and for donor support. The value of coconut as an ecologically-sound food and cash crop suitable for smallholder cultivation, the geographical diversity of its production, the potential for further research, the uncoordinated research effort to date, and the need to solve important disease problems are strong reasons for coordinating and strengthening present research efforts.

TAC considers that strengthened research for oilseeds in general is indicated. This is based on analyses of the projected increase in demand for vegetable oils, the deficit in these commodities already experienced by some developing countries, and the gap in international research on a number of potentially important oilseed crops. TAC recommends that the CG System increase its effort on groundnut and soybean, as well as on maize (whose use as an oil crop may increase when other needs are met) and recommends the inclusion of coconut research in the CG System as an additional activity.

Coconut is the oil crop most in need of international research support. International research on the crop is currently underfunded and it has the potential for high pay-off. Furthermore, coconut is a small-holder crop that is ecologically sound and offers

a broad range of dietary, income and employment opportunities. It is not only a primary source of edible oil, but also of fiber and livestock feed, once it can be processed into a variety of end-products. Furthermore, there appears to be good research potential for coconut... TAC, therefore, encourages the creation of a research network to strengthen and coordinate coconut research and supports CG system involvement in such a network."

3. WORLD FATS AND OILS MARKET

3.1 Consumption and Future Demand

Edible oil is a major component of the diet, and an important earner of foreign exchange for many countries. Demand for fats and oils is increasing faster than population growth. In an analysis of the world market for oils, fats and meals from 1958 to the year 2000, Mielkle (1988) noted that between 1982-87, world population increased by 8.7%, while per caput demand for 17 fats and oils increased by 10.3%.

Moreover, demand for fats and oils is rising more quickly in developing countries than in industrialized countries. Consumption of fats and oils is related closely to income levels. At low income levels, consumption has a high income elasticity of demand. At higher income levels the income elasticity of demand falls.

The developing countries have lower incomes and, consequently, a higher income elasticity of demand for fats and oils than industralized countries. Incomes in developing countries are also expected to grow at a faster rate than those in industrialized countries.

These trends are reflected in Figure 1, which shows the per caput dissappearance of fats and oils between 1958 and the year 2000. In 1958, the world average per caput disappearance of oils and fats was 10 kg. In 1983 it was approximately 13 kg. By the year 2000, it is expected to be approximately 18 kg. Much of this growth will come from above average increases in per caput consumption in developing countries, particularly countries such as Brazil, China, India and Indonesia.

The actual consumption in 1980, and the projected demand in 1990 for fats and oils in various geographic regions is given in Table 1. It is estimated that by 1990 total consumption will grow by 4.2% p.a. in developing countries, compared with 1.6% p.a. growth in industrialized countries and 2.4% in the centrally planned economies (Table 1).

The per caput disappearance of oils and fats between 1958 and the year 2000 is illustrated in Figure 2. The major consumers are 1) the European Community countries, 2) other industrialized countries, 3) China and India (Figure 3).

The growing deficits in oils and fats between 1987 and the year 2000 are illustrated in Figure 4. The areas expected to have major deficits by the year 2000 are China, India, as well as many other developing countries. The countries which are projected to have excess production available for export are USA, Canada, Argentina, Brazil, Malaysia and Indonesia (Figure 5).

Based on current assumptions, it is estimated that total world consumption of fats and oils will be 104 million tonnes by the year 2000 (Figure 3). This would be an increase of 42% on 1987 consumption. It means that on average an additional 2.4 million tonnes will be needed every year (Mielke, 1988).

Table 1: Fats and oils, actual consumption and projected demand, by region, 1980-1990

	Total Consumption		Per Caput Food		Growth Rates	
	Actual 1980	Projected 1990	Actual 1980	Projected 1990	Total 1972-80	Consumption 1980-90
	'000 tonnes		Kg per year		percent per year	
WORLD	58878	77602	10.8	12.0	3.4	2.8
DEVELOPING	25577	38646	6.5	8.2	5.9	4.2
Africa	3913	5652	8.3	9.2	5.5	4.0
Latin America	5517	8067	11.2	13.5	5.9	3.9
Near East	3239	4869	13.1	15.1	7.9	4.2
Far East	8663	13592	6.2	8.0	5.6	4.6
Asia CPE	4295	6417	3.3	4.5	5.4	4.1
Other Developing	50	50	7.0	5.5	7.1	-0.1
INDUSTRIALIZED	33301	38956	22.7	24.3	1.9	1.6
North America	8789	10176	29.5	30.5	1.9	1.5
Western Europe	12578	13664	25.9	26.6	1.6	0.8
E. Europe and USSR	8667	10982	18.1	20.8	2.1	2.4
Oceania	538	629	22.0	23.3	5.3	1.6
Other Developed	2728	3505	15.1	17.1	2.0	2.5

Source: IRHO (1986)

Demand for fats and oils is increasing, primarily in developing countries. It is expected that developing countries will account for 50% of total consumption in 1990, compared to 45% in 1980, and 36% in 1972 (IRHO 1986). The major increases in demand are in China, Indonesia, Brazil, and other developing countries (Figure 3).

In the industrialized countries, there is little prospect for significant increases in the consumption of fats and oils, since the income elasticity of demand is low, populations are not increasing, and there are some perceptions of health risk in fats and oils (particularly from saturated fat as a contributory factor in heart disease). The exceptions are Japan and USSR, where consumption is continuing to rise.

The net effect of these projections is that an increasing proportion of world production of fats and oils will be marketed in developing countries, where per caput consumption is low, and demand is rising.

The options for developing countries to meet the increasing demand are either to import fats and oils (using foreign exchange earned from other exports) or to increase local production. The long term projections on population growth and income growth suggest that there is a need for substantial production increases in developing countries in order to provide an adequate amount of fats and oils in the diet.

Since developing countries produce most of their fats and oils from oilseed crops (particularly several tropical annual oilseed crops, and the perennial tree crops, oilpalm and coconut) there is a need for greater concentration on their production and trade in developing countries.

3.2 Production

The data given below summarize FAO production data for 17 major fats and oils, (soybean, cotton, groundnut, sunflower, rapeseed, sesame, maize, olive, coconut, palm kernel, palm oil, butter, lard, linseed and castor oils, fish oils, and tallow).

The production data for 17 major fats and oils in the major economic regions between 1972 and 1990, and the growth rates in 1972/80, and 1980/90 for different regions are given in Table 2. The production of individual oilseeds (including coconut) between 1972 and 1990 is shown in Table 3. The projected growth in oilseed production is given in Table 4.

FAO has predicted that world production of fats and oils will grow by an average of 2.6% p.a., in 1980-90, compared with 3.7% p.a. in 1972-80. Production in the industrialized countries between 1980-1990 is expected to grow at only 1%, compared with 4.5% growth in the developing countries in the same period.

Thus, much of the future production increases will come from developing countries, particularly from Asia. By 1990, FAO estimates that approximately 50% of total world production will come from developing countries, in contrast to 40% in the 1970's (Figure 6).

Table 2: Fats and Oils, Actual and Projected Production, by Region, 1972-90

	ACTUAL			PROJECTED	GROWTH RATES	
	1972	1980	1983	1990	1972/80	1980/90
	thousand metric tons				percent per year	
WORLD	44876	60001	66178	77661	3.7	2.6
DEVELOPING	18010	25462	29033	39385	4.4	4.5
Africa	3093	3020	3119	3773	-0.3	2.3
Latin America	3757	6594	6618	9388	7.3	3.6
Near East	1226	1504	1595	1836	2.6	2.0
Far East	7104	10275	11096	18098	4.7	5.8
Asian CPE	2642	3790	5473	5881	4.6	4.5
Other Developing	188	279	322	411	5.1	3.9
DEVELOPED	26865	34539	37145	38276	3.2	1.0
N. America	11896	17435	18579	18427	4.9	0.6
Western Europe	5876	7344	8401	8534	2.8	1.5
E. Europe + USSR	7489	7805	8295	9092	0.5	1.5
Oceania	792	946	979	1084	2.2	1.4
Other Developed	813	1009	991	1140	2.7	1.2

Source: IRHO (1986)

Table 3: Fats and Oils: Actual and Projected World Production by Commodity, 1972-90

	ACTUAL			PROJECTED	GROWTH RATES	
	1972	1980	1983	1990	1972/80	1980/90
	thousand metric tons				percent per year	
ALL FATS AND OILS	48876	60001	66178	77661	3.7	2.6
VEGETABLE ORIGIN	29673	42476	48003	58090	4.6	3.2
Lauric acid oils	3218	3721	3900	5312	1.8	3.6
Coconut oil	2614	2834	2854	3542	1.0	2.3
Palm kernel oil	604	887	1046	1770	4.9	7.5
Other vegetable oils	26455	38755	44103	52778	4.9	3.1
Cottonseed oil	2925	3156	3283	4044	1.0	2.5
Groundnut oil	3299	3197	3356	4253	-0.4	2.9
Linseed oil	970	789	906	598	-2.5	-2.7
Olive oil	1618	1884	2002	2085	1.9	1.0
Palm oil	2420	5028	5421	10060	9.6	7.2
Rapeseed oil	2416	3553	4983	5283	4.9	4.0
Soybean oil	6745	12990	14391	15986	8.5	2.1
Sunflower oil	3482	4913	5851	6285	4.4	2.5

Source: IRHO (1986)

Table 4: Oilseeds (oil equiv.) production by main countries and regions, 1985-95

	Projected 85	90	95	Growth 85-95
		'000 tonnes		% p.a.
INDUSTRIAL	17,040	19,686	23,313	3.2
N. America	13,093	16,093	19,147	3.2
EEC-9	1,900	2,192	2,599	3.2
CENTRALLY PLANNED	5,182	5,806	6,473	2.2
USSR	3,680	4,180	4,693	2.5
DEVELOPING	33,559	39,103	46,307	3.3
Asia	21,640	24,988	29,472	3.1
Africa	3,803	3,670	3,505	-0.8
America	6,616	8,725	11,380	5.6
S. Europe	1,500	1,720	1,950	2.7
WORLD	55,781	64,595	76,093	3.2

Source: IRHO (1986)

The major production increases are expected to come from China, India, Indonesia, and Malaysia. It has been predicted that Malaysia will double its output by 1990, compared to 1970, and become the world's second largest producer of fats and oils, after the USA.

3.3 Exports

In 1980, developing countries provided 39% of total world exports of vegetable oils and fats. This is predicted to rise to 51% by 1990. Most of this increase will come from Asia, who provided 52% of total world exports in 1980, and is expected to provide 64% by 1990. These trends are illustrated in Figure 7.

The major exporters of fats and oils are Argentina, Brazil, Canada, Indonesia, Malaysia, the Philippines, and USA. They are expected to account for 80% of world exports by 1990, compared to 75% in 1980.

The major changes in exports of fats and oils expected in the 1990's are:

. The main increase in exports is expected to come from Asia, particularly from palm oil, palm kernel and coconut oil.

. Malaysia and Indonesia are expected to increase substantially their exports of fats and oils.

. Other countries which are expected to increase their exports are Argentina (soybean oil and sunflower oil), Brazil (soybean oil) and Paraguay (soybean oil). The Philippines may increase its output of coconut oil, if action is taken to improve coconut production.

3.4 Imports

Estimated imports of fats and oils in various regions of the developing world, in 1980 and 1990, are shown in Figure 8. Imports by developing countries are likely to increase from 41% to 49% of total world imports.

The major changes expected are:

. The increase in imports is expected to be mainly in Asia, (particularly by India, Pakistan, Korea, and China).

. The five largest importers of fats and oils are expected to be India, Pakistan, Egypt, Nigeria and China.

. Imports are also expected to increase in Africa (particularly Algeria and Nigeria), Latin America (particularly Mexico) and the Middle East (particularly Egypt and Iran).

. Imports by Russia are expected to increase substantially.

. Imports by countries in Western Europe are not expected to change significantly.

- Industrialized countries imports are not expected to change substantially, increasing only by 0.3% per annum, compared with 4.9% in the 1970's.

3.5 Future Prospects for Coconut

The future prospects for coconut are based on:

- the growing demand for vegetable oils and fats, especially in developing countries.

- the increasing importance of domestic consumption of coconut in producing countries to meet this demand.

- the predictions of future decreasing production in the Philippines (the world's major exporter of coconut oil), due to the increasing age of the palms. The Philippines provides the core of the export market, and other smaller exporters depend on the Philippines to keep the market open for coconut oil.

- the continuing price premiums paid for the lauric acid oils (coconut and palm kernel oil), primarily for their industrial uses in soaps and detergents. Buyers still favour the lauric acid oils, and there is a continuing demand for regular supplies. Coconut oil is also preferred over palm kernel oil, both for domestic cooking purposes and in export markets for industrial uses. This provides an opportunity for coconut oil exports, if the productivity of the crop could be improved.

- the current World Bank forecasts for the future of coconut oil exports indicate the continued availability of markets for coconut oil, provided that continuity of supply is maintained. This is an added incentive for research efforts to address problems in the industry.

- The declining availability of exportable surpluses of coconut oil in producing countries presently prevents coconut from taking advantage of the expanding market for vegetable oils and makes end-users apprehensive over the long term future supply in international trade. Coconut's share of the total export market for vegetable oils has been declining steadily. It provided 6% of the total world market in 1986, and is predicted to fall to 5% by 1990.

Demand Forecasts: Lauric Oils (Coconut and Palm Kernel Oil)

The future trade prospects for coconut oil relative to other vegetable oils as predicted by the World Bank (1989) are summarised below:

Although demand for industrial uses exist for most of the oilseeds, it is particularly important in the case of the lauric oils, (coconut and palm kernel oil). Historically, nonedible uses of coconut oil and palm oil have accounted for more than 50% of consumption in the United States and close to 50% in Europe.

Currently processing costs are higher for palm kernel oil than coconut oil for most industrial uses. In addition, coconut oil is greatly preferred as a cooking oil in most of the world. Coconut oil is therefore likely to retain a premium over palm kernel oil. Coconut oil is expected to retain the major share of both the European and North American markets, but growth in the markets is projected to go to palm kernel oil. Coconut oil consumption is projected to range from 420,000 to 470,000 tons annually in Europe over the next decade, and slightly higher demand levels are expected in the United States. The consumption of palm kernel oil is expected to more than double over the next decade, reaching levels over 200,000 tons in North America and 600,000 tons in Europe.

Demand for coconut oil in China, India, and Indonesia is expected to grow as fast as domestic production allows. However, only in the case of Indonesia is production expected to grow significantly. Demand in China is expected to remain at or below 50,000 tons over the projection period. India is expected to consume from 20,000 to 30,000 tons annually. Indonesia's productive capacity should allow domestic consumption of coconut oil of around 600,000 tons in 1988 and over 800,000 tons by the mid-1990s.

Supply Forecasts: Lauric Oils (Coconut and Palm Kernel Oil)

The share of the lauric oil market held by palm kernel oil and coconut oil has changed steadily over the past years. Supplies of copra have remained stagnant in the Philippines, which consistently accounted for 40-50% of world copra production in the 1960s and 1970s. Supplies have been growing in Indonesia, the second largest producer, yet domestic consumption in Indonesia has grown at an equal rate, leaving Indonesia a marginal exporter of copra and coconut oil at best.

At the same time, palm oil plantings have expanded at a rapid pace in both Malaysia and Indonesia. As a result, coconut oil's share of lauric oil production has dropped from about 85% in the early 1970s to 75% in the mid-1980s. Over the next decade, its share is likely to drop to below 70%.

Copra production remains primarily a smallholder operation in the Philippines and elsewhere. Reliable information on planted area is difficult to obtain. However, there appears to have been little new planting in the Philippines over the past decade. Many of the producing trees date back to the 1940s, and there is likely to be a decline in the tree stock's productive capacity over the next 10 to 15 years. Increasing prices and greater political stability should encourage an increase in Philippine copra production by 1990.

The World Bank has approved a loan of US$121 m to the Philippines in May 1990 to enable it to undertake a major replanting program. The purpose of this loan is to enable the Philippines to maintain its continuity of supply of coconut oil, and rehabilitate its coconut industry. The loan is the largest entered into by the World Bank and the Philippines Government for many years, indicating the priority being given to coconut.

GURE 1 : PER CAPUT DISAPPEARANCE OF 17 OILS & FATS (KILOS)

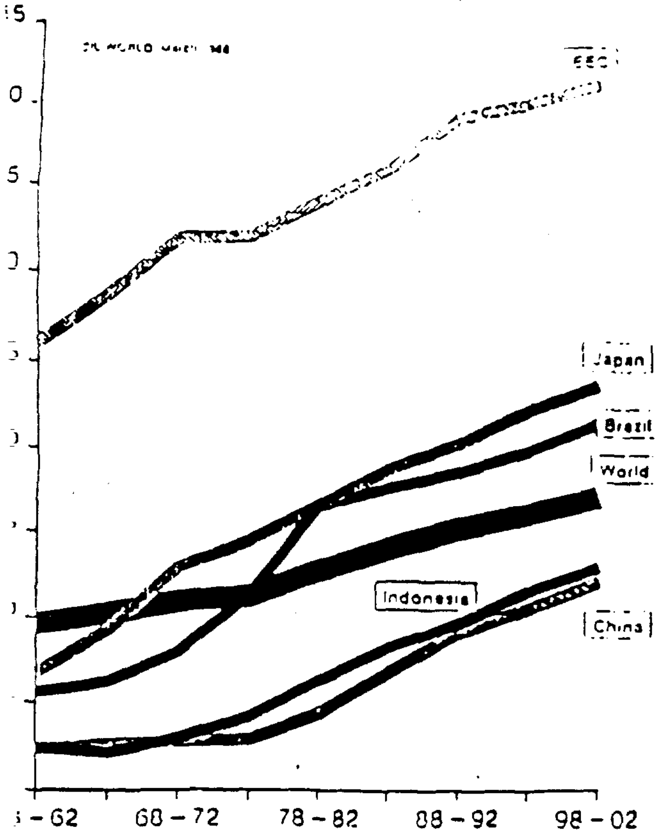
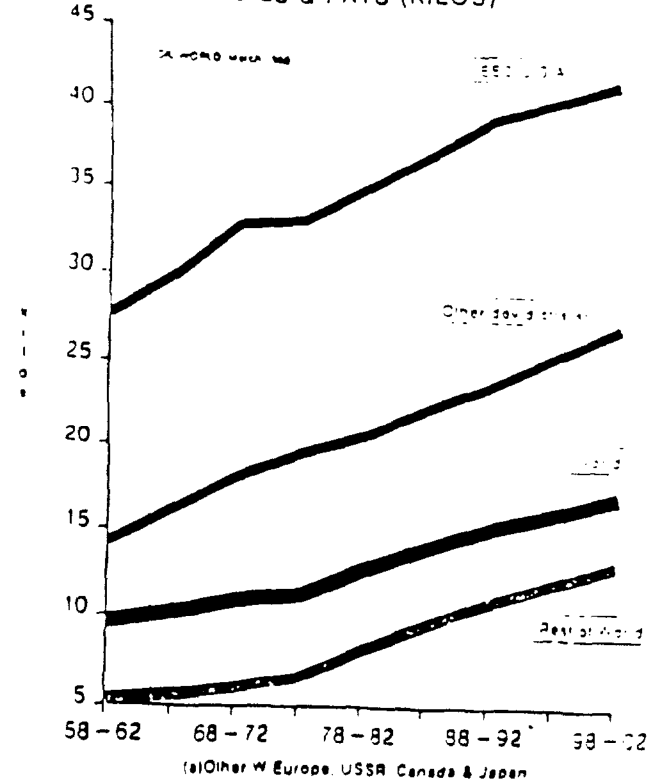
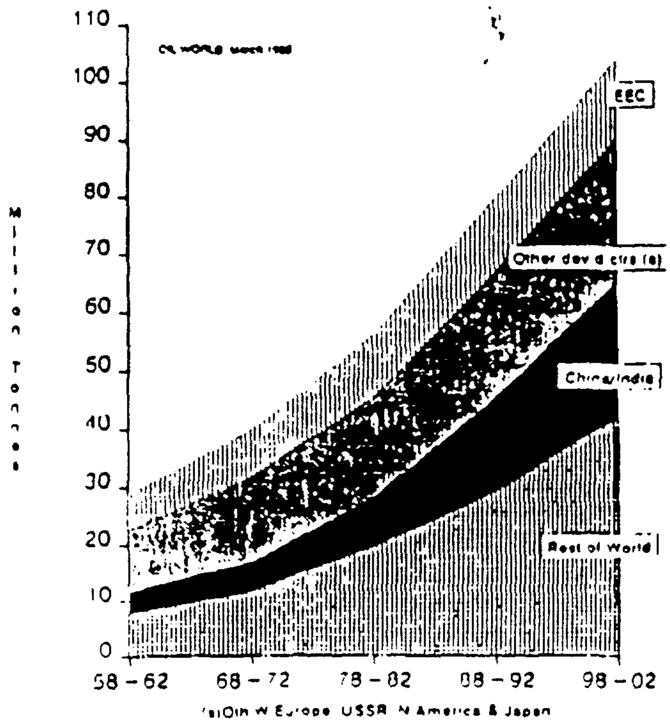


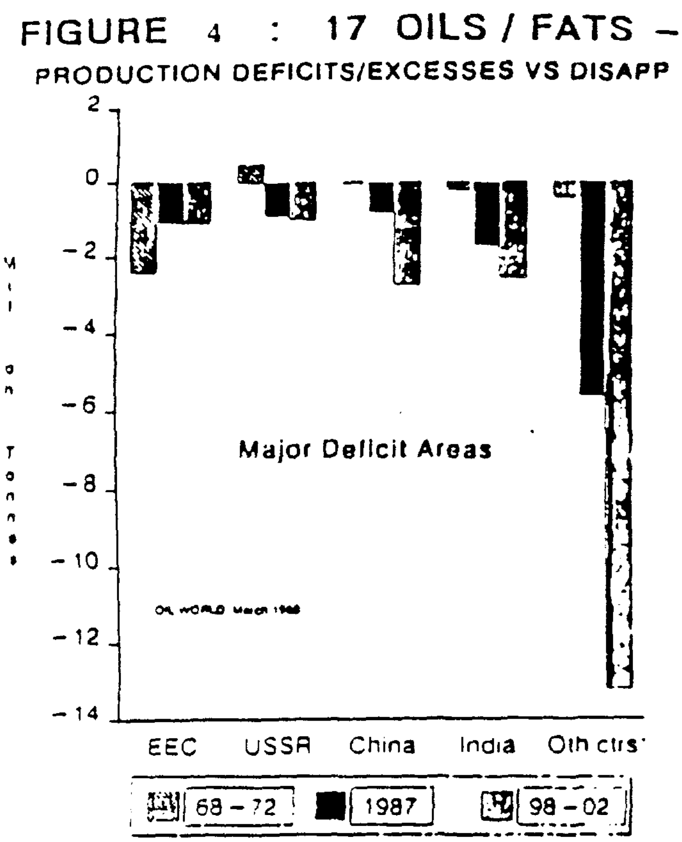
FIGURE 2 : PER CAPUT DISAPPEARANCE OF 17 OILS & FATS (KILOS)

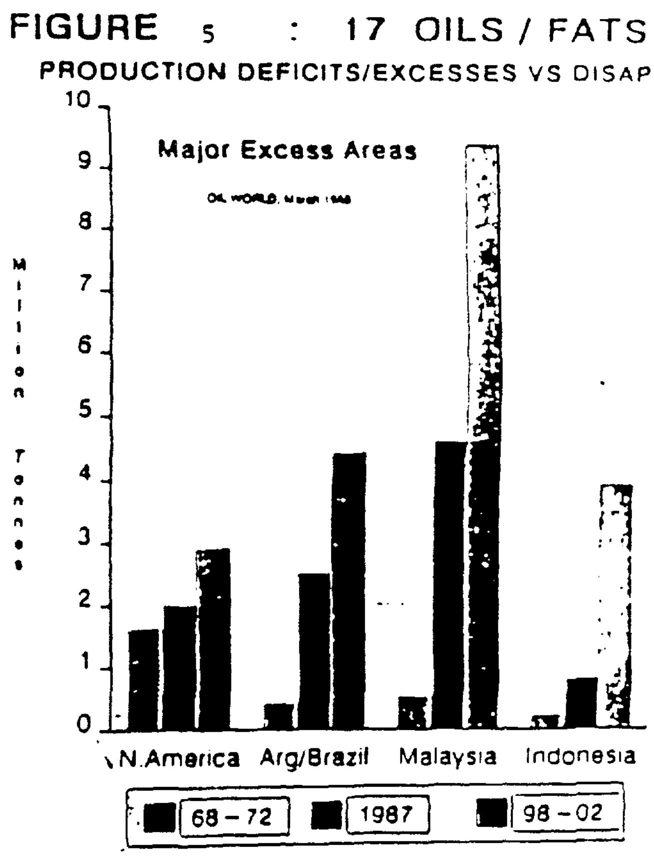


Source: Mielke, S. Oilworld, 11 March 1988.

