the Malaysian share of total world gross exports of palm oil and palm kernel oil to continue to rise by the year 2000. In the case of palm oil we expect it to reach 75% compared with 70% this year and in the case of palm kernel oil 76% compared with 72% this year.

However, substantial increases in exports are expected also from Indonesia, namely to about 2.2 million tons in the case of palm oil (from the present level of around 0.3 million tons) and to 0.2 million tons in the case of palm kernel oil (from the present level of only 13,000 tons) (Fig. 7).

CONCLUSION

Expressed in numbers, the development of world palm oil and palm kernel oil production and exports from 1958 to 1984 and the prospects for the year 2000 are as shown in Table I. These numbers as well as virtually all others have been taken from *OIL WORLD – The Past 25 Years and the Prospects for the Next 25 in the Markets for Oilseeds, Oils, Fats and Meals*, published by ISTA Mielke GmbH, 2100 Hamburg 90, West Germany. That 150-page book contains many additional details on this subject.

Present and Future Position of Coconut Oil in World Supply and Trade

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ABSTRACT

Coconut oil will remain available in quantities enough to meet the needs of industrial, institutional and household consumers in market countries at least throughout this century. Principal producing countries have restructured their domestic consumption formulations to make this commodity available to its users at more steady supply levels. This is being coupled by rejuvenation of tree stands, productivity measures and expanded hectarage. At the same time, parallel sources of similar oils are being explored in coconut-producing countries like Papua, New Guinea, which now is a coconut and palm oil supplier nation.

The availability of coconut oil to its major consuming countries in North America, the EEC and industrial nations of Asia and the Pacific has been assured by domestic production and imports.

In the case of the United States, this was the pattern at the time two coconut oil mills were crushing copra on the West Coast–Baker Commodities in Los Angeles and Cargill in San Francisco. When the two oilmills ceased to crush the coconut oilseed in 1972 (Baker) and 1974 (Cargill), the U.S. depended solely on imports mainly from producing countries like the Philippines and Malaysia (whose copra is sometimes processed in Singapore and re-exported to the U.S.).

For the European Economic Community, most of its member countries depend on supplies from oilmills in The Netherlands, West Germany, the United Kingdom and Italy. Other West European countries like Sweden (Karlshamn Oljefabriker) and France (Unipol Marseilles) crush copra for its coconut oil needs. This sytem was at its peak in 1976 when the Common Market produced 547,000 metric tons (MT) coconut oil out of 851,700 MT copra imported from the Philippines; Papua, New Guinea; Mozambique, Malaysia, Vanuatu, Solomon Islands and Western Samoa. In that year, the EEC imported only 390,400 MT coconut oil.

However, in subsequent years, owing mainly to the policy of the Philippines to encourage domestic processing of its exportables, the EEC has been importing its coconut oil needs from the coconut-producing countries. By 1981, its imports reached a peak 518,000 MT, while copra imports were down to a minimal 120,900 MT. This raw material volume was not enough to sustain a large sized copra crushing unit. While their coconut oil imports dropped to 496,000 MT and 470,100 MT in 1982 and 1983, the drop in copra import was more dramatic, to only 65,000 MT in 1983.

The same pattern now prevails in other West European countries, although Portugal and Sweden still import only copra. The same is true for Japan, the Republic of Korea, Pakistan and the USSR. The People's Republic of China and Australia, on the other hand, always have imported coconut oil in crude or semi-refined form (Refined/Bleached or RB), and this year RBD coconut oil.

This is expected to be the pattern for the rest of this decade, as coconut-producing countries strive to maximize utilization of their own oilmilling capacities. It would be only when the supply/crushing capacity gap is bridged that this pattern could change. Today, the Philippines has an installed milling capacity of 3.293 million MT copra/yr while copra production peaked at only 2.7 million MT in 1976 and is expected to average only 2.2 million MT in the next 5 yr (1985-86) for a 31% utilization gap (Fig. 1). Figure 2 shows copra and coconut oil ports of loading in the Philippines.

Thus, the drastic drop in the availability of copra to West Europe's oilmills has prompted them to concentrate on other oilseeds like soybean and rapeseed.

Basic Philippine oilmilling capacity is divided into solvent extraction (1.260 million MT copra p.a. or 38.3% of total) and expeller or mechanical process (2.033 million MT or 61.7% of total). In addition, it has 1.34 million MT copra throughput refinery capacity capable of producing 109 thousand MT Cochin-type coconut oil (semi-refined or neutralized and bleached) and 704,000 MT fully refined edible coconut oil (neutralized, bleached and deodorized or RBD).