FIGURE 3 : 17 OILS & FATS – WORLD DISAPPEARANCE





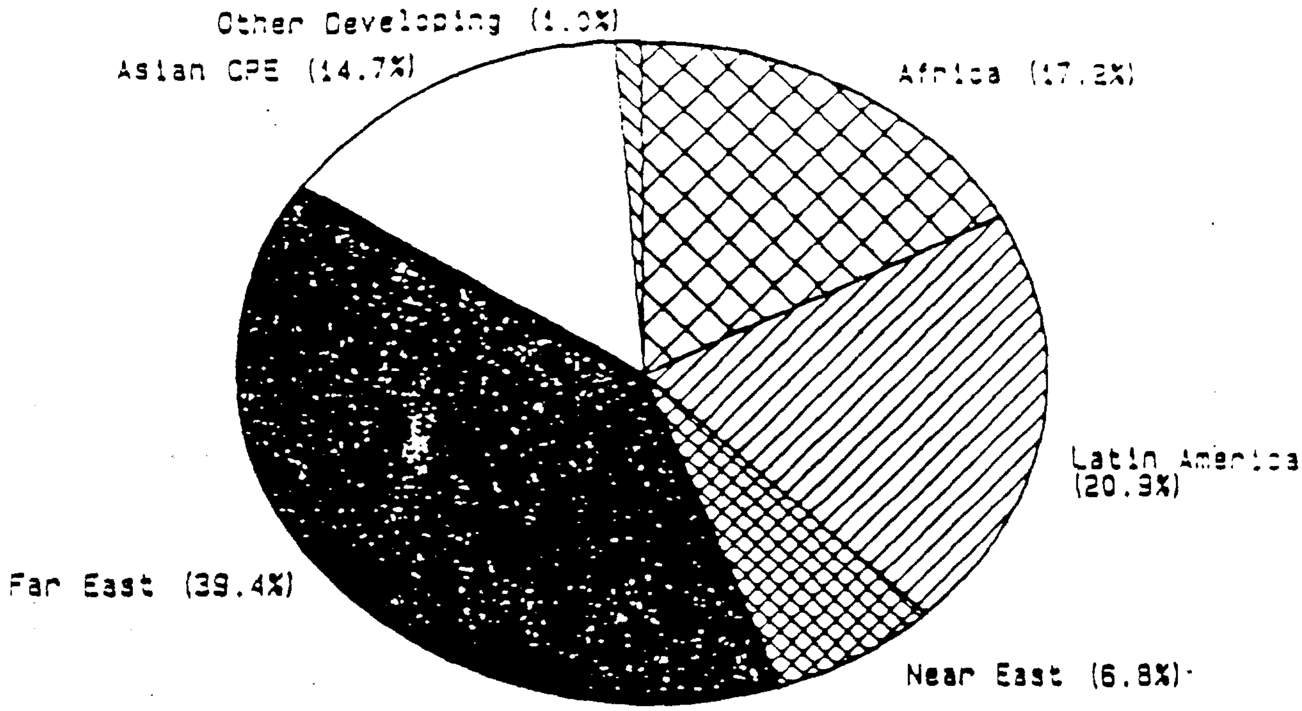


Source: Mielke, S. Oilworld, 11 March 1988.

Figure 6

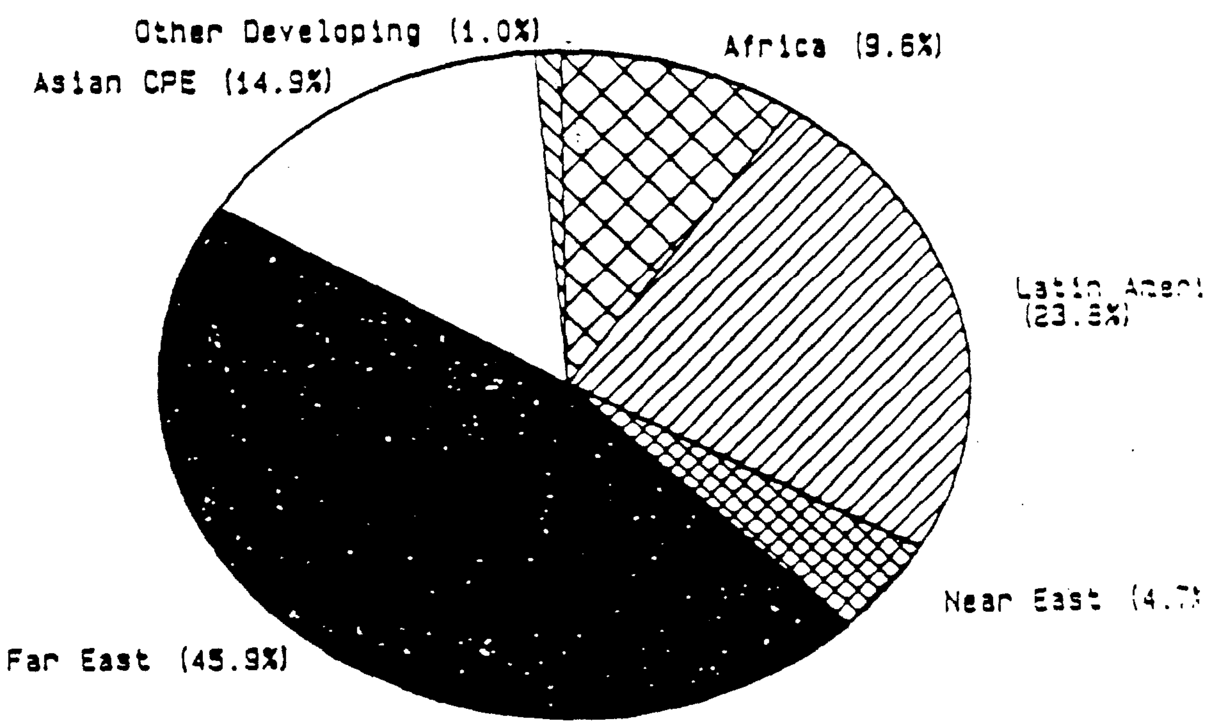
Production of Fats & Oils in 1972

(In Developing Countries: 40% World Total)



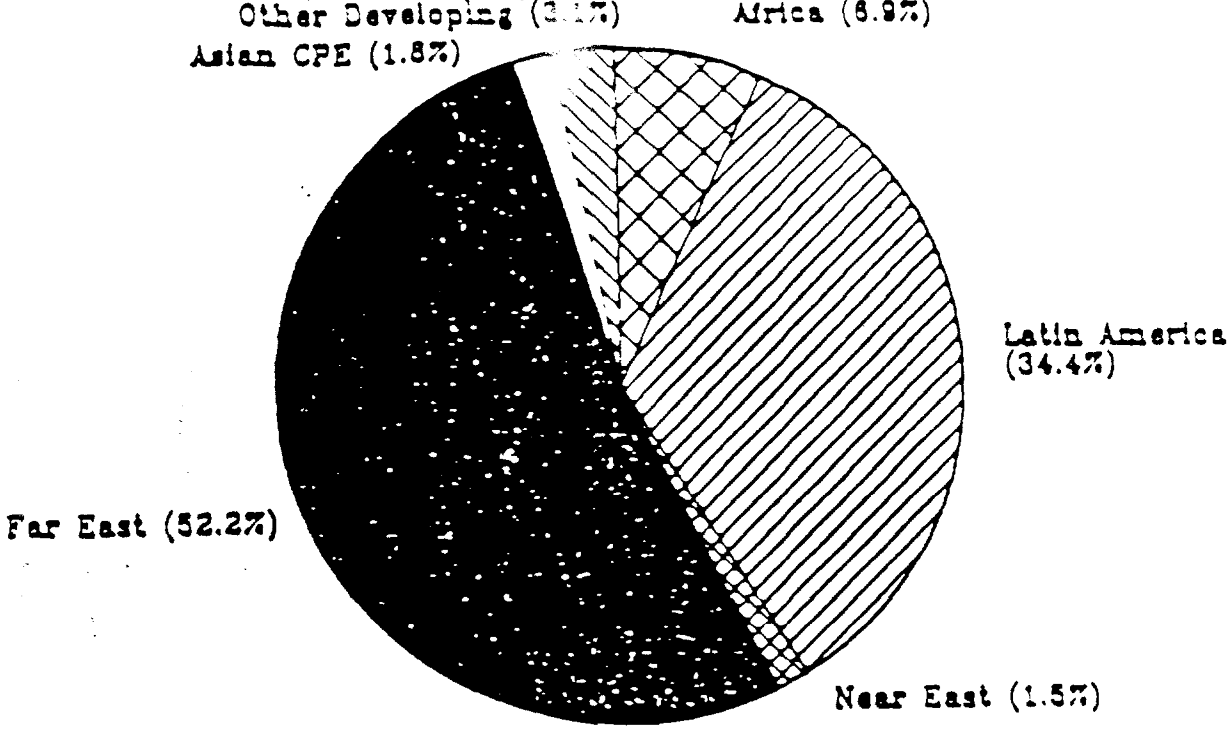
Production of Fats and Oils in 1990

(In Developing Countries: 51% World Total)



Exports of Fats & Oils in 1980

(In Developing Countries: 39% World Total)



Exports of Fats & Oils in 1990

(In Developing Countries: 51% World Total)

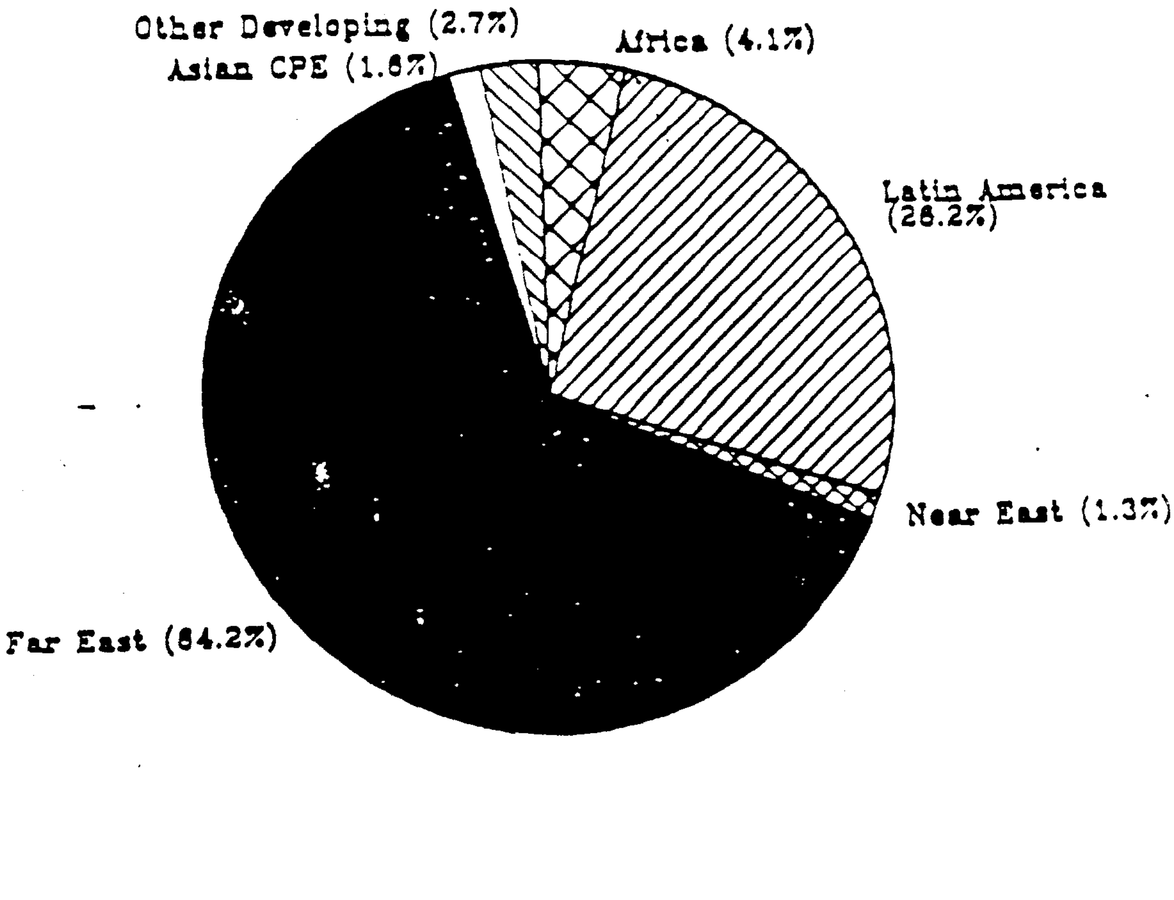
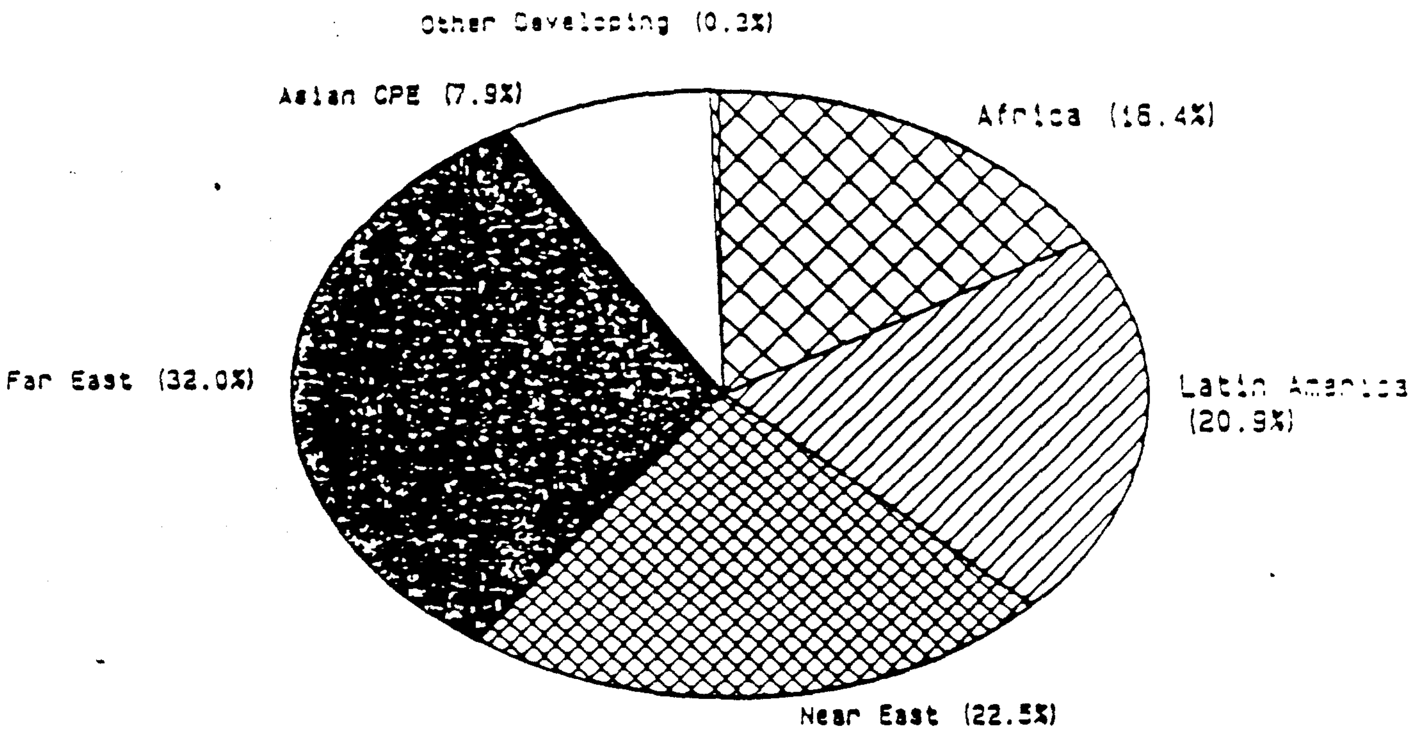


Figure 8

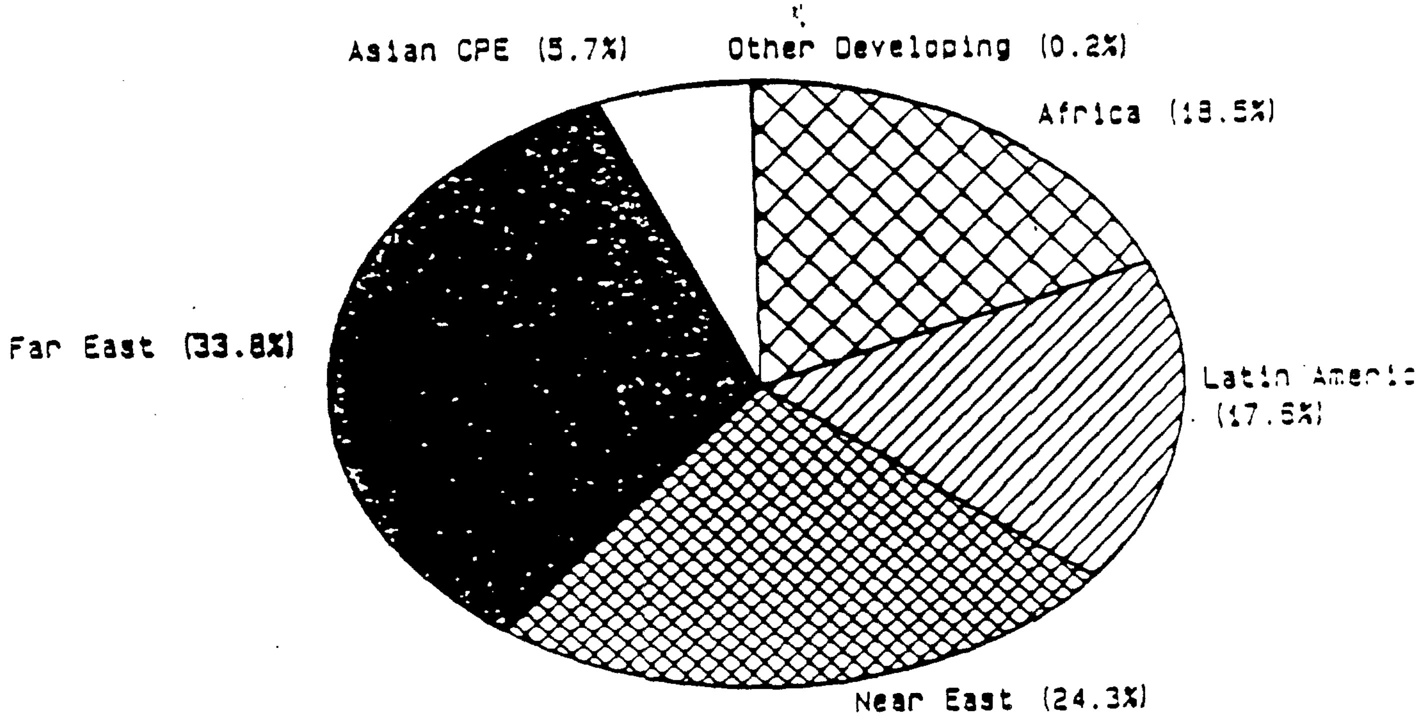
Imports of Fats & Oils in 1980

(In Developing Countries: 41% World Total)



Imports of Fats & Oils in 1990

(In Developing Countries: 49% World Total)



4. CURRENT STATUS OF COCONUT

4.1 Origin and Importance of the Coconut Palm

Coconut, Cocos nucifera, is the most important palm of the wet tropics. It has a pantropical distribution, occurring in coastal areas between 20°N and 20°S of the equator, in some 82 countries.

Coconut has a long history, in both the eastern and western hemispheres, and its widespread and apparent ancient occurrence in both hemispheres has led to uncertainty as to its centre of origin. It is believed that although the wild ancestor of coconut may have been from South America, the wild type was dispersed widely before coconuts were domesticated in the Western Pacific (Harries, 1978).

It is likely that coconut became so widely spread by the nuts floating in ocean currents and germinating after they were washed ashore in new locations; and also by being carried by man as a source of food and drink on long sea voyages (Harries, 1978). Coconut has been present in the Pacific Islands for thousands of years, even before their settlement by the Polynesians. Coconut also has a recorded history of 2000-3000 years in coastal areas of Sri Lanka and southern India.

In subsistence and semi-subsistence farming systems, coconut provides a reliable insurance as a supply of food even when other crops fail, and a source of cash. Coconuts are an important component of the daily diet, and significant contributor to human nutrition, providing a source of energy and vitamins. Although they contain a high proportion of saturated fatty acids, these are short chain, fatty acids which are quickly burned off as a source of energy, and which do not lead to cholestes/deposits (Harvard Medical School, 1989).

Coconut is an integral part of the functioning of local communities. It is often referred to as the "Tree of Life", since almost every part is used to make some item of value to the village community (Figure 9). The importance of coconut is thus closely associated with its suitability in providing a supply of food, drink and shelter at the village level, as well as copra, coconut oil and other products for local cash sale and export.

About seventy percent of the coconut crop is consumed in the producing countries, while thirty percent is traded internationally. Coconut is consumed daily in producing areas. The white coconut meat (and the coconut milk extracted from it) provide the basis for many dishes. Coconut oil is used for cooking, lights and lubrication, and for the manufacture of margarine, bakery products, fats, soaps, detergents and toiletries. Coconut meal (the residue left after the oil is removed from the copra) is used for animal feed. The timber can be used for load-bearing structures in buildings and for the manufacture of furniture. The leaves are plaited for roofing material. The husk is used to make fibres for ropes and matting. The shell is heated to make charcoal as a local fuel source. Various antifacts are made from the leaves and the shells. There are more than 100 products made directly or indirectly from coconut. These vary from simple cooking utensils used in the village, to high value-added products such as coco-chemicals and activated charcoal. The most important products in world trade are copra, coconut oil, copra meal, desiccated coconut, coir fiber, and shell charcoal. The coco-chemicals which are becoming increasingly important and valuable are methylester, fatty alcohol, and glycerine.

4.2 Coconut Production

Coconut is grown on approximately 11.6 million hectares spread over 82 countries. The area under coconut has been increasing at approximately 2 percent per annum for the past several decades.

The major producing areas are in Asia and the Pacific where about 85% of the crop is grown. There are 13 producing countries in Asia, and 18 in the South Pacific. The major producers are Indonesia, the Philippines, India, and Sri Lanka. Coconut is also locally important in Latin America and the Caribbean where there are 29 producing countries. In Africa, it is important as a food and oil crop in the coastal areas of 22 countries in West and East Africa.

Many of the producing countries are small island countries. Coconut is both their primary subsistence crop, and their only significant source of export earnings. There are few, if any, alternative crops to serve the needs of these small countries. There are more than 10 million farm families (approximately 50 million people) directly involved in its cultivation. A further 30 million people in Asia alone are dependent directly on coconut and its processing for their livelihood.

Since coconut is a smallholder crop, reliable statistical data is difficult to obtain. The best available source of quantitative data is the Coconut Statistical Yearbook, published annually by the Asian and Pacific Coconut Community (APCC), in Jakarta. The APCC statistics are derived from information supplied directly by APCC member countries, supplemented with information from FAO production yearbooks and other sources.

The APCC member countries are India, Indonesia, Malaysia, Philippines, Sri Lanka, Thailand, Papua New Guinea, Solomon Islands, Vanuatu, Western Samoa, Federated States of Micronesia, and Palau. The community members have approximately 9.3 million hectares of coconut, and account for approximately 80% of the total coconut area in the world.

The detailed production data for the APCC member countries in 1986 are given in Table 5. The figures show that coconut is predominantly a smallholder crop produced for local consumption. Almost all production (96%) comes from smallholdings of 0.5 to 4 ha. The average size of holdings in some areas, such as southern India is only 0.2 ha (World Bank, 1990). Approximately 70% of total production in Asia is consumed in the producing countries. The major exporter is the Philippines. In the Pacific Islands, with their small populations, about 30% is consumed locally and 70% exported.

Estimates by the APCC indicate that more than 10 million farm families are directly engaged in coconut cultivation (Table 5). If an average family size is taken as five, this infers that approximately 50 million people are directly involved in the growing of the crop.

The social significance of coconut is such that all family members are involved in its cultivation, harvesting, and local processing. Women, in particular, play an important role in copra making in the villages, and children often gather the nuts for copra-making. It is also important in povery alleviation as it is a source of ready cash income for families.

There are, in addition, large numbers of people concerned with the further processing of copra into coconut oil and other products in producing countries. Figures for the proportion of the labour force involved in coconut-based processing activities are difficult to obtain. However, in the Philippines, it has been estimated that 18 million people (one-third of the population) are directlv dependent on coconut for their livelihood (APCC, 1986). In Sri Lanka the coconut industry is also a major employer. Coconut is second only to rice in importance as an agricultural crop.

The FAO production statistics for 82 producing countries are given in Table 6. Outside Asia, coconut is a locally important crop in coastal areas, and in island communities. In Oceania, there are 18 countries for which coconut is both the dominant crop in traditional subsistence ecosystems and the most important export crop. For most, it is their only significant earner of foreign exchange.

A simílar situation exists in Latin America, especially in the island countries of the Caribbean. There are 29 producing countries in Central and South America and the Caribbean. The main producers are Mexico, Jamaica and Brazil.

Coconut is also important as a food crop and source of vegetable oil in coastal areas of West and East Africa. There are 22 producing countries in Africa, of which the largest are Mozambique and Tanzania.

Estimates by the World Bank (1990) also indicate that well over half the total crop is consumed in the producing countries. Furthermore, the World Bank predicts that although total coconut production is expected to increase (from 2.9 million tons of oil equivalent in 1985 to 3.7 million tons by 2000), exports are expected to increase only from 1.26 million tons in 1985 to 1.35 million tons in 2000. Thus much of the expected production increase will be used to meet the growing demand for vegetable oils in developing countries.

However, these aggregate figures conceal the wider variations amongst coconut producing countries, which vary from ones such as Indonesia and India which are large producers with large populations, who usually consume almost all their crop domestically, through to the many small island countries who export most of their crop as their only significant earner of foreign exchange (Table 5).

The total world production of coconut (in copra equivalent) between 1977 and 1986 is illustrated in Figure 10. World production by country and by region over this period is given in Table 7.

The four major products traded internationally are copra, coconut oil, copra meal, and desiccated coconut. The prices of coconut products, particularly copra, coconut oil, and desiccated coconut have fluctuated over the past few decades, generally in line with other vegetable oils. The fluctuations in the monthly average prices of the major export products between 1977 and 1986 are shown in Figure 10. Over this period, the price of copra, for example, has fluctuated from around US$400 in 1977, to a high of US$710 in 1984 and a low of US$197 in 1986. These are comparable to the price fluctuations of other vegetable oils, as illustrated in Figure 11. The increase in soybean and palm oil production since the 1960s has had an overall depressing effect on international vegetable oil prices.

Coconut provides only a relatively small component of the world's total vegetable oil market. Twenty-five years ago, coconut oil contributed 9% of the world supply of vegetable oils, contrast to its present 6% of the market.

The primary importers of coconut products are Western European countries, USA, and Japan. Harries (1978) provides a brief history of the development of coconut as an export crop. Although coconut has been grown as a smallholder subsistence crop for thousands of years, it became important as an export crop only in the 1840's. The industrial process for making soap, required a cheap source of oil. Coconut oil, from copra (the dried endosperm of the nut), provided that source. The development of dynamite from nitroglycerine between 1846 and 1867 turned glycerine, a once discarded by-product of soap manufacture, into another profitable product. Coconut oil also replaced animal fat in the manufacture of margarine.

Recent market studies by independent consultants for the World Bank and the Philippine Government, have concluded that future demand for coconut products, both for industrial uses and as an edible oil, is good, provided the Philippines can sustain end-user confidence in the continued availability of its supplies. Although the Philippines is the dominant world producer of coconut-based products, its output could fall off over the coming 10-15 years because of declining yields from its aging tree stock, unless serious replanting efforts are undertaken. Coconut production is very much a smallholder operation in the Philippines and because most coconut farmers are impoverished, there has been little private investment in replanting during the last decade.

On the other hand, while the Philippines' ability to supply coconut oil is at some risk, world demand is quite favourable. Non edible uses of coconut oil (mainly for soaps and detergents) have accounted for more than 50% of consumption in the US and close to 50% in Europe. Processing costs of coconut oil are lower than those of its main competitor, palm kernel oil, and producers of industrial chemicals have been showing an increasing preference for raw materials from renewable natural resources rather than petroleum-based synthetics. Overall, there are few economically attractive substitutes to the lauric oils for most industrial purposes. With regard to edible uses, the general demand for vegetable oils is expected to grow by about 3% p.a. over the medium-term, and coconut oil, which is a preferred cooking oil in many parts of the world, would certainly share in that growth.

Coconut oil's share of both the non-edible and edible vegetable oil markets is easily sustainable, with some room for modest expansion, unless end-users become convinced that they cannot rely on a stable supply from the Philippines. In that event, they would be prompted to make long-term investment decisions in favour of substitute products, especially for industrial purposes, and that would be a major setback for the Philippines itself and for other coconut producers. Deterioration of this industry would have important macroeconomic consequences for the Philippines (particularly as regards loss of foreign exchange earnings) and would seriously undermine the Government's rural poverty alleviation efforts (Meadows pers. comm.).

4.3 The Role of the Coconut in the Environment

Coconut is a crop of the lowland humid tropics. It grows best at low altitudes near the coast. It is most common and grows well on sandy coastlines, under conditions of high humidity, a temperature range of 27-32°C, and a loose, free draining, well aerated soil. Approximately 90% of production comes in the band between 20 N and 20 S latitude.

Coconut will grow in a wide range of environments. However, its yield is affected by climatic factors, particularly temperature and rainfall. For optimum production, coconut requires an average temperature of 27°C, with a diurnal fluctuation not exceeding 7°C, and an annual rainfall of approximately 1800mm, evenly distributed throughout the year.

Coconut will also grow in less ideal environments. Indeed it will grow in situations such as coral atolls, which few other usable plants will tolerate. It is moderately tolerant to drought, due to its extensive root system. It can also tolerate saline soils, sea spray, and alkaline conditions. Its tolerance to high winds is important in areas prone to typhoons, such as the Philippines and the Pacific Islands.

Over the years, coconuts have been planted in all possible areas of the tropics. They are found on the sea coast and at distances hundreds of kilometres inland and at altitudes up to thousands of metres above sea level. Inevitably some sites are better than others and many sites are unsuitable. Sea coasts are usually good sites whereas hill slopes or wet-land bogs are sensitive environments where coconuts should not be grown. Coconut palms can be found in those areas because that is where people have had to live and to farm or subsist. Coconuts are found to a lesser extent in agriculturally rich environments because other crops make better use of the land. Unlike many other crops, coconuts can grow well in areas of high rainfall, where the soil drainage is good, or equally well in areas of low rainfall, where there is a good supply of ground water. They tolerate a greater degree of soil salinity than other plants and they provide food and drink, fuel and shelter, and the possibility of a cash income.

It is not surprising, therefore, that before they were displaced by oil palm as the major tropical plantation tree crop, coconuts should have been planted extensively by large and by small farmers. The widespread planting also meant that the coconuts could naturally spread to areas where they survive unaided. And it is just these areas, on the isolated sea coasts and islands, that are now considered as environmentally sensitive. The simple answer, for those anxious about the environment, is that the coconut is the best possible choice of a plant to prevent the degradation of the sea-shore and improve the resilience of these sensitive environments. If global warming does cause the sea level to rise and coral atolls to submerge, the coconut is one plant that will survive. If the coral grows as quickly as the water warms and new atolls emerge, then coconuts will be the first to colonize them (Harries pers. comm.).

Coconut fits an ecological niche not able to be filled by other crops. The coconut palm grows on coastal sands that do not suit oil palm, and under rainfall that is too wet for soybean. Much, or all, of the energy needed for processing could come from the production of shell charcoal, a valuable product itself. Economic production can be enhanced by intercropping, under-planting, or grazing. Old trees need to be replaced by locally adapted, high yielding hybrids, tolerant to local pests and diseases.

Despite the long history of coconut cultivation, standards of cultivation are generally low. Coconut is able to continue to produce some nuts even under conditions of poor management. It is often referred to as a 'poor man's crop', and a low input/low output system has come to be recognized as standard in many countries. Yet, it also responds to good management, and improved nutrition.

Coconut is often grown in association with many other crops or with livestock. However, the productivity of these systems is often limited by inadequate inputs. There are traditional coconut-based cropping systems in the Pacific Islands and parts of Asia (such as Indonesia) which have proved to be sustainable systems in fragile environments for thousands of years. The question of multiple-cropping and intercropping strategies with coconuts is one which requires further investigation, as it is a key factor in improving the productivity of the coconut lands, while ensuring the sustainability of these systems.

Coconut has two naturally occurring types, the Talls and the Dwarfs. In addition, coconut hybrids, mainly resulting from Tall x Dwarf crosses, have been bred in many countries. Tall x Tall hybrids are also possible, and have certain desirable characteristics, such as large nuts.

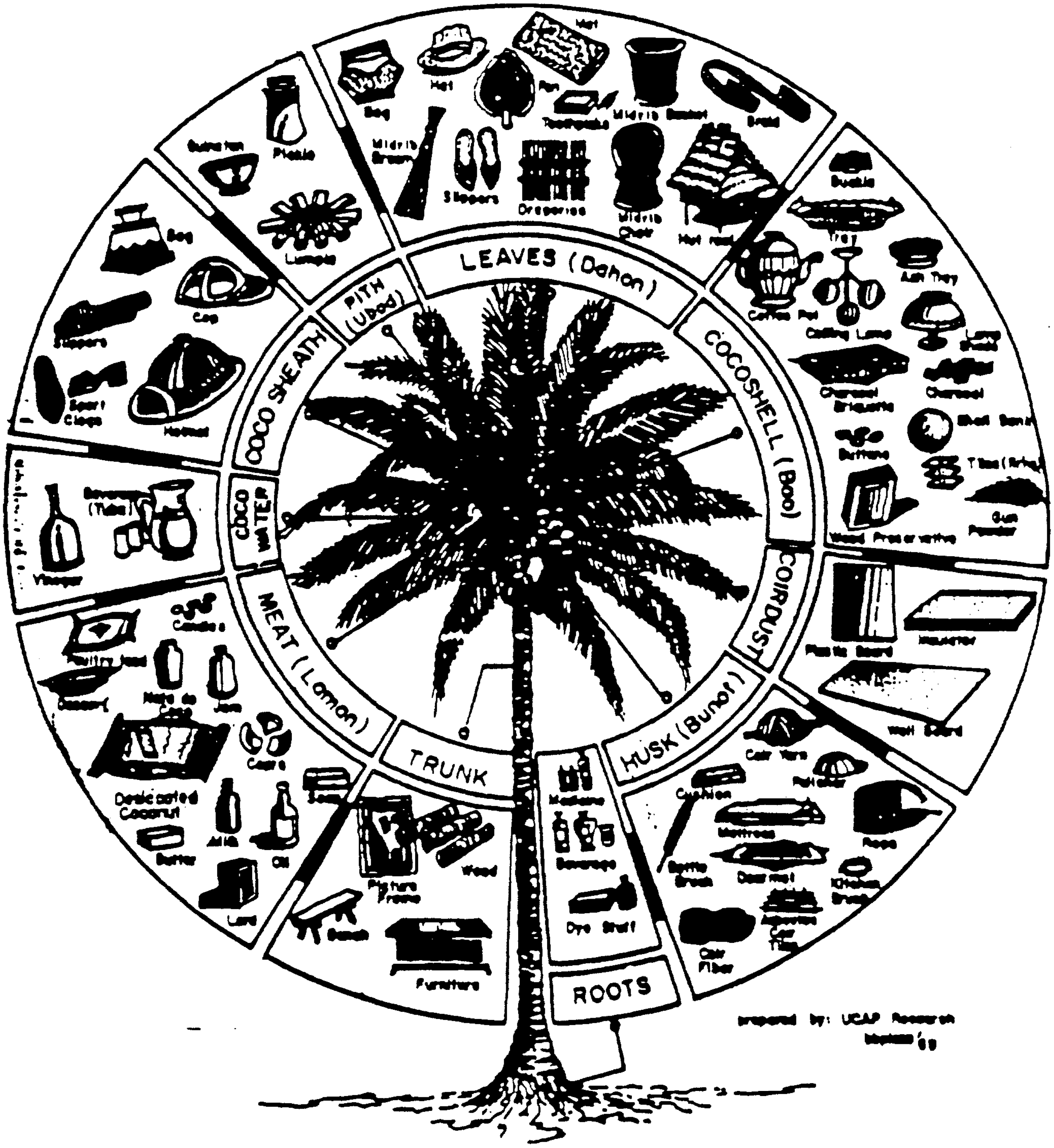
The common tall variety is a hardy type, which lives for at least 90 years. The economic life is generally considered to be about 60 years. Most of the world's coconut population is made up of the tall varieties. The tall type has a single, unbranched trunk, growing to about 30 meters in height. The crown has 25-40 fronds, with a fully opened frond being about 6 meters in length. The tall type begins bearing after about 6 years, with full bearing after 10 to 12 years. Under favorable conditions, it will produce 60-70 nuts per year, and the nuts mature within 12 months of pollination. The mature nuts consist of approximately 35% husk, 12% shell, 28% meat, and 15% water.

The dwarf variety is characterized by its short stature and early bearing. It starts bearing within 3 to 4 years, and reaches full production within 6 years.

Hybrid varieties combine the characteristics of both types, with their chief economic advantages being their early bearing and high yields at maturity. Under favourable conditions, hybrids will produce up to 160 nuts per year. They begin bearing within 3 to 4 years, and reach full production within 10 years.

Figure 9

THE TREE OF LIFE

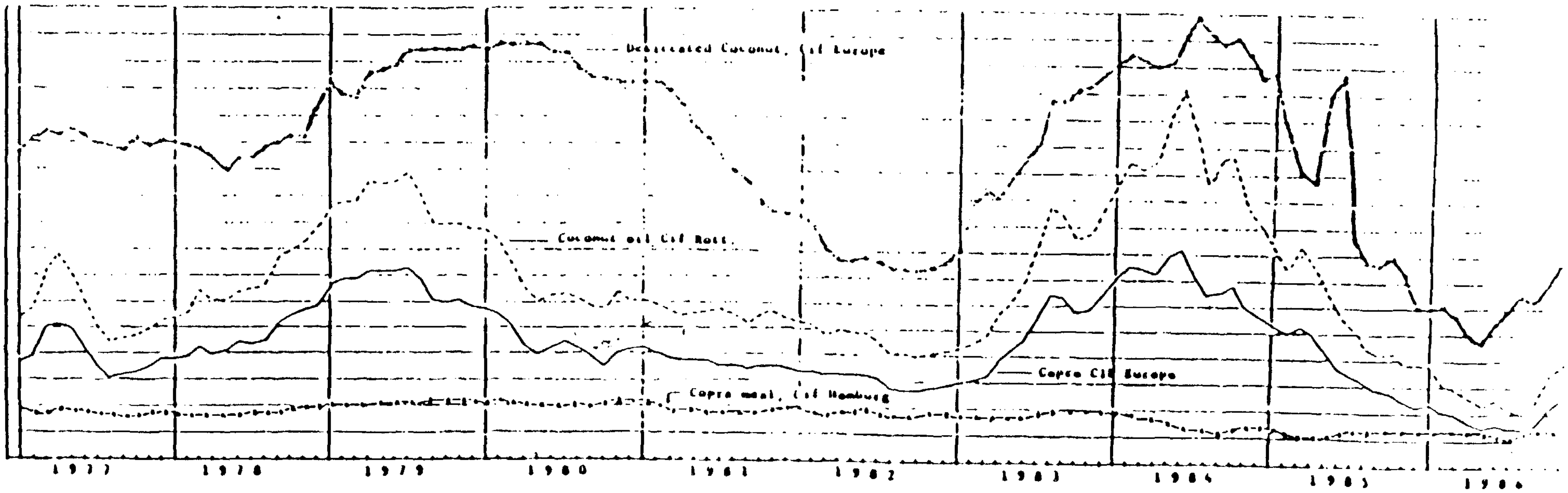


DIAGRAMATICAL CHART OF A COCONUT TREE

SHOWING THE DIFFERENT END-PRODUCTS

Figure: 10

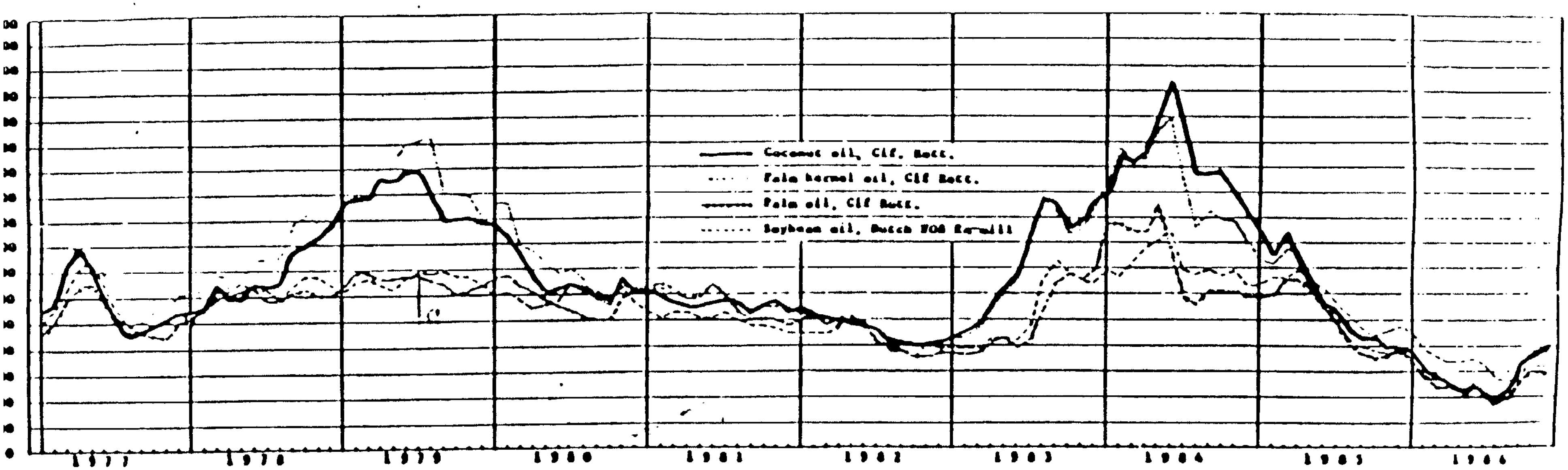
INTERNATIONAL: Monthly Average Prices of Coconut Products, 1977-1986
(US$ per Metric Tons)



Source: APCC (1986)

Figure: 11.

INTERNATIONAL: Comparative Price of Coconut Oil and Other Vegetable Oils
(US$ per Metric Tons)



Source: APCC (1986)

Table 5 Coconut Production Data for Asian Pacific Coconut Community, 1986
Area, Producers, domestic Production, Consumption

Area (1000 ha)	Avg size Holding (ha)	No. Farm Families (1000)	Estimated % Produc. from Small-holdings	Total Coconut Production: Nut equiv. million nuts	Total Coconut Production: Copra equiv 1000 metric tons	Estimated Domestic Consumption: Nut equiv million nuts	Estimated Domestic Consumption: Copra equiv 1000 m. tons	% Crop consumed domestically	Copra 1000 mt	Coconut Oil 1000 mt	Copra Meal 1000 mt	Desic Coconut 1000 mt	Shell 1000 mt	Fibre 1000 mt	Other 1000 mt	Total Export Earnings US$ Millions	% Central Export Earnings
1,209	2	5,000	98	6,620	988	6,743	1,006	100	-	-	-	-	-	24		26	[illegible]
3,182	4	3,000	97	10,491	2,098	10,397	2,079	99	-	-	380	303	1	-	.	37	
315	3 5	90	99	1,054	200	793	150	75	41	49	-	7	-	-	.	26	
3,262	3 8	1,000	98	11,675	2,631	2,106	402	15	136	1,238	818	68	27	n/a	129	558	11
419	0 5	[illegible]	99	3,040	617	1,916	391	63	10	85	40	60	35	85	-	101	8 [illegible]
415	n/a		99	707	200	541	153	76	-	-	6	-	-	5	415	3	0 [illegible]
8,802	Range 1 5 - [illegible]	9,805+	98*	33,587	6,734	22,506	4,781	70*	187	1,372	1,244	438	63	114	544	751	
A 241	1 5	104	60	1,248	208	300	50	24	93	41	20	-	-	-	-	23	2 2
63	4*	60*	80	209	46	81	18	38	32	-	-	-	-	-	-	3	5 2
93	4*	50*	70	429	59	131	18	38	40	-	-	-	-	-	-	4	50
48	n/a	n/a	90	159	35	46	10	28	3	14	6	-	-	-	-	4	35
16	1 5	n/a	99	50	10	49	9	99	1	-	-	-	-	-	-	n/a	n/a
461	Range 1 5 - 4 0 ha	214+	62*	2,095	358	607	105	30*	169	55	26	-	-	-	-	34	
9,623	Range 0 5 - 4 ha	10,019+	96	35,682	7,092	23,113	4,886	69*	356	1,427	1,270	438	63	114	544	785	

Table 6 FAO Coconut Production Statistics for 32 Countries, 1986.

	COCONUTS / NOIX DE COCO / COCOS — PRODUCTION 1000 MT				COPRA / COPRAH / COPRA — PRODUCTION 1000 MT				TUNG OIL / HUILE D ABRASIN / ACEITE DE TUNG — PRODUCCION 1000 MT			
	1979-81	1984	1985	1986	1979-81	1984	1985	1986	1979-81	1984	1985	1986
WORLD	34945	33315	37359	39463	4502	3964	4888	5352	79	80	84	87
AFRICA	1545	1592	1592	1637	177	195	196	202	1	1	1	1
BENIN	20	20F	20F	20F	3	3F	3F	3F				
CAMEROON	3	3F	4F	4F	1	1F	1F	1F				
CAPE VERDE	10	10F	10F	10F								
COMOROS	53	46F	47F	47F	3	3F	3F	3F				
COTE DIVOIRE	156	290F	300F	323F	22	42F	42F	47F				
EQ GUINEA	7	3F	8F	9F								
GHANA	160	120F	108	108F	7	7F	7F	7F				
GUINEA	15	15F	15F	15F								
GUIN BISSAU	25	25F	25F	25F	5	5F	5F	5F				
KENYA	55	70F	70F	71F	6	10F	10F	10F				
LIBERIA	7	7F	7F	7F								
MADAGASCAR	67	78	79F	80F	10	9F	9F	9F				
MALAWI									1	1F	1F	1F
MAURITIUS	5	5F	5F	5F								
MOZAMBIQUE	453	400F	400F	410F	72	65F	65F	67F				
NIGERIA	90	101	102	100F	10	12F	12F	12F				
SAO TOME PRN	38	35F	35F	35F	4	4F	4F	4F				
SENEGAL	4	5F	5F	5F								
SEYCHELLES	22	17F	16F	17F	4	3F	3F	3F				
SIERRA LEONE	3	3F	3F	3F								
SOMALIA	1	1F	1F	1F								
TANZANIA	310	320F	320F	330F	29	29F	29F	29F				
TOGO	14	14F	14F	14F	2	2F	2F	3F				
N C AMERICA	1415	1588	1246	1272	187	213	183	187				
BARBADOS	2	2F	2F	2F								
BELIZE	3	3F	3F	3F								
COSTA RICA	25	27F	27F	27F	2	2F	2F	2F				
CUBA	17	19	20F	20F								
DOMINICA	10	13F	13F	13F	1	2F	2F	2F				
DOMINICAN RP	72	95F	95*	95F	6	14*	14*	15*				
EL SALVADOR	55	79	81	18*	3	3*	3*	3*				
GRENADA	7	8	8	9F		1		1F				
GUADELOUPE	3	3	3	3F								
GUATEMALA	2	2F	2F	2F								
HAITI	34	36F	36F	37F								
HONDURAS	16	14F	14F	14F	2	2F	2F	2F				
JAMAICA	176	120F	120F	120F	7	7F	8F	8F				
MARTINIQUE	1	2	3	3F								
MEXICO	851	1008	700F	700F	148	188	120	120*				
NICARAGUA	1	2F	3F	3F								
PANAMA	23	21	21	21F	1							
PUERTO RICO	9	8	7	7F	2	2F	1F	1F				
ST KITTS NEV	2	2F	2F	2F								
SAINT LUCIA	34	31F	28F	31F	8	5F	4F	5F				
ST VINCENT	22	21F	20F	22F	2	2*	2*	2*				
TRINIDAD TOB	48	52F	42F	52F	5	6	4F	7*				
SOUTH AMERIC	602	628	642	670	38	33	32	38	25	20	24	24
ARGENTINA									13	10	10F	10F
BRAZIL	254	257	282	288	2	3F	3F	3F	1	1F	1F	1F
COLOMBIA	64	98	98	97								
ECUADOR	73	56	38	56F	13	9F	8F	9F				
GUYANA	30	40	40	41	3		2	3				
PARAGUAY									11	9	13F	13F
PERU	15	14F	15F	15F								
SURINAME	8	7	7	7F	1	1F	1F	1F				
VENEZUELA	160	162	164*	168F	19	19*	20*	20F				
ASIA	[illegible]	27098	31288	33480	3768	3184	4113	4811	53	58	58	51
BANGLADESH	75	83	83	85F	3	3F	3F	3F				
BURMA	96	142	145	152F								
CHINA	58	68F	70F	75F					53	58F	58F	51
INDIA	4192	5134	4819	4818	374	370*	380*	383F				
INDONESIA	11333	10700F	11600F	11650F	1048	1101	1280	1300*				
KAMPUCHEA DM	28	35F	38F	38F	5	9F	7F	9F				
MALAYSIA	1625	1718*	1721*	1741*	210	214	198	190				
MALDIVES	7	11	11	12F	1	2F	2F	2F				
PHILIPPINES	8811	8018	8800F	10800F	1807	1248	1877*	2308*				
SINGAPORE	10	7*	4*	4F	2	8F	9F	9F				
SRI LANKA	1692	1478	2248	2295F	128	83	218	230*				
THAILAND	781	1128	1228	1279F	38	43F	53F	35F				
VIET NAM	290	580F	600F	665F	58	108F	108F	115F				
OCEANIA	2384	2427	2813	2382	335	348	388	336				
AMER SAMOA	5	5F	5F	5F								
COCOS IS	4	5F	5F	5F	1	1F	1F	1F				
COOK ISLANDS	13	14F	12F	10F	1	2F	1F	1F				
FIJI	217	234F	215F	220F	22	25	21	22F				
FR POLYNESIA	132	65F	150	150F	17	7	13	14F				
GUAM	30	33F	34F	35F	1	2F	2F	2F				
KIRIBATI	72	90F	90F	30F	9	13F	12F	12F				
NAURU	2	2F	2F	2F								
NEWCALEDONIA	14	11F	10F	10F	1	1						
NIUE	3	3F	3F	3F								

	COCONUTS NOIX DE COCO COCOS PRODUCTION 1000 MT				COPRA COPRAH COPRA PRODUCTION 1000 MT				TUNG OIL HUILE D ABRASIN ACEITE DE TUNG PRODUCCION 1000 MT			
	1979-81	1984	1985	1986	1979-81	1984	1985	1986	1979-81	1984	1985	1986
PAPUA N GUIN	335	990*	1017*	820F	145	153*	178*	145*				
SAMOA	207	200F	200F	200F	21	23*	23*	24F				
SOLOMON IS	234	303	320F	253F	32	43	45	35F				
TOKELAU	2	2F	2F	2F								
TONGA	36	46F	51F	52F	12	5*	6F	5F				
TUVALU	5	5F	3F	3F		1*						
VANUATU	302	326F	300F	327F	43	48	40	47F				
WALLIS ETC	3	3F	3F	3F								
USSR										1F	F	1F
DEVPING M E	34568	32632	36681	38885	4438	3842	4754	5231	28	21	25	25
AFRICA	1545	1592	1592	1637	177	196	196	202	1	1	1	1
LAT AMERICA	2016	2198	1888	1942	225	248	198	204	25	20	24	24
FAR EAST	28622	26416	30567	32725	3702	3052	3988	4480				
OTH DVPING	2384	2427	2613	2382	335	348	368	335				
CENTR PLANND	377	683	708	768	63	112	115	121	53	58	58	52
ASIAN CPE	377	683	708	768	63	112	115	121	53	58	58	51
E EUR + USSR										1	1	1
DEVPED ALL										1	1	1
DEVPING ALL	34945	33315	37358	38453	4502	3954	4869	5352	78	79	83	38

Source: FAO Production Yearbook 1986. Vol. 40

Table: 7

LD: Production of Coconut in Copra Equivalent, 1977-1985
(In 1000 Metric Tons)

Countries	1977	1978	1979	1980	1981	1982	1983	1984	19[illegible]
PCC COUNTRIES	5,913	6,005	5,723	5,797	6,166	5,885	5,825	5,087	[illegible]
India	860	856	855	841	854	847	949	867	[illegible]
Indonesia	1,567	1,578	1,622	1,666	1,792	1,604	1,608	1,512	[illegible]
Malaysia	161	140	210	212	255	257	244	222	[illegible]
Papua New Guinea	203	220	230	218	200	200	205	208	[illegible]
Philippines	2,452	2,455	2,015	2,180	2,346*	2,172*	2,028*	1,441*	[illegible]
Solomon Islands	36	37	45	39	45	43	37	45	[illegible]
Sri Lanka	371	448	486	411	458	510	469	394	[illegible]
Thailand	150	155	141	130	112	148	179	184	[illegible]
Vanuatu	57	60	59	48	61	50	54	64	[illegible]
Western Samoa	36	36	40	30	23	34	28	24	[illegible]
F.S. Micronesia	5	7	12	9	6	6	10	12	[illegible]
Palau	15	13	8	13	14	14	14	14	[illegible]
THER ASIA	114	118	150	148	158	161	154	162	[illegible]
rma	23	23	24	24	25	25	23	24	[illegible]
Vietnam	44	50	82	78	88	89	86	91	[illegible]
Others	47	45	44	46	45	47	45	47	[illegible]
THER PACIFIC	173	166	140	151	154	144	125	124	[illegible]
Fiji	71	69	51	54	53	53	56	56	[illegible]
Tonga	25	23	19	25	31	13	10	11	[illegible]
Others	77	74	70	72	70	78	59	57	[illegible]
RICA	393	389	366	374	386	385	377	379	[illegible]
Ghana	75	75	40	40	40	40	33	29	[illegible]
Ivory Coast	31	38	38	39	40	40	62	69	[illegible]
Mozambique	110	100	100	105	108	100	98	96	[illegible]
Tanzania	75	73	75	78	80	80	76	76	[illegible]
Others	102	103	113	112	118	125	108	109	[illegible]
ERICA	544	558	465	513	507	509	470	454	[illegible]
Brazil	59	60	62	66	63	68	57	62	[illegible]
Jamaica	36	40	44	48	48	49	27	29	[illegible]
Mexico	272	280	175	203	213	209	195	167	[illegible]
Venezuela	40	40	39	38	40	40	38	39	[illegible]
Others	137	138	145	158	143	143	153	157	[illegible]
Total	7,137	7,236	6,844	6,983	7,371	7,084	6,951	6,206	[illegible]

- Data refers to total production of coconut, whether consumed fresh, processed into copra or desiccated coconut.
- Estimates for non-APCC Countries up to 1985 are calculated by converting the nut weight into whole nuts given in the FAO Production Year Books, by using a common conversion factor of one ton of husked nuts = 1250 whole nuts. Data for 1986 are APCC estimates.

* = estimate

Source: Compiled from information provided by APCC member-

5. FUTURE NEEDS

5.1 Opportunities and Constraints

The opportunities are:

1) The increasing demand for oils and fats and animal feed sources, particularly in developing countries as incomes rise.

2) The ability of the coconut tree to produce a wide variety of food and non-food products, additional to the traditional products of copra, coconut oil and copra meal.

The key problems are:

1) The low productivity of many coconut trees due to their age and poor nutrition. The world average yield of 500 kg/ha/year of copra equivalent has changed little in 25 years.

2) The failure of many replanting programs designed to replace old trees with higher yielding hybrids or locally adapted types. These failures have been due largely to a lack of incentive for smallholders to replant when prices are low.

3) Fluctuating productivity due to variable environmental conditions.

4) Inefficient handling and processing, with a low farm gate price to smallholders.

The needs are:

1) To increase the productivity of coconut by the use of higher yielding, pest and disease tolerant varieties in any replanting or new planting schemes.

2) To increase the productivity of existing plantings by encouraging better agronomic practices, including control of diseases, insects and weeds, use of fertilizers, and profitable inter-cropping systems.

3) To develop improved methods of handling and processing coconuts.

4) To diversify the coconut products traded and actively promote new products in the marketplace, so as to utilize fully the potential of the crop.

5.2 Potential Returns from Research

Over the past 25 years, coconut production has increased by about 1.5% per year, largely as a result of new plantings. The world average yield of 500 kg per ha per year copra equivalent (300 kg/ha oil equivalent) has shown no improvement over the same period (World Bank 1988).

In contrast, oilpalm production has been increasing by around 10% per year, and soybean production by 5% per year (World Bank, 1988). These increases are the result not only of increased areas but also of higher yields from oil palm clones.

In 1986, coconut provided 6% of the total world vegetable oil market, and in 1987 provided 5%. The World Bank estimates that by the year 2000 it will provide only 4% of the market (World Bank, 1988). Thus coconut is steadily losing ground to other vegetable oils. Given the importance of coconut to many developing countries, the large number of poor people involved in its cultivation and processing, and the lack of alternative crops able to fill the same ecological and social niche, it is important that efforts be made to make coconut a more competitive and a more economically attractive crop.

The comparison between the performance of coconut and oilpalm in recent years merits consideration. A concentrated research effort on oilpalm by both the public and private sector over the past 40 years has resulted in higher yielding clones which are able to be multiplied rapidly by micropropagation, and for which efficient production and processing technology is available. Oilpalm is thus competitive with annual oilseed crops grown in temperate zones in the world vegetable oil market, and is well positioned to take advantage of the increasing world demand for fats and oils.

The application of new technologies to oil palm cultivation has been facilitated by the strong participation of private sector plantation interests. Since coconut is predominantly a smallholder crop, the application of research results will require the commitment of producing countries to provide the necessary extension services and appropriate policies to encourage smallholders to adopt new technologies. The new technologies also need to be designed to meet the needs of smallholders.

Coconut research over the past few decades has shown that substantial increases in yield are possible. The best hybrids yield at least 5 tons of copra per ha per year, under favourable environmental conditions and good management.

The World Bank (1990) in assessing the state of the art in coconut research identifies seven areas where further research may be expected to yield high rates of return:

1. Micropropagation, for rapid propagation of high-yielding varieties. Conventional methods of coconut propagation are slow and expensive, and only a limited amount of improved material is available.

2. Breeding, to develop new varieties able to produce well in difficult environments and under conditions of low inputs. This will require expanding the germplasm base of existing breeding collections. Molecular biology may also contribute to improved breeding techniques.

3. Nutrition, to determine the nutritional requirements of new varieties, and economic practices for smallholders.

4. Multi-cropping, to establish profitable and sustainable coconut-based farming systems.

5. Pest and disease control, to solve problems which limit or preclude coconut cultivation in various parts of the world. Coconut is susceptable to a number of lethal diseases, some of unknown etiology, which cause the death of millions of palms each year.

6. Harvesting and processing, to develop more economic methods. Traditional methods are labour intensive, unpopular and increasingly expensive. Higher yields will require more small-scale mechanization, to reduce the costs of production.

7. By-product utilization, to enable the maximum profit to be derived by the full use of the crop, and increase returns to the farmer.

5.3 Beneficiaries of Coconut Research

Coconut was one of twelve commodities analyzed by Davis, Oram and Ryan (1987), in a model for the assessment of agricultural research priorities. On the grounds of efficiency, investments in coconut research are likely to offer a high rate of return. On distributive or equity grounds, virtually all of the benefits of coconut research accrue to developing country producers and consumers. Furthermore, over half of the benefits accure directly to producers in developing countries (who are almost all smallholders). The remaining benefits accrue to consumers in developing countries. Thus, the major beneficiaries of coconut research would be the millions of small farmers cultivating coconuts.

Another consideration is that of income security for smallholders. The present price fluctuations are partially a result of erratic supply. Research should aim to develop technologies to stabilize production (including varieties able to yield under poor environmental conditions, such as drought) and thus contribute to regular income levels for coconut producers, and the reduction of poverty.

6. CURRENT RESEARCH

6.1 General

Coconut is a scientifically neglected crop, relative to other crops of similar importance. This neglect persists despite the fact that there is a history of coconut research going back to the early 1900's. Davis et al. (1987) identified 193 scientists working on coconut, of whom 103 were in Asia, 48 in Africa, 32 in Latin America and 10 in Oceania (Table 8).

There are several national research programs in each of the coconut-growing regions of the world. The current programs are listed in Table 9. In Asia, there are programs in the Philippines (Philippines Coconut Authority and several universities), Indonesia, India, Sri Lanka, Malaysia, Thailand, China and Vietnam. In Oceania, there are several small but active programs, including those in Papua New Guinea (Cocoa and Coconut Research Institute), Solomon Islands, Vanuatu, Fiji and Western Samoa.

In Latin America, the main research programs are in Brazil, Jamaica, Trinidad, and Mexico. Currently, there is no breeding program in Latin America, despite the existence of some lethal disases which are limiting production. There is a germplasm collection in Jamaica, established when a major international effort was made on lethal yellowing disease.

In Africa, the major program is in Cote d'Ivoire, at the Marc Delorme Coconut Research Centre established in 1951. This station is managed by IRHO on behalf of the Government of the Cote d'Ivoire. There is also an active program in Tanzania, and several smaller programs elsewhere in Africa.

The only coconut research program which operates in several countries is that of the Institut de Recherches pur les Huiles et Oleagineux (IRHO). IRHO manages the world's major coconut breeding station in the Cote d'Ivoire, and a smaller station in Vanuatu, as well as laboratories in France. IRHO also has staff stationed with national programs in several countries, including the Philippines, Indonesia, Brazil, and Fiji. IRHO's research activities have been concerned primarily with addressing the needs of planting programs, particularly by the production and evaluation of new hybrids, and establishing their nutritional requirements. IRHO's best available hybrid has a yield potential of 6 tons copra/ha (compared to the current world average of 0.5 t/ha).

The International Board for Plant Genetic Resources (IBPGR) has supported several germplasm collections for coconut. It has also commissioned research on coconut embryo culture by IRHO.

FAO and UNDP have supported several coconut research and development projects which have included a component of research support for the national program. Bilateral donors support a range of individual projects.

Table 8. Numbers of coconut research scientists by region.

Geoclimatic regions	Coconut scientists
Africa Sub-Saharan	
- Semi-arid tropics	10
- Sub-humid tropics	0
- Equatorial wet tropics	4
- Humid coastal tropics	10
- Tropics modified by altitude or latitude	24
Total (Africa)	48
Latin America	
- Subtropical South America	4
- Tropics modified by altitude or latitude	21
- Humid tropics, Central America	0
- Humid tropics, Caribbean	7
Total (Latin America)	32
Asia	
- Subtropics/tropics, South Asia	15
- Subtropics, East Asia	0
- Humid tropics, South/S.E. Asia	88
Total (Asia)	103
Oceania	
- Humid tropics (Total Oceania)	10
West Asia/North Africa	0
GRAND TOTAL	193

Source: Davis, Oram and Ryan, 1987.

There is laboratory-based research on coconuts in several industrialized countries in both the private and the public sector. The major efforts have been in Europe on tissue culture (U.K. and France), and post-harvest technology (U.K.). The European activities have been described in a study commissioned by the EC (IRHO 1986). The EC has recently established a small Secretariat in Paris (BUROTROP) to coordinate and support European research on coconuts and oil palm, and to improve the linkages between such research and bilaterally-funded development projects in producing countries. This European initiative on oil crops research is complementary to any CGIAR initiative on coconut research, and should facilitate participation by scientists and research institutes in Europe in collaborative international research on coconuts. The priority for BUROTROP in its first year is oil palm in Africa. Further details of BUROTROP are given in Annex A.

The Australian Centre for International Agricultural Research (ACIAR) is sponsoring collaborative research between Australian scientists and coconut researchers in Oceania, and the Philippines, on coconut improvement particularly germplasm collection and exchange, tissue culture and virus/viroid diseases (cadang-cadang and foliar decay disease).

The dearth of strong national coconut research programs is a serious situation for the crop, given that it is the stated policy of many governments to increase coconut production, by rehabilitating and/or replanting existing areas and planting new land, where available. The implementation of these policies will require substantial, long-term, financial investments.

Many small and large-scale planting programs have been initiated (often with external financial assistance by grants from bilateral development agencies or development bank loans). These replanting programs require an adequate research base, so that appropriate technical decisions are made as to what is the best available planting material, and what are the accompanying management practices to allow the material to achieve its yield potential. Pest and disease control and nutritional requirements are important components of this package. An understanding of the socio-economic factors which influence farmers to replant or not is also important (and often neglected in many schemes).

The major problems with the current research efforts are that, with few exceptions, the national coconut research programs are seriously understaffed and underfunded. Even in the major producing countries in Asia, the national programs are not supported in a manner commensurate with the economic importance of the crop to the country.

The key problems with the current research effort are that most of the national programs are not well supported financially, neither by government nor by the industry; especially, they lack continuity of funding from national and external sources; they lack sufficient appropriately trained staff and suitable facilities; they are not addressing adequately the major problems facing the crop; they are not producing sufficient substantive results directly relevant to smallholders; nowhere are the needs of the crop worldwide being addressed; and there are presently no means by which small producing countries, who are unable to mount their own research effort, are able to gain access to new technologies, including higher yielding varieties.

There are, however, several national programs which could contribute substantially to any international initiative on coconut research, if suitably supported. For example, the Philippines Coconut Authority manages an active research program with three research stations concerned with agronomy, breeding and diseases. Their current effort is hampered by lack of funds.

The Marc Delorme Research Centre managed by IRHO in Cote d'Ivoire has a substantial germplasm collection and a number of promising hybrids, the result of some thirty years of research. Any international initiative needs to find a way to build on the substantial financial and scientific investment at this station to enable it to continue to contribute to coconut research internationally.

A brief description of the existing national coconut research programs is given in the following sections (6.2-6.6).

6.2 Asia

The Philippines

Much of the coconut area in the Philippines is planted with senile palms, and yields are not increasing. In May 1990, the World Bank approved a major loan to the Philippines to enable it to embark on an ambitious coconut rehabilitation and replanting scheme. This program will require a sound research and extension base to ensure its success.

Research on coconuts has been undertaken by various organizations in the Philippines since 1908. This research was largely fragmentary and discontinuous, until the establishment in 1973 of the Philippines Coconut Authority (PCA). PCA's research program was established with support from FAO, through the UNDP supported Coconut Research and Development Project, from 1971 to 1982.

There are three principal PCA research stations, which employ a total of 40 scientists. These are:

1) Albay Research Centre, Southern Luzon. Albay Research Centre has concentrated on cadang-cadang disease. This disease kills millions of coconut trees each year in the Philippines. It has been estimated to cost the Philippines US$ 16 m per year in lost production. The causal agent of the disease has been shown to be a viroid. Collaborative research has been undertaken with the University of Adelaide, Australia over the past decade to identify the causal agent and establish effective control programs. A resistance screening method has been devised, and germplasm is being screened for tolerance to cadang-cadang. A field-assay technique has also been developed and an extensive field survey is underway to determine the geographic spread of the disease. It appears to be more widely distributed in the Albay area and neighbouring regions than has been recognized previously. The Albay area was severely damaged by a typhoon in early 1988 and much coconut rehabilitation is required.

Recently, tissue culture research has been initiated at Albay with support from GTZ.

2) Davao Research Centre, Southern Mindanao. Research here is concerned with agronomy, particularly the study of nutritional deficiencies such as nitrogen and chlorine; and entomology, particularly biological control of rhinoceros beetle and other coconut pests.

3) Zamboanga Research Centre, South-West Mindanao. Zamboanga is the principal PCA breeding and selection station. A germplasm collection with 74 accessions has been assembled initially with support from the International Board for Plant Genetic Resources (IBPGR). The upkeep of the collection after the completion of the IBPGR activity is a continuing problem.

Both local and exotic hybrids are being assessed in a national hybrid evaluation trial which is being conducted in the Philippines, with emphasis on the identification of suitable locally adapted hybrids for different regions.

Zamboanga Research Centre is also the site of coconut wood utilization research. Experimental work over several years, conducted in cooperation with FAO and New Zealand forestry specialists has shown that coconut wood can be used in the construction of houses, as well as furniture and specialty items such as parquet flooring. This research was designed to find uses for old palms, so that palms felled in replanting programs would yield an income to the farmer and reduce the risk of rhinocerous beetle infection in new plantings. A cash return on the old trees alter the economics of replanting schemes, and makes them more attractive to smallholders. It has important implications for all coconut-growing countries.

Philippine Universities

Research on coconut is also conducted at several universities in the Philippines, particularly the University of the Philippines at Los Banos (UPLB) and the Visayas State College of Agriculture (VISCA). UPLB has a long history of tissue culture research. Dr. de Guzman first successfully cultured coconut embryos there, to allow the propagation of Makupuno nuts, a coconut variety with jelly-like endosperm which is a local delicacy.

Research at VISCA is concerned with the production and evaluation of hybrids suitable for the local conditions. Research is also conducted on intercropping, in order to recommend the best replanting options to farmers. Village-level processing methods are also being developed at VISCA, and elsewhere in the Philippines, in order to make the best use of the total coconut resource. Considerable work has also been done on coconut product development, including various food products.

Indonesia

Coconut research in Indonesia commenced in the early 1900's. The first research station was established in 1930 at Menado, Sulawesi. Most research now comes under the direction of the Agency for Agricultural Research and Development (AARD). The responsible institute within AARD is the Coordinating Research Institute for Industrial Crops. Within this, a Research Institute for Coconuts, is located near Menado in North Sulawesi, with a sub-station at Pakuwon (West Java), and farms at eleven other locations. The Bone-Bone station has a germplasm collection. AARD has received external assistance from FAO and the World Bank for coconut research.

The state-owned industrial plantations (PTP/PNP) which support nucleus estates and associated coconut smallholdings also fund a coconut research program through the Pusat Penelitian Kelapa (PPK). This program was established in 1982 at Bandar Kuala near Medan in North Sumatra. The PPK has had technical support from France, who provided 2 IRHO scientists (an agronomist and an entomologist) to assist a team of 10 Indonesian scientists.

India

Coconut research in India began in 1916 with the establishment of the Central Plantation Crops Research Institute at Kasaragod, which is still in operation today. It is now part of a national program, the All India Coordinated Coconut and Arecanut Improvement Project (AICCAIP), which is responsible for coordinating the activities of 12 research centers located throughout the major coconut growing regions.

The objectives of the national program are:

1) Collection, conservation, cataloguing, and evaluation of germplasm.

2) Evaluation of hybrids and high yielding cultivars.

3) Standardization of research techniques for various agro-climatic regions.

4) Development of suitable multiple cropping and intercropping systems.

5) Development of efficient pest and disease management systems.

There is a germplasm collection at the Central Plantation Crops Research Institute, containing some 60 exotic cultivars and 30 local varieties.

There was a report from India in 1984 that direct embryogenesis of coconut has been obtained from seedling leaf tissue. If clonal propagation of young leaf tissue from mature palms is possible, this would allow the rapid multiplication of mature palms, in a manner analogous to clonal propagation of oil palm. However, the report remains unconfirmed.

Although extensive nutritional trials have been conducted with monocropped local varieties, little is known of the nutritional needs of locally produced or introduced hybrids in a monocrop or intercrop situation. Drought is a major problem to Indian coconut production.

The major coconut disease in India is Kerala root wilt disease. Losses due to the disease have been estimated at approximately 340 million nuts per year (equivalent to 40,000 tons of coconut oil). A mycoplasma has been reported to be implicated in the disease, but has not been confirmed as the causal agent. A possible vector for the disease has been identified. Further research is required to clarify the causal agent and its vector and to devise effective control strategies.

Sri Lanka

Research has been undertaken in Sri Lanka since 1929, at the Coconut Research Institute (CRI), Lunuwila. Results in its early years contributed to coconut breeding and selection, nutritional requirements, and pest and disease control. In recent years, the institute has had severe financial constraints and its research productivity has declined.

The Sri Lanka Government has commenced upgrading of the institute, with the provision of improved laboratory facilities, a biological control facility, a new coconut processing research and development center, and a new seed garden. There are approximately 34 scientists on the staff, at least 14 of whom have received or are receiving post-graduate training overseas.

The five research divisions of the institute are concerned with: 1) soils and plant nutrition; 2) genetics and plant breeding; 3) agronomy; 4) crop protection; and 5) processing research. There are support units for biometry, economics, botany, and publications.

The institute also maintains a coconut information service, with external support from the International Development Research Centre (IDRC). This serves primarily the APCC member countries.

Malaysia

Coconut research is undertaken by the Malaysian Agricultural Research and Development Institute (MARDI). MARDI's recently established coconut research program is concerned with the research needs of the smallholder planting and rehabilitation program. Private sector research interests have contributed to research on hybrid seed production and cocoa and coconut intercropping.

Malaysian universities have done some interesting work on coconut processing and food technology, notably the development of a process to produce "instant" coconut cream powder, which can be reconstituted to coconut cream by the addition of water. This product is now marketed internationally.

Thailand

Coconut research is conducted at the Sawi Research Centre in southern Thailand. This center is part of the Horticultural Research Institute of the Department of Agriculture. The Overseas Development Administration of the United Kingdom provided technical and financial support for the program for several years. A seed garden at Kanthuli has produced hybrid seed nuts for distribution to smallholders. The preferred hybrid is the Thai Tall x West African Tall, which produces a large nut. The main market in Thailand is for whole nuts, and nut size is a critical factor.

Food technology research at Kasetsart University has been successful in developing processes to allow the inclusion of dried coconut in 'instant' curries, which can be reconstituted by the addition of water. These products are now marketed in the USA, and elsewhere.

China

There is a small national coconut research program in China on Hainan Island. There is a seed garden producing hybrids (Malayan Dwarf x West African Tall) and (Malayan Dwarf x Hainan Tall). The major problems are cold and drought. Hainan Island is close to the northern marginal limit for coconut palms, which only produce there for 4 months of the year. It is thus a site of particular interest to coconut breeders for cold tolerant material.

Vietnam

There is a research institute for oil crops in Vietnam, at which some coconut hybrid evalution has been conducted. A hybrid seed garden has been established. FAO has provided technical assistance, by the provision of a coconut breeder. France also provides bilateral assistance.

6.3 South Pacific

There are several small research programs in the South Pacific, including those in Papua New Guinea, Fiji, French Polynesia, Solomon Islands, Tonga, Vanuatu, and Western Samoa. Technical assistance is provided by France to the programs in Fiji, French Polynesia and Vanuatu. FAO has provided technical assistance to the program in Western Samoa. Collaborative research has been established between these programs and Australian institutions, under the sponsorship of the Australian Centre for International Agricultural Research (ACIAR). The research programs in Solomon Islands, Vanuatu, and Western Samoa are described briefly by Foale (1987). A South Pacific regional coconut network was established by the University of the South Pacific, in cooperation with the South Pacific Commission. Its primary role was information exchange.

Papua New Guinea

Coconut research has been conducted in PNG for many years with support from both the public and private sector. In 1986 the Papua New Guinea government established the Cocoa and Coconut Research Institute (CCRI) in Rabaul. The institute is largely industry-funded, and managed by a Board of Directors representing producers, exporters, and the government. The institute employs several graduate staff, both expatriate and national scientists. These include a full-time coconut breeder and agronomist, and a pathologist and entomologist who share their time between coconut and cocoa.

The major initial research at the institute has been to establish a program for germplasm collection within Papua New Guinea, arrange for the introduction of potentially useful material from elsewhere, and establish a hybrid breeding program. Pest control is also important, since pests, particularly Scapanes beetle, are a major threat to production. Diseases are less serious than pests at present, but the recent finding of a cadang-cadang-like viroid in the Solomon Islands means that the occurrence of diseases needs to be carefully monitored. Embryo culture techniques are being established in PNG. These techniques, when combined with disease indexing, should allow the safe introduction of germplasm.

Fiji

The first hybrid coconut palms produced by artificial pollination were grown in Fiji by Marechal in 1928, who crossed an introduced Malayan Red Dwarf with Fijian Green Dwarf (Niu Leka). It was the variability shown by the F2 progenies of the Fijian hybrid material when growing at Yandina in the Solomon Islands, that demonstrated the potential benefits from coconut breeding. In the past 20 years hybrids have been produced in several countries which yield substantially more than the best parent.

After the initial crossing program in Fiji, there have been several attempts to establish a hybrid breeding program there, but none of these has resulted in any substantial production of hybrid material for use in replanting schemes. A new program commenced in 1985, with technical assistance being provided by IRHO, with the aim of producing hybrids to replace the large proportion of senile palms in Fiji.

A successful biological control program for rhinoceros beetle was conducted in Fiji and several other Pacific islands, with suport from UNDP and FAO, in the 1960s and 70s. The beetle is controlled by an introduced baculovirus. Regular releases of the virus are still made, to maintain the effectiveness of the biological control (Waterhouse and Norris, 1987).

Solomon Islands

There is a long tradition of coconut research in the Solomon Islands, going back to 1952, when a research station was established at Yandina by Levers. In 1960, a joint coconut research scheme was established between the Solomon Islands Government and Levers. This scheme operated until 1975, when the research program became the sole responsibility of Levers. A brief description of the past research at Yandina and the current research program is given by Foale (1987).

There is presently one coconut breeder stationed at Yandina. Current research includes the continued production and evaluation of hybrids; intercropping trails to determine optimum palm spacing to suit intercropping with cocoa, and the youngest age at which coconut may be underplanted with cocoa. Yandina also provides coconut tissue to the Unifield laboratories in Britain who are working on somatic embroygenesis in coconut. A single palm growing at Yandina was produced from coconut callus culture in the UK.

In 1987, a viroid similar (but not identical) to that which causes cadang-cadang in the Philippines was found in oil palms and coconut palms in the Solomon Islands. The significance of this discovery is not yet clear, but extensive field surveys are being undertaken throughout the Pacific Islands to assess the distribution of the viroid and if it is causing any damage to the palms. This work is being undertaken in collaboration with the University of Adelaide, Australia, with support from ACIAR.

Vanuatu

IRHO established a coconut research program in Vanuatu in 1962, at the Saraoutou Oil Crops Research Station on the island of Espiritu Santo. The work at the station has been described in detail by Calvez et al (1985). IRHO has 4 scientists stationed at Saraoutou research station, which is the best equipped coconut research facility in the South Pacific.

The station has established a hybrid breeding program, and a hybrid seed and seedling production system. The seed and seedling production systems could be used as a model for nursery management elsewhere. The station has produced a local hybrid with higher yield potential than the local tall and tolerance to foliar decay disease.

The major limitation to the station being the center for coconut research in the South Pacific is the presence of foliar decay disease. This disease affects introduced, exotic material, while the local talls are tolerant. The insect vector of the disease is Myndus taffini. All hybrids developed for use in Vanuatu will have to have tolerance to the disease. Germplasm from Vanuatu cannot be distributed with safety elsewhere, unless it goes through embryo culture and disease indexing.

Collaboration between IRHO and the Waite Institute at the University of Adelaide, Australia (supported by ACIAR) has shown that foliar decay disease is caused by a low molecular weight DNA virus. A diagnostic probe has been developed to allow field surveys to be made of the distribution of the disease in Vanuatu and elsewhere, and for use in other epidemiological studies and for disease indexing. A more rapid diagnostic test based on the use of monoclonal antibodies is also being developed (Hanold and Randles, 1989).

6.4 Latin America

Brazil

Brazil has a national cocount research center at Aracaju. Its germplasm collection contains both local and exotic germplasm. It has embarked on a hybrid breeding program.

Brazil makes extensive use of coconut milk, coconut cream, and coconut flakes in cooking. The amount consumed is the equivalent of production from 50,000 ha of coconuts per annum. The processing technology developed in Brazil would be of considerable interest to other countries wishing to develop these items as value-added products for local sale or export. Brazil also uses lauric acid extracted from coconut oil in its oleochemical industry, and these demands are increasing. Brazil wishes to become self-sufficient in lauric oils, and has decided to expand its coconut production.

Other Countries

There are small national research programs in Mexico, Panama, Surinam, and Venezuela. Little coconut research is being done in Colombia, Ecuador, and Peru, where priority is given to oil palm.

6.5 The Caribbean

Jamaica

The major research program in the Caribbean is that of the Coconut Industry Board of Jamaica. This program has been funded by the industry and from international and bilateral sources, particularly the U.K. Regretfully, most of the external asistance has been withdrawn in recent years.

A germplasm collection was built up as part of the program on lethal yellowing disease. This is a very damaging disease, first reported from the Caribbean. It would be devastating if it reached the main coconut growing areas in Asia.

An International Council on Lethal Yellowing was established with support from FAO. It sponsored research in Jamaica for several years. The disease was shown to be caused by a mycoplasma (possibly related to several other mycoplasma-like diseases of coconuts in other countries). Lethal yellowing and related mycoplasmas are problems of international significance. Research on the lethal diseases in Latin America and the Caribbean area would be an appropriate initiative in any new internationally-funded program.

Trinidad

Trinidad has a small national program which focuses on research on red ring disease.

6.6 Africa

Cote d'Ivoire

Although only a small coconut producer, the Cote d'Ivoire has a substantial coconut research institute. This is the Marc Delorme Coconut Research Center, established by IRHO in 1951.

The major emphasis has been on germplasm collection and hybrid breeding and evaluation. The germplasm collection contains 52 different varieties (34 talls, 18 dwarfs) and 74 hybrids. This is the most comprehensive coconut germplasm collection in the world. Embryo culture techniques have been established to facilitate germplasm collection and exchange. There has also been a significant research effort on coconut nutrition. The hybrid PB 121 (Malaysian Yellow Dwarf x West African Tall) was bred at the center. This hybrid is now grown commerically in approximately 40 countries. Some other promising hybrids in experimental trial are PB 132 (Malaysian Red Dwarf x Polynesian Tall) and PB 213 (Rennell Tall x West African Tall). There are about 500 ha of hybrid trials at the center (IRHO 1986).

The genetic potential of the best hybrids (eg. PB 121), when grown under favorable agronmic and environmental conditions, is of the order of 6.5 tons copra/ha. This contrasts with a world average yield of 0.5 t/copra/ha. Thus, there is a real prospect that coconut yields could be increased several fold by the use of well-adapted hybrids combined with appropriate agronomic pracices.

Tanzania

Research is conducted in the National Coconut Development Program, which has received technical support from I.R.H.O., GTZ of West Germany, and The University of London Imperial College at Silwood Park. Four expatriate scientists have been based in Tanzania over the past several years. The program conducts research on the resistance to mycoplasma diseases; biological control of insect pests; agronomy; and socioeconomic problems of smallholders. It is closely linked to a World Bank development project for the rehabilitation of the coconut lands in Tanzania.

Table 9. National Coconut Research Institutes, Current Programs and External Collaborators

Region	Country	Research Institutes	Programs	External Collaboration Past/Present*
Asia	China	Chinese Academy of Agricultural Sciences Hainan Island	Hybrid production	
	India	All-India Coordinated Coconut and Arecanut Improvement Project		
		Central Plantation Crops Research Institute, Kasaragod (plus 11 other research centres)	Pest and disease control Tissue culture Germplasm collection, conservation, and evaluation Hybrid breeding	
	Indonesia	Agency for Agricultural Research and Development (AARD)		
		Coordinating Research Institute for Industrial Crops, Research Institute for Coconuts. Main stations at Menado, Pakaiwon, Bone-Bone	Germplasm collection Hybrid breeding	IBPGR FAO World Bank
		Industrial Plantations (PTP/PNP) Coconut Research Program, Medan, North Sumatra	Hybrid breeding	France (IRHO)*
	Malaysia	Malaysian Agricultural Research and Development Institute (MARDI)	Smallholder planting and rehabilitation	
		Private Sector Research Programs	Hybrid seed production Intercropping	
		Universities	Processing Food technology	
	The Philippines	Philippines Coconut Authority	PCA	World Bank* France (IRHO)*
		Albay Research Centre	Cadang-cadang disease Tissue culture Entomology (disease transmission)	FAO/UNDP Australia (ACIAR)* Germany (GTZ)
		Davao Research Centre	Agronomy, nutrition entomology Post-harvest	FAO/UNDP Potash Institute France (IRHO) ODA*/GTZ*
		Zamboanga Research Centre	Germplasm conservation Hybrid breeding Coconut wood utilization	IBPGR FAO/UNDP New Zealand

Region	Country	Research Institutes	Programs	External Collaboration Past/Present*
		<u>Philippine Universities</u>		
		University of the Philippines, Los Banos (UPLB)	Embryo culture Tissue culture	
		Visayas State College of Agriculture (VISCA)	Hybrid breeding Intercropping Village level processing Product development	
	Sri Lanka	Coconut Research Institute	Breeding and selection Soils and plant nutrition Agronomy Pest and disease control Coconut information service	
		Coconut Board	Post-harvest processing	U.K.*
	Thailand	Department of Agriculture, Horticultural Research Institute, Sawi Research Centre	Hybrid breeding	ODA
		Kasetsaart University	Food technology	
	Vietnam	Oil Crops Research Institute	Hybrid production	FAO France
South Pacific	Fiji	Ministry of Forestry	Hybrid breeding Pest control (biological control of rhinoceros beetle)	France (IRHO)*
	French Polynesia	Coconut Research Institute	Hybrid breeding	France (IRHO)*
	Papua New Guinea	Cocoa and Coconut Research Institute	Germplasm collection and conservation Hybrid breeding Pest control (Scapanes)	Australia (ACIAR)*
	Solomon Is.	Levers Research Yandina	Hybrid breeding Intercropping (cocoa/coconut) Tissue culture	Unilever* Unifield*
		Department of Agriculture	Disease surveys (viroid diseases)	Australia (ACIAR)*
	Vanatu	Oil Crops Research Saraoutou	Hybrid breeding Disease control (foliar decay)	France (IRHO)* Australia (ACIAR)*

Region	Country	Research Institutes	Programs	External Collaboration Past/Present*
	Western Samoa	Department of Agriculture	Hybrid breeding Pest control (biological control of rhinocerous beetle)	FAO* World Bank ADB*
Latin America	Brazil	Coconut Research Institute, Aracaju	Germplasm collection Food processing	
	Mexico	National Coconut Research Program		
Caribbean	Jamaica	Coconut Industry Board	Germplasm collection and evaluation Lethal yellowing disease	U.K. FAO International Council on Lethal Yellowing
	Trinidad	National Coconut Research Program	Red ring disease	
Africa	Cote d'Ivoire	Marc Delorme Coconut Development Centre	Germplasm collection Hybrid breeding	France (IRHO)*
	Mozambique	National Coconut Development Program	Germplasm evaluation	Portugal
	Tanzania	National Coconut Development Program	Hybrid breeding Agronomy Disease control (mycoplasmas) Biological control of insect pests Socioeconomic	World Bank* Germany (GTZ)* France (IRHO)* U.K. (Imperial College)*

* Existing research project supported by technical assistance, or collaborative research grants.

7. INTERNATIONAL RESEARCH PRIORITIES

7.1 Rationale for an International Initiative

The preceding chapters lead to the rationale for establishing an international research initative on coconut. This rationale is based on:

1. The growing demand for vegetable oils and fats, especially in developing countries.

2. The declining competitiveness of coconut which is not able to take advantage of the expanding market and is losing ground to other crops. Coconuts share of the total market has been declining steadily. It provided 6% of the total world market in 1986, and is predicted to fall to 5% by 1990.

3. The average yield of 500 kg per ha per year (copra equivalent) has not increased for the past 25 years. Production increases (of about 1.5% per year) have come from the planting of new land. There are approximately 11 million ha of coconut land, spread over 82 countries.

4. Coconut is a smallholder crop, produced largely for domestic consumption. Approximately 96% comes from smallholdings of 0.5-4.0 ha. There are more than 10 million farm families (about 50 million people) directly involved in its cultivation. A further 30 million people in Asia alone are directly dependent on coconut and its processing for their livelihood.

5. Approximately 70% of the total crop is consumed domestically, and the balance exported. The main export products are copra, coconut oil, copra meal and desiccated coconut. The major exporter is the Philippines. Some countries, such as India and Indonesia consume almost all their crop domestically. Other smaller countries, with low populations export at least half their crop. For many island countries it is their only significant earner of foreign exchange.

6. The major producing areas are in Asia and the Pacific where about 85% of the crop is grown. There are 13 producing countries in Asia, and 18 in the South Pacific. Coconut is also locally important in Latin America and the Caribbean where there are 29 producing countries, the major ones being Mexico, Brazil and Jamaica. In Africa, it is important as a food and oil crop in the coastal areas of 22 countries in West and East Africa. The major producers are Mozambique and Tanzania.

7. Research results in recent years suggest that there are areas from which there could be a high rate of return on research investment, analogous to that achieved from oil palm. Appropriate methods will be required for the transfer of new technology to smallholders, if these returns are to be realized. Coconut hybrid breeding over the past 30 years has demonstrated that hybrids are capable of yielding up to 6 tons copra per ha per year, under favourable conditions (cf. the current world

average yield 500 of kg/ha/year). However, in some instances their acceptance by smallholders was subject to a number of real or perceived constraints and poor performance has been reported under some local conditions. These constraints need to be further investigated in any international research program.

Progress has also been made in the identification of the causal agents of diseases of previously unknown etiology. Nutritional studies have shown that coconut responds to fertilizer application, particularly potassium and chlorine.

These promising results from only a few programs suggest that a well-organized and adequately funded international research effort would yield high returns.

8. All the benefits from coconut research accrue to developing countries. Furthermore, the majority of these benefits go to the smallholder producers. The balance go to consumers in developing countries.

9. Coconut research is presently under-funded. There are several national research programs, but, with few exceptions, they are not well-supported financially nor do they have sufficient appropriately trained staff and facilities. Most suffer from a lack of continuity in funding, both from national sources, and from external agencies. Many small countries are not able to support a coconut research program at all. At present there is no means by which such countries can access new technologies, especially for higher yielding planting material. Yet they could be active participants in an international program. The present research effort is not addressing the needs of the crop internationally, nor capitalizing on the promising results from breeding and other areas of research, for the benefit of smallholders.

10. The long-term nature of coconut research, the history of discontinuity and lack of support in its funding, the prospects of high returns from research investments, and the likely distribution of research benefits to smallholder producers and consumers in developing countries, make coconut a suitable target for an international research initiative.

7.2 Criteria for an International Initiative

There is need for a focused international research effort on coconut which would address the main problems facing the crop and make it more economically attractive to smallholders by giving them a higher return for their efforts. A number of high priority research activities can only be realistically addressed through an international program, since they are beyond the scope of any individual national program. The key criteria for inclusion of an activity in an international program are that it should be relevant to several countries, and that it should not be site-specific.

There are presently several national coconut research programs in the larger producing countries. There is also a multi-country program operated by the Institut de Recherches de Huiles et Oligeaneaux (IRHO). The Asian and Pacific Coconut Community (APCC) sponsors an annual technical meeting of coconut researchers (COCOTECH), in Asia and the Pacific. Several individual projects are supported by APCC, FAO/UNDP and other multilateral and bilateral development agencies.

The European Community has established a small secretariat to assist in the coordination of coconut and oil palm research, particularly amongst European scientific institutes, and their collaborators in national and regional programs.

Any new international initiative should be additional to existing national activities, and not a replacement for them. The existence of an international effort, which brings together a critical mass of expertise, resources and research capacity. It should also stimulate greater investment in national coconut research programs, which are presently underfunded, in relation the importance of the crop to the economies of many countries.

National programs also need to be supported through bilateral activities. As well, an international initiative could provide training opportunities for national program staff. The fragmentary nature of existing research, often resulting from a discontinuity of funding, would be addressed by an international initiative, as proposed here.

Production research is required to increase the productivity of coconut trees by the use of locally adapted, high-yielding hybrids, pest and disease management, and improved crop husbandry. Much of the research on the selection of locally adapted genotypes and appropriate agronomic practices is site-specific and should be the responsibility of national programs. However, there are certain areas of production research which need to be done at an international level, because they are beyond the scope of any one country but which would generate information of relevance to many national programs. These areas are outlined in the following section.

7.3 Priority Research Areas

The priority research areas that should be addressed by an international initiative are:

- Germplasm improvement
  (germplasm collection, conservation, selection, and breeding)
- Disease and pest control
- Postharvest aspects
- Sustainability of coconut-based farming systems

Socioeconomic research

The option of whether there should be a separate socio-economic research program, addressing issues affecting rehabilitation and replanting programs, as well as other socio-economic issues has been canvassed. However, it is considered preferable for there to be a socio-economic component within each of the priority research areas above. This would better ensure that socio-economic issues relevant to small-holders are addressed within each of the areas of technology development, rather than as an afterthought.

Specific topics for socio-economic research have been identified as:

1. Mono-cropping and multi-cropping systems for traditional varieties and hybrids.

2. The economics of smallholders using inputs, such as fertilizers need to be examined critically. Smallholders are often reluctant to fertilise coconut.

3. The social constraints to participation in replanting and/or rehabilitation programs, also need to be addressed. Ways need to be found to provide income to farmers while the new trees are coming into bearing. Even for the early-bearing hybrids, the first nuts are not harvested for 3 or 4 years. Smallholders need a reliable source of income from other crops or coconut timber during these years.

Germplasm Improvement

Introduction

Germplasm improvement is comprised of research on the collection and evaluation of germplasm, and its selection and breeding. There is much opportunity for genetic improvement of coconut. The crop is heterozygous, with a great deal of unexploited variability from which to select. There is a need for new sources of resistance to the major diseases and for methods of rapidly transferring resistance genes into commercial varieties.

Already available coconut hybrids have been shown to yield at least double some of the best available local material under favourable conditions. A well-planned and internationally financed program to make available higher yielding material to many producing countries for evaluation under local conditions has the potential for high returns on research investments. Average coconut yields have languished around 500 kg/ha/year for 25 years.

There have been various international and regional activities amongst coconut breeders dating back to 1968. These activities and their outputs relevent to any new international activity are summarised in Annex D. The long term nature of coconut breeding, and the need for large areas for field based germplasm collections means that few countries have been able to mount effective breeding programs. Even those which have breeding programs suffer from lack of continuity in funding (and a consequent stop-start approach to breeding), and often poor maintenance of their collections. All are breeding for national priorities. None has the mandate to collect germplasm for use throughout the world, nor to breed hybrids and make them freely available for international testing in many countries.

Germplasm Collection, Conservation and Evaluation

The current status of coconut germplasm collections is summarised in Table 10. The main existing collections are located in Cote d'Ivorie, India, Indonesia, Jamaica, Malaysia, Philippines, Solomon Islands, Sri Lanka, Tanzania, Thailand, and Vanuatu. In most cases the collections have been made for a specific purpose, in support of a breeding program. The collection in Jamaica, for example, was established for breeding against lethal yellowing disease. The content of material in existing collections is uneven, with certain types being over represented. For instance the Malayan Dwarf accounts for nearly 50% and some particular talls, such as the West African and Rennell, for about 15% (Table 10). Plant breeders have tended to concentrate on material of known value. The number of accessions in most collections is too few and not representative of the available germplasm. The maintenance of existing collections has become too expensive for most national budgets.

There is a need for further collection of coconut germplasm. Much indigenous germplasm is under constant threat from genetic erosion, especially in areas where hybrids are likely to be widely planted, as in Indonesia. It is also important to widen the genetic base of existing collections for future breeding programs. IBPGR has supported coconut germplasm collections in the Philippines, India, Malaysia, and Indonesia. Unfortunately, IBPGR has not been able to extend its support to the conservation and evaluation of the collected material, some of which is being progressively lost as some collections are not well maintained.

It is considered essential for the effective implementation of an international research initiative on coconut that an internationally-funded germplasm research unit be established. The Unit would require sufficient land on which to establish a coconut germplasm collection which would be held under international auspices at one primary site, and several sub-sites on different continents.

The primary site of the international collection should be located ideally in an area usually free of natural disasters (especially typhoons); where there are no major disease problems that would preclude the exchange of material; and near the centre of origin of the crop (thought to be in the Asia/Pacific region.)

Collaboration between the international germplasm research unit and existing collections will be essential. All material held under international auspices needs to have continuity of funding to ensure that valuable material is not lost. Free exchanges of material would be a key requirement for all participating countries.

TABLE 10. Current Status of Selected Coconut Germplasm Collections

Country	Number of accessions	Total Number of palms	Mean Number/ accession
India			
Kasaragod	121	3173	27
Indonesia			
Mapanget	20	833	42
Pakuwon	32	1786	56
Bone-bone	50	2476	50
Ivory Coast			
Marc Delorme	60	12,213	204
Jamaica			
C.I.B.	35	?	?
Philippines			
Zamboanga	83	9552	118
Laguna	64		9
Baybay	7		
Tiaong	6		30
Albay	33		
Tanzania			
Zanzibar	13	1197	13
Mafia	13	1194	13
Thailand			
Chumphon	16	5808	363
Vanuatu			
Saraoutou	31	4805	155
Named Types			
Malayan Dwarf	34	20168	593
West African Tall	10	3801	380
Rennell Tall	7	2583	369
All types	460	43037	104

Notes:

Information compiled by H. Harries, 1989. Data from Indonesia, Ivory Coast, Philippines, Thailand and Vanuatu was drawn from IBPGR/SEAP and FAO/UNDP working group reports (IBPGR, 1976; Chumphon, 1988). Data from Tanzania and Jamaica is from annual research reports. In Jamaica, the original number was reduced by lethal yellowing disease, increased by selected multiplication, then decimated by a hurricane in 1988. At Albay in Philippines, the 1987 typhoon destroyed about 50% of palms.

Additional information is being sought on the collections in Malaysia, the Philippines, and Sri Lanka.

An IBPGR working group on coconut germplasm in 1976 described the international needs for coconut germplasm and breeding. The report of this group (IBPGR 1976) and other reports listed in Annex D will be useful as the basis for detailed planning on germplasm research needs, including the identification of future needs for germplasm collection and conservation.

Facilities and techniques for the international exchange of breeding material (particularly via embyros) need to be identified so that material can be exchanged safely, with appropriate quarantine precautions, and disease indexing where necessary.

There is also a need for an assessment of coconut germplasm evaluation techniques, so that results are comparable between countries.

Strategic research

Since germplasm improvement in coconut is a long-term process, technologies to hasten the process are especially useful. Development of such techniques may require collaboration between laboratories in producing countries and other advanced laboratories elsewhere. Sponsorship of such linkages via contractual research is an appropriate role for an international orgranization.

The development of techniques based on molecular biology to assist in the classification of coconut types as well as the early screening of material in breeding programs (including new hybrids) would be valuable Similarly, the development of other laboratory-based biochemical techniques (such as isoenzyme markers) to allow the characterization of naturally occurring coconut types (and eliminate duplicates from collections) would be useful.

There is also a need for improved methods for the long-term storage of coconut germplasm. The present field collections are expensive to maintain, and susceptible to natural disasters, especially typhoons. Links with the research program being sponsored by IBPGR and others on in-vitro conservation methods such as cryopreservatioin will be important.

Coconut breeding

Major progress on coconut breeding has been made by the production of hybrids, often produced by crossing varieties of widely different geographic origin. The best tall varieties rarely produce more than 2 tons of copra per ha. The best hybrids, under favourable conditions, can produce up to 6 tons per ha. (World Bank, 1990).

The breeding cycle in coconut is 16 years, using presently available techniques. An international effort is required to provide the continuity of funding which has been lacking for coconut breeding, and to meet the needs of the many countries who are unable to support their own breeding program.

There are many hybrids presently available from existing breeding programs which could be tested widely, in an international germplasm evaluation network. Locally adapted varieties are required which combine high yield with tolerance to pests and diseases, and desirable agronomic characteristics. Varieties which produce well in poor environments and with low inputs are required for most situations. The genetic base of the breeding programs needs to be expanded.

The adoption of standardized techniques of evaluation applicable in many national breeding programs would be valuable.

A major problem is that results from different countries are not comparable. A protocol for providing material for evaluation in many countries needs to be devised and adopted. Interchange of material and advice on agreed methodology for its evaluation would be a major contribution from an international coconut improvement program.

A proposal for inter-country variety trials has been prepared for APCC by the Philippines Coconut Authority. This could provide the basis for the planning of initial inter-country evaluation of promising material.

Tissue Culture

An international effort is required on coconut tissue culture to bring a critical mass of funds and expertise to the problems. The research needs in coconut tissue culture have been reviewed by Professor Cocking of the University of Nottingham in September, 1989 as part of the consultation on the initiative. The main issues are summarised below:

The present methods for the propagation of coconut are slow and expensive. Even when elite material is available, it takes several years to produce sufficient quantitites for use in planting programs. Clonal propagation would allow the rapid propagation of high-yielding palms from hybrid populations and the multiplication of disease-resistant types. It would also allow greater use to be made of elite individuals in breeding programs. It would facilitate in-vitro germplasm storage. Also, the future application of molecular biology to coconut improvement is dependent on having perfected tissue culture techniques to regenerate plantlets from single cells.

Clonal propagation would allow the wide phenotypic variability of the heterozygous hybrids to be stabilised, thus producing recognizable palm cultivars with stable characteristics (Jones, 1989). When successful, this technology will allow major improvements in yield and quality to be achieved. Although the techniques are now widely available for oil palm, commercial development is delayed by the occurrence of flowering abnormalities in some of the first commercial clones. The cause of these problems has now been identified and clonal propagation of oil palm (combined with quality control) is proceeding in field trials. Comparable techniques are required for the clonal propagation of coconut palm.

Clonal propagation of tissue from mature palms has been reported in a few instances (from Unifeld, and Wye College in Britain, ORSTOM/IRHO in France, India and the Philippines, amongst others) (Cocking, 1989; World Bank, 1990). Only a limited number of plantlets have been produced so far. The techniques need to be developed much further to allow large-scale, routine propagation of material. The successful development of vegetative propagation for oilpalm, and the recent report of vegetative propagation of date palm suggest that clonal propagation is also technically feasible for coconut palm.

Embryo culture was first demonstrated in the Philippines for t Makapuno coconut type. Embryo culture techniques for other varieties ha been developed by ORSTOM/IRHO and IBPGR, and in several national program Embryo culture is important for the transport and preservation of germplas for international exchange of germplasm (when combined with appropria disease indexing techniques); multiplication of Makapuno-like nuts, whi have a jelly-endosperm; and in the multiplication of hybrid embryos i breeding programs. A protocol for culturing and establishing embryos nee to be made widely available so that there is a high success rate in t establishment phase.

Tissue culture is an area where a subject-specific research netwo could be established amongst interested scientists. An internation initiative which had a significant contractual research budget could bri additional funds for contract research with existing laboratories, as well a bring some new expertise into the network, especially in regard to clona propagation.

Although not all countries need to be involved in the research, th results would be of benefit to all producing countries. The willingness o the private sector (where much of the current research is being done) t participate in this effort needs to be explored further.

Modern Biotechnology

Jones (1990) has reviewed the possible opportunties and threats fr modern biotechnology to coconut (and oilpalm), and identified the followin priority areas:

Transformation and Regeneration Systems. The transfer of foreign gene requires the development of effective transformation systems for the delive of DNA. As yet little work has been done on palm transformations, partl through lack of resources, but mainly because the tissue culture systems fo plant regeneration are still too unpredictable. The advent of reliabl transformation systems for other monocots will provide an impetus to appl such systems to palms.

Genetic Mapping. There is almost total lack of knowledge of the genetic of any of the characters which it might be of interest to modify, eg. yield quality, drought resistance, wind resistance, disease resistance, etc. Suc studies are vital to future applications of recombinant DNA technology t coconut.

Molecular biology provides useful tools for genetic mapping in the fo of DNA probes, for example the use of Restriction Fragment Lengt Polymorphisms (RFLPs). Developments in genetic mapping could greatly reduc the number of plants carried in large and expensive field trials. There wil be an increasing number of applications as the knowledge of the genetics o the crop develops. An RFLP map of coconut palm could provide the basis fo genetic mapping of a large number of phenotypic characters within 2 to years, and contribute to the choice of parents in directed breeding programs.

Support is required for a coordinated effort in the production of a se of DNA probes and restriction enzymes for RFLP mapping of the coconut palm This could be regarded as precompetitive research and could be funded b interested parties in both the public and the private sectors. It is important that techniques developed either by or on behalf of the industry are accessible to the individual companies and public research institutes concerned with conventional coconut breeding. Support will also be required to help these organisations develop in-house expertise, so that they can apply the new technologies in their breeding programs.

Biotechnological developments in competitive crops may provide a threat to the producers of palm and coconut oil in the future (timespan 20 years). In particular the appearance of a temperate crop producing lauric and other short/medium chain fatty acids would pose a threat to coconut oil and palm kernel oil, which command a price premium as lauric oils. This possibility should be monitored by agencies investing in coconut research, and action taken to ensure that coconut remains a competitive crop.

The specific recommendations of Jones (1990) for the application of modern biotechnology to coconut are:

Cell and Tissue culture:

- Improve tissue culture procedures, particularly in respect of plant regeneration.

- Improve success in culture of excised zygotic embryos, and methods of plantlet hardening and establishment.

Genetic mapping (RFLP mapping)

- Identify sources of resistance to lethal yellowing, cadang-cadang and other diseases, and drought resistance.

New diagnostics

- Prepare new diagnostics for coconut diseases.

Disease control

The distribution and relative importance of diseases of coconut are listed in Table 11. The priority diseses for investigation by any new international initiative are:

Phytophora palmivora (important in all coconut-growing regions)
Lethal diseases (primarily mycoplasma-like diseases)
Viris/viroid diseases

There are no reliable global estimates of total losses attributable to disease on coconut. Cadang-cadang disease in the Philippines was estimated to be causing annual losses of US$ 16 million per year during the 1950's and it has continued to spread since then (World Bank, 1988).

The existence of several diseases whose etiology remains unknown despite many years of research suggests the need for a concerted international research effort. This would facilitate collaborative research on the target diseases. Priority should be given to the lethal diseases. There are several lethal diseases, including some mycoplasma-like diseases of unknown etiology in Africa and Latin America which are killing existing trees and precluding new plantings in some areas.

TABLE 11: Distribution and severity of coconut diseases

	Asia				Pacific	LAC	Africa
Disease	India	Indo-nesia	Phil-ippines	Sri-Lanka	PNG/ Pacific Islands	Latin America and the Caribbean	Africa
Phytophthora palmivora	+	+++	+	+	+	+	++
Virus/viroids	-	-	+++	-	++	-	-
Mycoplasmas	+++	+	-	-	-	+++	+++
Unknown Etiology	+	+[a]	+[b]	+[c]		++	
Aspergillus (Aflatoxins)	++	++	++	++	++	++	++

Severity; +++ high, ++ medium, + low

Unknown etiology

a Natura wilt in Indonesia
b Saccarro wilt in the Philippines
c Leaf scorch in Sri Lanka
d Hart rot in Latin America

Disease indexing techniques should also be developed to allow the safe international exchange of germplasm. This is particularly important for virus and viroid diseases (such as cadang-cadang and foliar decay). Improved (and quicker) methods for screening for disease resistance are also required.

The recent report of a cadang-cadang-like viroid from Solomon Islands suggests that the geographic distribution of coconut diseases is not well known. Disease surveys should be funded in any international program to clarify the present distribution of diseases. This is important for international quarantine and for the safe movement of germplasm, as well as for the development of national disease control programs.

Pest Control

There are several major insect, mammalian and weed pests of coconut. The geographic distribution and relative importance of insect pests are shown in Table 11. The priority areas for international support should be the development of integrated pest management practices applicable to major pests in several countries.

Biological control is a particularly appropriate technology for smallholders, since it requires few inputs, and is self-sustaining. It is also especially suited to the restricted environment of islands where coconuts are the dominant crop (Waterhouse and Norris, 1988).

The following specific research topics could be addressed.

- Inter-country exchange of natural enemies against major pests for laboratory screening and field testing.
- Surveys for natural enemies in as yet unexplored areas (e.g. Burma.)
- Identification of improved strains of viral and fungal pathogens used for the biological control of the Rhinocerous beetle.
- Contract research to specialised laboratories for work on promising new technologies (such as the use of pheromes).
- Biological control of the weed Chromolaena odorata.

There may be possibilities for public and private sector collaboration in research on processing technologies and food technology.

Sustainability of Coconut-Based Farming Systems

Coconut is suited to multiple-cropping, and is traditionally part of along-term, multi-story farming system in many countries. These traditional tree-crop systems have proved to be sustainable over centuries. The continued sustainability of these systems is vital to the ecological and social stability of these areas.

TABLE /1: Regional distribution and severity of coconut pests

INSECT	India	Indo-nesia	Phil-ippines	Sri-Lanka	Pacific Islands	Latin America	Africa
Rhinocerous beetle	++/+	+++	+++	+	+++	-	++
Leaf eating caterpillars	+++	+++	++	+++	+	+++	+++
Spike moth (Thirathba sp.)	-	++	+	-	+	-	-
Weevils (Rhynchophorus)	+	++	++	++		+++	++
Mites	-	+	-	-		+++	++
Nematodes	-	-	-	-		+++	
Copra beetle	++	++	++	++	++	++	++

Severity: +++ high, ++ medium, + low

Various multi-cropping systems have been recommended for coconut, as part of rehabilitation and replanting programs. Socio-economic research is required to assess the economic returns from mono-cropping and multi-cropping systems, for traditional varieties and for hybrids. The economics of smallholders using inputs, such as fertilizers for coconut need to be examined critically. Smallholders are often reluctant to fertilize coconut, especially when the price of copra is low.

The economics of replanting systems also need to be addressed, and ways found to provide income to farmers while the new trees are coming into bearing. Even for the early-bearing hybrids, the first nuts are not harvested for 3 or 4 years.

Rehabilitation of Existing Plantings

Significant and rapid improvement in the production of many existing coconut smallholdings should be possible if economic means of enhancing the nutrition of the palms can be developed; The research priorities are:

- Establishment of response curves of major nutrients, particularly K, under differing conditions of moisture availability, to permit better interpretation of leaf analysis results.

- Effect of fertilizer on drought tolerance with emphasis on the effect of chlorine on stomatal activity.

- Residual effects of fertilizer to better predict the influence of discontinued application at times of low product prices.

- Nutrient recycling and the benefits to be derived from minimizing the removal of plant products from the farm.

- Effect of leguminous shrubs and trees in the interline to enhance soil conditions and nitrogen status with the production of firewood as an additional potential benefit.

Post-harvest Handling and Processing and Food Technology

There is a need to make more efficient use of the total coconut resource. The present practice of producing copra, then coconut oil is wasteful. A process which allowed the direct production of high quality coconut oil would be extremely valuable.

Small-scale processing techniques which allowed the production of coconut oil (and other products) at the village level would also be useful, especially in isolated areas with infrequent shipping services. The development of simple, mobile dehusking devices is also a priority.

These issues are important for smallholders, who require less labour-intensive means for processing coconut. Etherington (1988) has reviewed the possibilities for research into new processing technologies which would maximize returns to smallholders.

There is a need to develop and market all the usable products from the coconut tree. The present small market for fresh coconuts could be expanded if improved methods for the post harvest handling of fresh coconuts (including young drinking coconuts) were available. There may also be opportunities to develop new food products from coconut for wider sale. There is a need for market research to identify potential new products, and the promotion necessary to establish coconut products (both new and traditional) in new markets. The growing urban markets in developing countries may offer new openings for coconut.

The majority of coconuts (approximately 70%) are consumed in the vicinity of their production, but a substantial volume (30% of total production) enters world markets in the form of products derived by processing in the producing countries.

The broad objectives of coconut research must be:

- to increase nut production to satisfy increasing domestic requirements;
- to increase the size of the coconut processing industry;
- to strengthen its competitive position;
- to increase the size of the markets for coconut products.

These objectives are inter-linked. Through research on germplasm improvement, disease and pest control and sustainability, an increase in nut production is sought, together with reliability of supply. Reduction of waste after harvest complements this approach. In many countries good post-harvest handling offers substantial scope for effective increase in domestic supply of food and animal feed, and of the marketable surplus for use as raw material by processing industries. Advantage cannot always be taken of that surplus unless expanded markets can be secured for the products of the industries.

There are two main foci for international research efforts on coconut post-harvest: (1) the health of coconut consumers, and (2) value added in coconut processing. The first relates to the toxic metabolites which contaminate badly handled and badly processed coconut foods and feeds. The second will be best addressed in the short term through improvements in copra production and processing - the only system available at present which offers market outlets for kernel products commensurate with the volume of nuts available for processing. These improvements must be accompanied by a progressive increase in the proportion of nuts converted into higher priced products such as desiccated coconut and coconut cream. Market research, and technology response to its findings is essential to foster the development of increased sales of these products.

It is incorrect to assume that improvements in the post-harvest area require only the wider application of existing technology. There are many research tasks to be addressed. Some can be met through bilateral programmes, addressing country-specific problems. However, there are problems requiring research which affect coconut producers in many countries, and which are appropriate for public sector support under international auspices.

The post harvest research requirements for coconut as described by Adair (1989) are summarised here. The present research needs concern the domestic processing of coconut, and the more efficient production of copra, coconut oil, desiccated coconut, coconut cream, shell, fibre products and stem are summarised below. Emphasis in any international intiative should be given to the processing of the major products (copra and coconut oil), since improvements here will be relevant to producers, in many countries.

(1) Domestic Processing of Coconuts:

More efficient, less wasteful, and less laborious methods of extraction of cream and oil from fresh kernel.

(2) Copra production:

Reliable sampling methodology; reliable and rapid methods of assessing moisture content of kernel, suitable for field use. Standardised methods of aflatoxin determination. Improved equipment and procedures for copra making, with increased energy efficiency. Processes for de-toxifying aflotaxin-contaminated copra, unrefined coconut oil and oilcake.

(3) Coconut oil:

Improved understanding of the role of coconut oil in human nutrition; additional industrial uses of coconut oil.

(4) Desiccated coconut:

Better market information as a guide to technological R&D requirements; clearer product standards; improved hygiene; better energy efficiency in processing.

(5) Coconut cream:

Better market information as a guide to creation of new outlets.

(6) Shell:

Integration of shell charcoal production with kernel-processing operations to optimise use of the shell's energy and to reduce atmospheric pollution.

(7) Fibre products:

Better market informaton as a guide to technological research needs; optimisation of mechanical de-husking; improvement of safety and efficiency in extraction of fibre from husks; adaption of fibre processing equipment to new scales of operation to suit potential new users; reduction of negative effects on the environment through identification of viable technologies for use of coir dust.

(8) Stem:

Better market intelligence as a guide to the expansion of stem utilisation; better technology for the preservation and utilization of stem fractions.

8. INSTITUTIONAL OPTIONS

There are several possible options for providing additional support for coconut research under international auspices. Four possible mechanisms and their major advantages and disadvantages are outlined below.

Option 1. Provide Additional Support to National Programs

Advantages

Builds on existing research capacity and facilities in national programs.
Decentralized activities, in major and minor producing countries.

Disadvantages

Does not bring a critical mass of scientific expertise and resources to the international problems of the crop.
No international focus.
No global view of research needs.
No in-house research capacity.

Option 2. Establish an International Coconut Research Network amongst national research institutes, and other interested regional and international bodies to coordinate existing activities.

Advantages

Maximizes use of existing programs and institutions.
Cost-effective mechanism.
Develops a strong sense of equal partnership.
Provides global view of research needs.
Decentralized activities, in major and minor producing countries.

Disadvantages

Previously attempted in the Asia-Pacific region with little success.
Without an international coconut research centre (analogous to the International Potato Centre), problems of scientific back-stopping may arise.
Long-term funding may be difficult to obtain.
Continuity of funding would continue to be a problem since most research would be funded from national and bilateral sources, on a short-term project basis.
No in-house research capcity.

Option 3. Establish an International Coconut Research Centre in the mode of existing commodity research centres such as IRRI, with centralized research facilities.

Advantages

Provides a focus for research, training, and documentation on coconut.
Assembles a critical mass of scientists and resources at one location, under effective management and with continuity of funding.
Establishes a 'centre of excellence' in coconut research.
Provides global view of research needs.
Guarantees free availability of research results and improved germplasm for international use.

Disadvantages

High cost, especially in establishment phase.
Does not build on nor support present national research capacity and facilities at existing research centres.
Geographic concentration of staff and resources.

Option 4. Establish a new body (called here the International Coconut Research Council) to identify, support, promote, and undertake research of international significance. The new body would be able to undertake research itself; contract research to national programs and to other advanced laboratories elsewhere; establish subject-specific research networks on problems of international significance; and establish regional networks.

Advantages

Brings additional scientific and financial resources, and leadership to coconut research.
Provides global view of research needs.
Identifies internationally important research priorities.
Provides continuity of funding.
Builds on existing research capacity by providing additional funds to enable national programs to undertake research of relevance to many countries.
Provides a mechanism to internationalize the activities of existing coconut research institutions (where they so desire).
Provides financial support for germplasm collections and breeding programs of international significance.
Facilitates collaborative research amongst scientists in different countries.
Facilitates participation by both public and private sector organizations.
Allows participation by small countries with no national research program in an international coconut breeding and evaluation program.
Decentralized approach.
In-house research capacity, and limited in-house research facilities for germplasm unit only.

Disadvantages

Research leadership and management more difficult than with a commodity centre at one location.
More difficult to avoid a 'top-down' perception with national programs.

9. AN INTERNATIONAL COCONUT RESEARCH COUNCIL

9.1 Institutional Arrangements

The preferred option in the consultations that formed part of this study is to establish a new body whose purpose would be to identify, support, promote and undertake priority research on coconut of international significance. It is called here the "International Coconut Research Council."

The new body would be able to:

1. Undertake research itself on a limited number of topics of international significance, with some emphasis on those related to germplasm conservation, evaluation and improvement;
2. Contract research to national programs and to other existing research institutions on the priority research topics of international significance;
3. Establish subject-specific research networks amongst active research workers, on problems of international significance and contract additional research on these subjects; and
4. Establish regional networks, to identify the priority problems requiring additional research efforts, and to facilitate the distribution of research results to all coconut producing countries.

The advantages of establishing such an international initiative are that it could:

1. Identify important research priorities relevant to several producing countries, which cannot be addressed adequately by any one country.
2. Build on existing research capacity by providing additional funds to enable national programs to undertake research of relevance to many countries.
3. Provide additional support for germplasm collections held under international auspices and breeding programs of international significance.
4. Allow small countries with no national coconut research program to participate in the evaluation of new technologies, including new coconut varieties, and improved processing technologies.
5. Provide continuity of funding, especially for coconut germplasm collection held at several sites under international auspices, and related research on coconut improvement of importance to many countries.
6. Facilitate participation in an international coconut research effort by both public and private sector organisations. The buyers of coconut oil in industrialized countries would benefit from continuity of supply from producing countries. These private sector interests could be invited to participate in, and contribute to, an international research effort.

9.2 Organization and Functions

The components of the proposed International Coconut Research Council are:

- Board of Directors
- Headquarters Unit
  - Administration
  - Information Services
  - Training Program
  - Socioeconomic Program
- Germplasm Research Unit
- Regional Networks
  - Asia/Pacific
  - Africa
  - Latin America and the Caribbean
- Subject Specific Research Networks
  - Tissue Culture
  - Diseases
  - et al.

The proposed initial complement of senior staff would be 14. In addition, the Council would require some support staff. It would also require a significant contractual research budget. The Council would then have the responsibility to commission research of international significance with national programs and other interested research organisations within its identified high priority research areas.

The indicative staffing of the Council is as follows:

Headquarters Unit

Director
Administrative Officer
Information Officer
Training Officer
Socio-economist

Germplasm Research Unit

Germplasm conservator - germplasm collection and conservation
Plant breeder - hybrid production
Plant breeder - international testing network
Plant pathologist
Research station manager

Regional Networks

Four regional coordinators for 1) Asia, 2) Papua New Guinea and the Pacific Islands, 3) Africa, and 4) Latin America and the Caribbean.

Board of Directors

International body, composed of individuals, appointed in their personal capacity, who are knowledgeable about the production, problems and uses of coconut, and its research needs. It would be important to include persons knowledgeable of the private sector, as well as those with public sector interests. Members would come from both developing and industrialized countries.

The functions of the Board would be consistent with those of other CGIAR centres, and which are well documented.

Headquarters Unit

The headquarters unit would provide the management services and logistical support for the Council, and its germplasm research unit, regional and subject-specific research networking. It would also provide training and information services.

Germplasm Research Unit

The germplasm research unit would be responsible for the management of the coconut germplasm collection established under international auspices, with a primary site in Asia (preferably in Indonesia), and secondary sites elsewhere in Asia/Pacific, Africa, Latin America and the Caribbean. The unit would conduct research on the collection, conservation, dissemination and evaluation of coconut germplasm, including both natural selections and hybrids.

The first priority for an international research initiative on coconut is for the collection, conservation, distribution and evaluation of germplasm. This is the area with high potential pay-off from research. Already available hybrids have been shown to yield at least double the best available local material. A well-planned and internationally financed program able to make available higher yielding material to many producing countries for evaluation under local conditions has the potential for high returns. Average coconut yields have languished around 500 kg/ha/year for 25 years.

The long-term nature of coconut breeding, and the need for large areas for field-based germplasm collections means that few countries have been able to mount effective breeding programs. Even those countries which have breeding programs suffer from lack of continuity in funding and a consequent stop-start approach to breeding, and often poor maintenance of the collections. All are breeding for national priorities. None has the mandate to collect germplasm for use throughout the world, nor to breed hybrids and make them freely available for inter-country evaluation.

It is therefore considered essential for the effective implementation of an international research initiative on coconut that an internationally-funded germplasm research unit be established. The Unit would require sufficient land (about 1000 ha) on which to plant the primary site of a coconut germplasm collection which would be held under international auspices. Collaboration with existing collections would be essential, in order that parts of the international collection be replicated at sub-sites elsewhere. Free exchanges of material would be a key requirement for all participating countries.

In the early years, existing collections, such as those in the Cote d'Ivoire and Jamaica would be key sites of activity. They would continue to play an important role (should they so desire) as a new international collection was established with its primary site in Asia.

The primary site of the international collection would be located ideally in an area usually free of natural disasters (especially typhoons), where there are no major disease problems that would preclude the exchange of material, and near the centre of origin of the crop (probably in the Asia/Pacific region.

Regional Networks

The primary role of the regional networks would be to provide guidance on the identification of problems affecting several countries, and the relative priority of these problems. The regional networks would also be important in facilitating the international exchange and evaluation of germplasm. The regional networks would be the major vehicle for the dissemination of results coming from the subject-specific research networks and contracted research projects. A Regional Coordinator would act as the secretary to the Steering Committee in each geographic area.

It is proposed that three regional networks be established for 1) Asia/ Pacific; 2) Africa; 3) Latin America and the Caribbean. Ideally, there would be two coordinators within the Asia/Pacific network, one responsible for Asia, and the other for Papua New Guinea and the Pacific Islands, as well as one coordinator for Africa, and one for Latin America and the Caribbean.

The regional coordinators would be research workers who would also coordinate at least one of the subject-specific networks appropriate to their technical area of expertise. Each would be based at a suitable coconut research institution in their geographic area of responsibility.

Regional networks would also be one of the major vehicles for the dissemination of results coming from the subject-specific research networks and contracted research projects.

Subject-Specific Research Networks

The international coconut research council would also sponsor subject-specific collaborative research networks. These networks could be large or small, depending on their subject matter and amount of relevant research in progress. Not all member countries need belong to all networks, since the research results would be made widely available through the regional networks.

Illustrative subject matter areas on which the Council could sponsor collaborative research networks are:

- Tissue culture
- Coconut diseases
- Biological control of coconut pests
- Post-harvest handling and utilization

Training Program

The Council would organize a training program associated with its priority research areas. This program would include: In-service training for research scientists and technicians from national programs; and training for scientists and technicians on specialized research techniques.

The training program would cooperate with available training institutions. It would foster study exchanges between countries, based on their relative strengths in different areas of coconut research. It may also include attachments to institutions in industralized countries where relevant research is being conducted. A training officer would be located with the headquarters unit to manage the program.

Information Services

The Council would provide information services to assist the collaborating scientists. The Council's information and documentation services would complement the activities of existing agencies such as APCC and the Coconut Research Institute in Sri Lanka. The International Development Research Bureau (IDRC) is presently considering support for an integrated coconut information program, to be implemented by the APCC in Jakarta. This would be a significant contribution to the information needs of coconut researchers, and would be compatible with the concept of an international initiative on coconut.

The proceedings of workshops and seminars sponsored by the Council would be published and made widely available. Members of subject-specific research networks would be encouraged, and, if necessary, assisted in the publication of their results.

9.3 Locations of Activities

It is proposed that the international coconut research council establish itself in a decentralised fashion so as not to build itself into a centralised-commodity institute, and to facilitate participation of existing research institutes in the international program.

The Germplasm Research Unit and the main site of the international germplasm collection should be located in the centre of origin of the crop in the Asia/Pacific region, in a country without lethal diseases; and outside the typhoon belt, since the primary site would be a field-based collection.

In keeping with the decentralised nature of the initiative, it would be preferable for the Headquarters Unit to be located in a different country to the Germplasm Unit. Given that Asia is the main producing region, the headquarters should be located in Asia, in a country with substantial scientific capacity, efficient international communication facilities, and good international airline connections.

The regional coordinators would be located in coconut research institutes in countries in their regions of activities. The interest of various producing countries in hosting a regional coordinator would need to be explored.

10. CONCLUSION

A case has been presented for establishing an international research initiative on coconut. This subject has been examined before by other bodies interested in improving the productivity of coconut, and increasing the incomes of the millions of smallholders dependent on the crop. Although the needs have been demonstrated, and the potential returns from research appreciated, these other efforts have lapsed, due to various political and financial reasons.

In the intervening period, research workers have shown the potential for substantial increases in yield from crop improvement research, the development of new technologies for pest and disease control, and the improvement in processing of coconut products. Investment in research in these priority areas would benefit directly smallholder producers in many countries. Coconut research is commended to TAC for its consideration as an international research initiative appropriate for support by the CGIAR.

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Annex A

TESTIMONY
BEFORE THE U.S. SENATE COMMITTEE ON LABOR AND HUMAN RESOURCES ON S. 1109, A BILL TO AMEND THE FEDERAL FOOD, DRUG AND COSMETIC ACT TO REQUIRE NEW LABELS ON FOODS CONTAINING COCONUT, PALM AND PALM KERNEL OIL

BY:

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DECEMBER 1, 1987

Mr. Chairman and Members of the Committee:

Thank you for this opportunity to ppear before you today and to alert ou to the possibility that our quest for healthy American diet is being disorted by an unwarranted attack against ropical oils.

My testimony will focus on coconut il, also known as the lauric acid group. ecause this particular tropical oil along with palm kernel oil) is saturated, ssumptions have been made that it has n adverse effect on blood cholesterol. n fact, the fairest interpretation of the cientific literature says that there is a eutral effect, even in situations where oconut oil is the sole source of fat. In most cases, coconut oil makes up less than 2% of the calories per day, thus aking a trivial contribution to fat inke.

Coconut oil can also be seen as a specialty oil that plays an important role in our food products. It increases shelf-life in most products and thus reducces the cost of production; and it adds to flavor (principally, in biscuits, cookies, and other baked goods) and thus satisfies the consumer.

The reason for these two phenomena is that this particular vegetable oil contains shorter chain fatty acids which affect the oil's melting point. Therefore, as a cookie changes from room temperature to body temperature, a cooling effect occurs that enhances the taste. At the same time, the body requires no transport system to absorb, digest, or metabolize this oil. Therefore, virtually none of it is incorporated into body fat, and nor? of it is available for the synthesis of cholesterol.

It is also important to note that coconut oil has long been an important component of medical foods and baby foods. Research in our laboratory is demonstrating that coconut oil may be the preferred fuel for individuals sustaining serious illness, including burns, sepsis, malnutrition, and immunologic problems, including AIDS. We are currently investigating the effects of lipids on endotoxemia, which is particularly prevalent in patients with AIDS and other immunologic deficiency syndromes. We have shown the superiority of coconut oil in comparison to polyunsaturated oils (corn oil).

It is now apparent that selective labeling requirements that focus on the lauric acid tropical oils (coconut and palm kernel) would represent an inaccurate and misleading use of existing data. There is simply no scientific basis for describing coconut oil as a health risk.

Mr. Chairman, those who would claim that coconut oil or palm kernel oil pose a threat to the consumer are relying on misinformation allegedly derived from statements contained in the U.S. Dietary Guidelines and recommendations from health organizations such as the American Heart Association. The focus of these recommendations, however, is on weight control through calorie control, the reduction of total fat intake to less than 30% of calories and control of cholesterol. Specifically, fat intake is recommended to be 1/3 saturated, 1/3 monounsaturated, and 1/3 polyunsaturated. A focus on the so-called "omega-6" vegetable oils versus the tropical oils would yield trivial results and certainly would not be supported by scientific data dealing with the U.S. diet where these oils play such a small part in the dietary intake.

I refer you to Figure I showing the fatty acid composition of various fats, including those fatty acids typically thought to affect blood cholesterol, and thus, the pathogenic process of atherosclerosis and development of cardiovascular disease. I call your attention to the common oils and to the striking differences between sub-groups of saturated oils and polyunsaturated oils.

Any valid conclusion concerning the health effects of oils must take into consideration the chemical structure for the turated oils and must recognize that : medium chain lauric acid (C6 to 12) are quite different from the long hain (C16 to C18). Coconut and palm ernel oils derive more than 2/3 of their atty acids from lauric acids or shorter hain fatty acids. For more than 30 ears, it has been known that the group f "medium chain triglycerides" has roperties very different from long iain triglycerides which predominate soybean and vegetable oils. Saturated ts composed principally of medium iain triglycerides (MCT's) do *not* evate serum cholesterol when taken as rt of the normal diet. The chemical operties of MCT's are such that they e rapidly metabolized, and therefore nstitute a preferred energy source for e body. As a result, unlike other turated fats, they are not stored in the dy as fat.

Soybean oil, by contrast, is a long ain triglyceride. In its natural state, it polyunsaturated of the omega-6 gory. When soybean oil is hydro- iated, however, it becomes more like imal fats, which are long chain trigly- ides of the saturated variety known contribute to blood cholesterol, although in a modest to trivial fashion. Typically, soybean oil is hydrogenated when used as a substitute for coconut oil and does tend to elevate cholesterol levels. Coconut oil, in contrast, whether in its natural state or hydrogenated, still has the majority of its fatty acids as a medium chain triglyceride.

As already noted, ideal dietary fat intake combines a mixture of three main fat groups, as reflected in the U.S. Dietary Guidelines and the American Heart Association's recommendations. In practice, since coconut oil is only a tiny fraction – less than one percent – of the U.S dietary fat intake, and since it is a mixture of mono- and polyunsaturated fats, it is a very unique and desirable fat for human use.

It is interesting to consider how misinformation regarding lauric acid oils originated. Largely, this arose from the fact that coconut oil has always been cheap and easy to use in animal experiments investigating the basic science process of atherosclerosis. While such experiments were helpful in these investigations, they bear no relationship to the topic of a healthy heart diet. The principal reason is that in atherosclerosis investigations, two to three percent of fat calories must come from linoleic acid to satisfy the essential fatty acid requirement. Yet in the experiments that have been used as the foundation for labeling coconut oil as a "bad fat," this linoleic acid component was usually missing. When you study coconut oil as part of a diet that does contain linoleic acid, as the American diet does, you discover that coconut oil does not affect the process of atherosclerosis any differently than any other vegetable oil, even though it is high in saturates. Thus, for the U.S. consumer, the use of coconut oil does not increase the risk of heart disease.

In contrast, hydrogenated soybean and other vegetable oils do tend to raise cholesterol levels. Moreover, if those vegetable oils are consumed in a natural state as part of a diet that derives more than ten percent of its calories from polyunsaturated, they may increase the risk of various types of cancer. We have provided a detailed review of the animal and human studies to document these facts.

When one combines our studies with the epidemiologic data developed by Dr. Quintin Kintanar, Executive Director of the Philippines Council on Health Research and Development, the findings reveal that no relationship exists between coconut oil consumption and heart disease mortality.

Dr. Kintanar's findings are illustrated in Table 1, which shows that in the Philippines, where coconut oil is a far greater portion of the daily dietary fat intake than in the U.S., the rate of cardiovascular disease is much *lower* than in the U.S. Table 1 also shows the Philippine caloric pattern of diet with specific focus on coconut oil consumption in relation to cardiovascular disease mortality rate. Over half of the cardiovascular disease is due to coronary heart disease.

In the Philippines, a diet deriving six percent of calories from coconut oil correlates to an incidence of heart attack mortality of 22 per 100,000. In the U.S., the intake of coconut oil is less than one percent of dietary calories; yet the incidence of heart attack mortality is 227 per 100,000 – ten times the incidence in the Philippines. Further in neither the Philippines nor the U.S. is there a proven relationship, either statistically or as a matter of cause and effect, between coconut consumption and heart disease. Indeed, the average coconut oil consumption in the U.S. is less than two percent of the total annual edible oil consumption of 16 million tons. While the trend in U.S mortality due to cardiovascular disease is declining, the consumption of coconut oil remains stable, further challenging the focus on coconut oil as a health risk.

In closing, I wish to emphasize that a great deal of research remains to be done in analyzing the effects of dietary fatty acids on human health. It is not a subject that is yet ripe for legislation of the sort under consideration today. It would be particularly unfortunate if consumers were deterred from buying products containing coconut oil on health grounds, when the most recent medical evidence suggests that coconut oil is more beneficial to consumers than the hydrogenated fats that would be exempt from the proposed legislation.

Thank you.

ANNEX 8

THE BUREAU FOR THE DEVELOPMENT OF RESEARCH IN TROPICAL PERENNIAL OIL CROPS

(BUROTROP)

Bureau for the Development of the Research in tropical perennial oil ɔs was created on the initiative of the European Economic Community and the European countries willing to reinforce and co-ordinate research ivities on coconut and oil palm in tropical countries and the ɜrventions of donor countries.
in the view of reinforcing North-South co-operation.
structure remains open to any country or organisation wishing to ticipate.

AIMS

. Long-term objectives

overcome production problems of perennial oil crops,

overcome constraints, especially in coconut and oil palm research,

promote self-sufficiency in oils and fats in certain countries in the humid tropical zone,

promote increases in income for perennial oil crop producers, particularly smallholders.

The Principles

principles governing the choice of the Bureau's activities are as lows:

he priority beneficiary is the coconut or oil palm smallholder. ut this obviously does not exclude co-operation with the plantation ector, which is called up to co-operate in research and transfer of echnology and expertise.

riority beneficiaries will be the countries with the least adequate esearch facilities and whose national and international programmes re in jeorpardy for financial or other reasons.

he Bureau will co-operate closely in every respect with national, regional nd international centres involved in tropical perennial oil crop research nd development, with existing and potential donors.

ıe geographical and top priorities are as follows:

Africa	:	1) oil palm; 2) coconut
Latin America	:	oil palm and coconut
Asia	:	1) coconut; 2) oil palm, depending on country
Pacific	:	coconut

efficiency, save on resources or avoid pointless duplication. This does not, however, rule out support for national research and development.

3. The Structure

e Bureau will not be structured to conduct research. It will organise change of information, co-ordinate and galvanize the activities of research d development centres in producer countries and encourage donor countries better their aid programmes.

e Bureau comprises:

e Executive Committee consisting of 15 members, 7 from the producer untries (Africa: 2; Latin America: 2; Asia: 2; Pacific: 1), 1 EEC presentative (DG XII) and 7 from donor countries.

e Executive Comittee manages the bureau and appoints from among its members Programme Committee and nominates the Director.

e Programme Committee has 5 members, appointed by the Executive Committee d provides technical advice to the Director of the Bureau, it meets twice arly, the day before the Executive Committee. The Committee can co-opt ternal experts as required.

4. The Programme

e Bureau's immediate objectives are:

1. Organise the exchange of information between coconut and oil palm research institutes and related organisations, by establishing research networks for coconut and oil palm.

2. Create a data base on coconut and oil palm research and development, in conjunction with specialised organisations and from data currently available or yet to be gathered.

3. Identify production constraints and research and development needs.

4. Foster research and development projects under national programmes and establish co-ordinating networks in response to need.

5. Analyse research and development staff training requirements and identify organisations capable of providing training.

6. Organise seminars, conferences and workshops.

7. Seek funding for network or national activities.

8. Edit activity reports and newsletters.

Funding

ating costs are covered by contributions from the EEC, donor countries organisations whether or not they are represented on the Executive ittee.

bureau approaches donors to obtain funding for projects it considers ssary in achieving its objectives.

LIST OF THE MEMBERS OF THE EXECUTIVE COMMITTEE OF BUROTROP

Member from the European Economic Community:

Mr. UZUREAU	DG XII

Members from the donor countries:

Dr. de HAAS	BMZ - Federal Republic of Germany
Mr. VICARIOT	MRT - France
Dr. SMITH	ODA - Great Britain
Mr. GULDENTOPS	Ministry of Agriculture - Belgium
Dr. HARDON	CGN - The Netherlands
Pr. MENDES-FERRÄO	IICT - Portugal
	Italy

Members from the producer countries:

Mr. SAWADOGO	Côte d'Ivoire
Mr. Aloïs KULLAYA	NCDP - Tanzania
Dr. MESA-DISHINGTON	FEDEPALMA - Columbia
Dr. TRIGO	IICA - Costa Rica
Dr. PUNCHIHEWA	APCC - Indonesia
	PCAARD - The Philippines
	Commission Pacifique Sud

Director : Mr. O. DUFOUR

Secretariat-translation : Mrs. G. Quentel

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ANNEX C

PHILIPPINES

SMALL COCONUT FARMS DEVELOPMENT PROJECT

Loan and Project Summary

Borrower: Republic of the Philippines

Beneficiaries: Coconut smallholders and the Philippine Coconut Authority (PCA)

Loan Amount: US$121.8 million.

Financing Plan:

Farmers	US$ 21.9 million
PCA/GOP	US$ 31.6 million
ODA	US$ 1.3 million
Bank	US$121.8 million
Total	US$176.6 million

Economic Rate of Return: 40%

<u>Background</u>. The Philippines accounts for over 70% of total international trade and 40% of total world production of copra products. Some 925,000 coconut farms occupy about 3.0 million ha, or over 25% of total agricultural land in the country. They are mainly smallholdings (half of which are less than 1 ha each, and over 90% of which are less than 5 ha), and provide incomes for some 16 million people. With over 84% of the 2.2 million tons equivalent of annual copra production being exported, coconut-based products are the third largest contributor of foreign exchange, accounting for [illegible] of total merchandise export revenues and 40% of commodity exports in 1987.

Recent market studies by independent consultants for the Bank and the Philippine Government, have concluded that future demand for coconut products, both for industrial uses and as an edible oil, is good provided Philippines can sustain end-user confidence in the continued availability of its supplies. Although Philippines is the dominant world producer of coconut-based products, its output could fall off over the coming 10-15 years because of declining yields from its aging tree stock, unless serious replanting efforts are undertaken. Coconut production is very much a smallholder operation in the Philippines and, because most coconut farmers are impoverished, there has been little private investment in replanting during the last decade. The Government launched a coconut replanting initiative in the late 1970s, but little was accomplished as funds collected from the farmers by a levy on copra sales, with an aggregate value of approximately US$1 billion, were mostly diverted for unrelated purposes. Since that time, the Government has been unable to implement any meaningful coconut replanting or rehabilitation program, with the result that the Philippines' producing tree stock is now increasingly senile, much of it dating back to the 1940s.

On the other hand, while the Philippines' ability to supply is at some risk, world demand is quite favorable. Non edible uses of coconut oil (mainly for soaps and detergents) have accounted for more than 30% of consumption in the US and close to 50% in Europe. Processing costs of coconut oil are lower than those of its main competitor, palm kernel oil, and producers of industrial chemicals have been showing an increasing preference for raw materials from renewable natural resources rather than petroleum-based synthetics. Overall, there are few economically attractive substitutes to the lauric oils for most industrial purposes. With regard to edible uses, the general demand for vegetable oils is expected to grow by about 3% p.a. over the medium-term, and coconut oil, which is a preferred cooking oil in many parts of the world, would certainly share in that growth. In other words, coconut oil's share of both the non-edible and edible vegetable oil markets is easily sustainable, with some room for modest expansion, unless end-users become convinced that they cannot rely on a stable supply from the Philippines. In that event, they would be prompted to make long-term investment decisions in favor of substitute products, especially for industrial purposes, and that would be a major setback for the Philippines itself and for other LDC coconut producers. Deterioration of this industry would have important macroeconomic consequences for the Philippines (particularly as regards loss of foreign exchange earnings) and would seriously undermine the Government's rural poverty alleviation efforts.

<u>Project Objectives</u>. These would be to support an appropriate long-term strategy for the coconut industry in the Philippines, which would increase the incomes of small coconut farmers by improving coconut yields and copra quality, and would boost foreign exchange earnings by ensuring a gradually increasing and reliable supply of higher quality copra for processing and export.

Project Description. To sustain these objectives, a long-term program of coconut replanting and productivity improvement, supported by the necessary infrastructure and strengthened Government services, would be set in place through the proposed project. The five-year project would constitute the critical first phase of a long-term small coconut farms development program which, over the next twenty years, would rehabilitate the coconut industry and ensure its continued contribution to the Philippine's export trade. The project would develop and apply improved technologies, establish the infrastructure and operating procedures and prepare the institutional and financial bases for the program. The project consists of: (a) establishment of seedgardens, nurseries and other infrastructure sufficient to sustain a replanting program of about 50,000 ha per year; (b) replanting of 25,000 ha and support for intercropping during the first three years of replanting; (c) rehabilitation of 348,000 ha of middle-aged palms and the development of 50,000 ha of immature palms; (d) equipping of laboratories for aflatoxin assay and research and demonstration of techniques, survey of aflatoxin origins and incidence, and a pilot program to introduce hot-air copra driers to smallholders in 2-3 major mill catchment areas; and (e) institutional strengthening of the Philippines Coconut Authority (PCA). The total cost of the project is estimated at US$176.6 million, with a foreign exchange component of US$91.1 (52%). The latter includes US$1.3 million equivalent for technical assistance and equipment, which would be co-financed by a grant from ODA. A breakdown of costs and the financing plan are shown in Schedule A. Amounts and methods of procurement and of disbursements, and the disbursement schedule, are shown in Schedule B. A timetable of key project processing events and the status of Bank Group operations in the Philippines are given in Schedules C and D, respectively. IBRD Map No. 21986R is also attached. The Staff Appraisal Report No. 8210-PH dated May 1, 1990, is being distributed separately.

Benefits. The main project benefits would be: (a) improved productivity and farm incomes for small coconut farmers, tenants and resident workers, who are a major poverty group in the country; (b) increased foreign exchange earnings from coconut product exports; and (c) development of technical, financial and institutional bases for the long-term coconut replanting program. Some 275,000 coconut farms (about 30% of total coconut farms in the country) are expected to benefit from the project's replanting, rehabilitation and technical support activities and about 180,000 farms from the drying component. The project on-farm activities would generate about 12.3 million days of incremental work per year (equivalent to about 50,000 jobs) at full development. At the peak, incremental exports of coconut products would be about US$97 million per year. The project would provide the technical basis for improving planting material, cultural techniques and pest/disease control in future phases of the long-term program. The establishment of about 1,000 ha of seed gardens would supply sufficient material by the year 1997 for replanting the national coconut stand at a rate of 50,000 ha per year, appropriate to the long run needs of the industry and would reestablish confidence among end-users in the future supply of better quality coconut-based products from the Philippines. The internal economic rate of return for the overall project is estimated at 40%.

ANNEX D

Selected International and Regional Activities on Coconut Germplasm 1968 - 1990

H. Harries

ANNEX D

Selected International and Regional Activities on Coconut Germplasm 1968-1990*

Year	Project	Lead Agency
1968	Introduction and exchange of coconut germplasm 1959-1966	FAO Technical Working Party on Coconut Production, Protection, and Processing

This report gives, in tabular form and in chronological order, information from many sources on introduction and exchange of coconut germplasm effected from 1959 to 1966. Much of this period coincided with the life-span of an FAO Regional Coconut Improvement Project and followed the First Session of the FAO Technical Working Party on Coconut Production, Protection and Processing, held in Trivandrum, Kerala State, India, in November-December, 1961.

Year	Project	Lead Agency
1969-1981	Coconut Breeders' Consultative Committee	FAO Technical Working Party on Coconut Production, Protection, and Processing

The Coconut Breeders' Consultative Committee was set up in 1968 as an _ad hoc_ sub-committee of the FAO Technical Commission on Coconut Production, Protection, and Processing. Three Technical Working Parties were held (India, 1961; Sri Lanka, 1964; Indonesia, 1968) before the Breeders' Committee was established and two afterwards (Jamaica, 1975; Philippines, 1979). The FAO Technical Working Party on Coconut Production, Protection and Processing was abolished in 1981.

Following the format used in the 1968 report, tabulated data on coconut germplasm introduction and exchange, together with written information on evaluation and utilisation, were compiled in ten issues of a Yearly Progress Report on Coconut Breeding between 1969 and 1978. This became the Yearly Progress Report on Coconut Research and Dvelopment for three issues from 1979 to 1981 and continued to include the contributed germplasm information. At its zenith a forty page report was distributed to 224 individuals or organisations in 54 different countries.

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* Information provided by Dr. Hugh Harries, Consultant, and formerly Secretary of the Coconut Breeders Consultative Committee.

Year	Project	Lead Agency
1979	Multilocational testing of promising hybrids	UNDP/FAO

A detailed protocol for multilocational testing of F_1 hybrid coconuts was drawn up and countries in Asia and the Pacific expressed interest in the proposal but it did not proceed.

Year	Project	Lead Agency
1981	IBPGR Directory of Germplasm Collections 5.1 Industrial Crops	International Board for Plant Genetic Resources (IBPGR)

This directory was produced towards the beginning of the IBPGR's active interest in coconuts when it assisted with germplasm collection by Indonesia, Philippines, Malaysia, and Mexico between 1980 and 1983.

Year	Project	Lead Agency
1987	IBPGR/SEAP Working Group on Palms and UNDP/FAO Working Group on Genetic Improvement	IBPGR Cooperative Regional Programme Southeast Asia and FAO/UNDP Project RAS/80/032 Coconut Production in Asia and the Pacific.

A joint meeting was held at which genetic resource activities in India, Indonesia, Malaysia, Papua New Guinea, Philippines, Sri Lanka, and Thailand were reported. Recommendations were made on collecting and characterization, evaluation, multiplication, conservation and documentation, germplasm exchange and utilisation, research, and regional joint projects. IBPGR, FAO and IRHO were also represented at the meeting.

Year	Project	Lead Agency
1988	UNDP/FAO Working Group on Genetic Improvement	FAO/UNDP Project RAS/80/032 on Improved Coconut Production in Asia and the Pacific.

A second meeting of coconut breeders was held under the auspices of the FAO/UNDP regional coconut project, with participation from Indonesia, Malaysia, Papua New Guinea, Philippines, Sri Lanka, Thailand, Vanuatu, and Western Samoa. FAO and IRHO were also represented.

The objectives of the meeting were to establish a protocol for varietal trials, discuss and recommend appropriate quarantine procedures and possibilities for expanding the use of embyro culture to facilitate the safe exchange of plant material; review recent germplasm exploration, identify areas for collecting and propose a program for phased exploration and collection; and discuss accessibility of collections held in the region.

Year	Project	Lead Agency
1989	International Registration Authority for Coconut	International Society for Horticultural Science (ISHS)

The ISHS interest in making a checklist of coconut cultivars was first expressed in 1973. In addition to clarifying the confusion over identifying named types of coconut there was the stated intention of registering the F_1 hybrids which were being produced in commercial quantities for the first time. The initiative was not followed up at that time. Renewed interest by ISHS in 1988 has been supported by the International Palm Society and a Registrar is likely to be appointed this year (1989). There are international registration authorities for many ornamental plants and for fruit tree crops, such as mango, but none for any palm genera.

1989	Coconut Germplasm Research Unit	UNDP/FAO

A proposal for a national germplasm collection in Indonesia has been submitted to FAO.

1989	Latin American Regional Coconut Germplasm Collection	UNDP/FAO

A proposal for research in Mexico into lethal yellowing disease has been submitted to FAO. If accepted it would involve varietal testing for resistance. A regional germplasm collection in a disease-free country in the region would be required. Interest in the possible location of the regional collection has already been expressed in Costa Rica.

[1990]	Inter-country Trial of Promising Coconut Hybrids and Cultivars	Asian and Pacific Coconut Community

A proposal for multilocational, inter-country trials of promising coconut hybrids and cultivars has been submitted to APCC by the Philippines. Similar to a project proposed to FAO in 1979 (see above) this will take advantage of embyro culture techniques to promote safer and faster exchange of important coconut germplasm.

The immediate objectives are to undertake performance tests of promising coconut varieties, hybrids and cultivars, to identify widely adaptabed coconut ecotypes for use in planting and replanting programs and to study their reaction to pests and diseases in the region.

Year	Project	Lead agency
[1990]	Training course on coconut collection, conservation and evaluation.	International Board for Plant Genetic Resources, Office for South and Southeast Asia.

The IBPGR has committed itself to support a course in the Philippines with a course tutor from IRHO. India, Malaysia, and Thailand have expressed interest in participating and other countries in the region are likely to follow suit.

[1990]	Coconut germplasm directory	International Board for Plant Genetic Resources, Office for South and Southeast Asia

The establishment of a coconut germplasm directory is on the list of activities to be executed by the IBPGR Office for South and Southeast Asia.

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