The Philippines also has a growing oleochemical capacity with a throughput of 190 thousand MT crude coconut oil capable of producing 32.3 thousand MT methyl ester, 88 thousand MT fatty alcohol, 50,000 MT fatty acid and 1 thousand MT alkanolamide, mainly for export. It also produces and exports crude and refined glycerin, crude cocoa fatty acid and acid oil.

LONG TERM AVAILABILITY

The shape of production, import/export, consumption/disappearance of coconut, palm kernel and palm oils vis-a-vis five other heavily traded and consumed oils in the world can be drawn from a study of *Oil World* on the past and prospective quarter centuries (Tables I and II).

The study shows the current (1983-87) average world import/export of coconut oil at 1.435 million MT while consumption/disappearance is at 2.938 million MT, indicating consumption of net exporting countries at approximately 1.43 million MT considering a beginning stock of 0.080 million MT. Going into the next decade (1988-92),

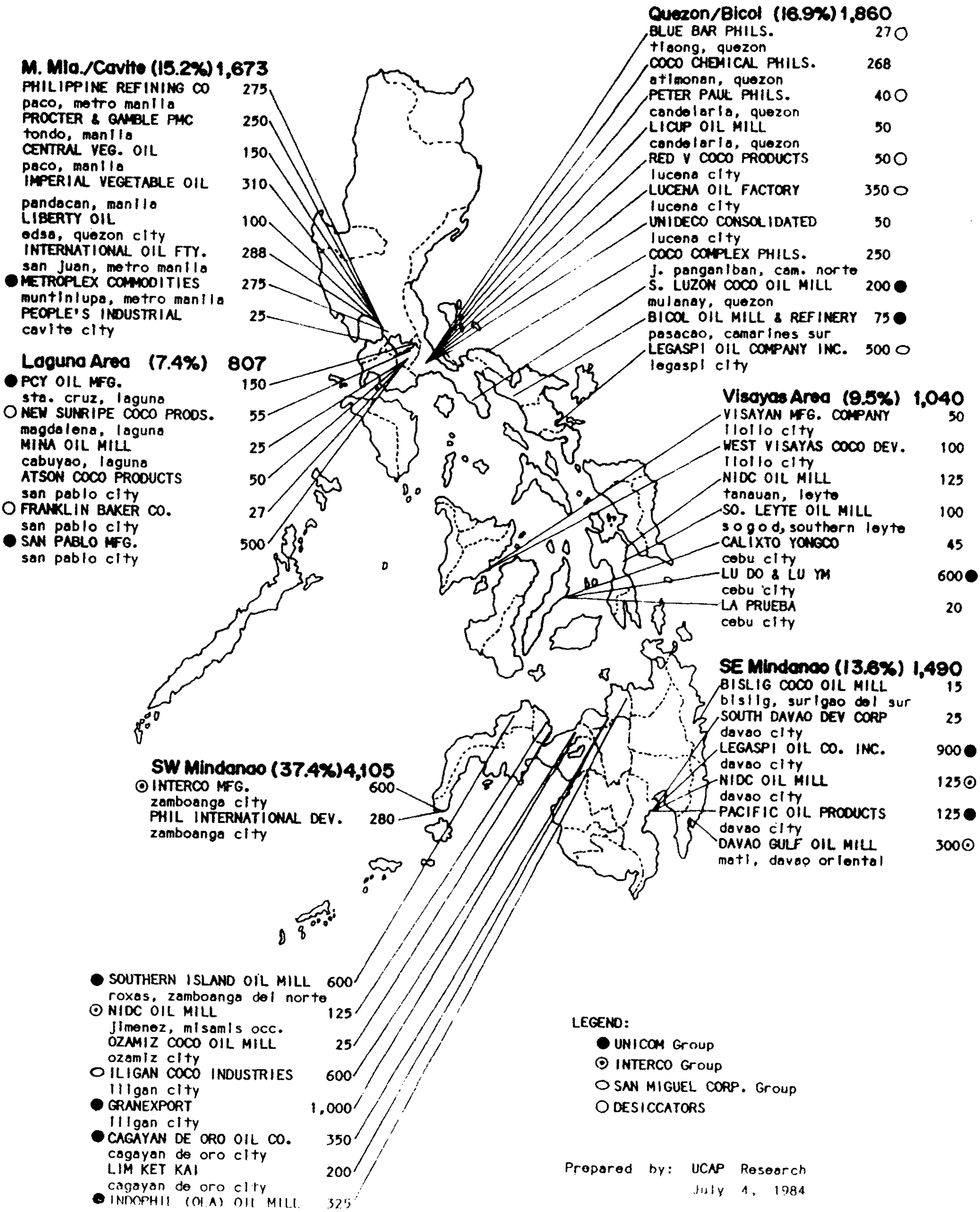

FIG. 1. Crushing capacities of RP oil mills showing plant sites (MT per day).

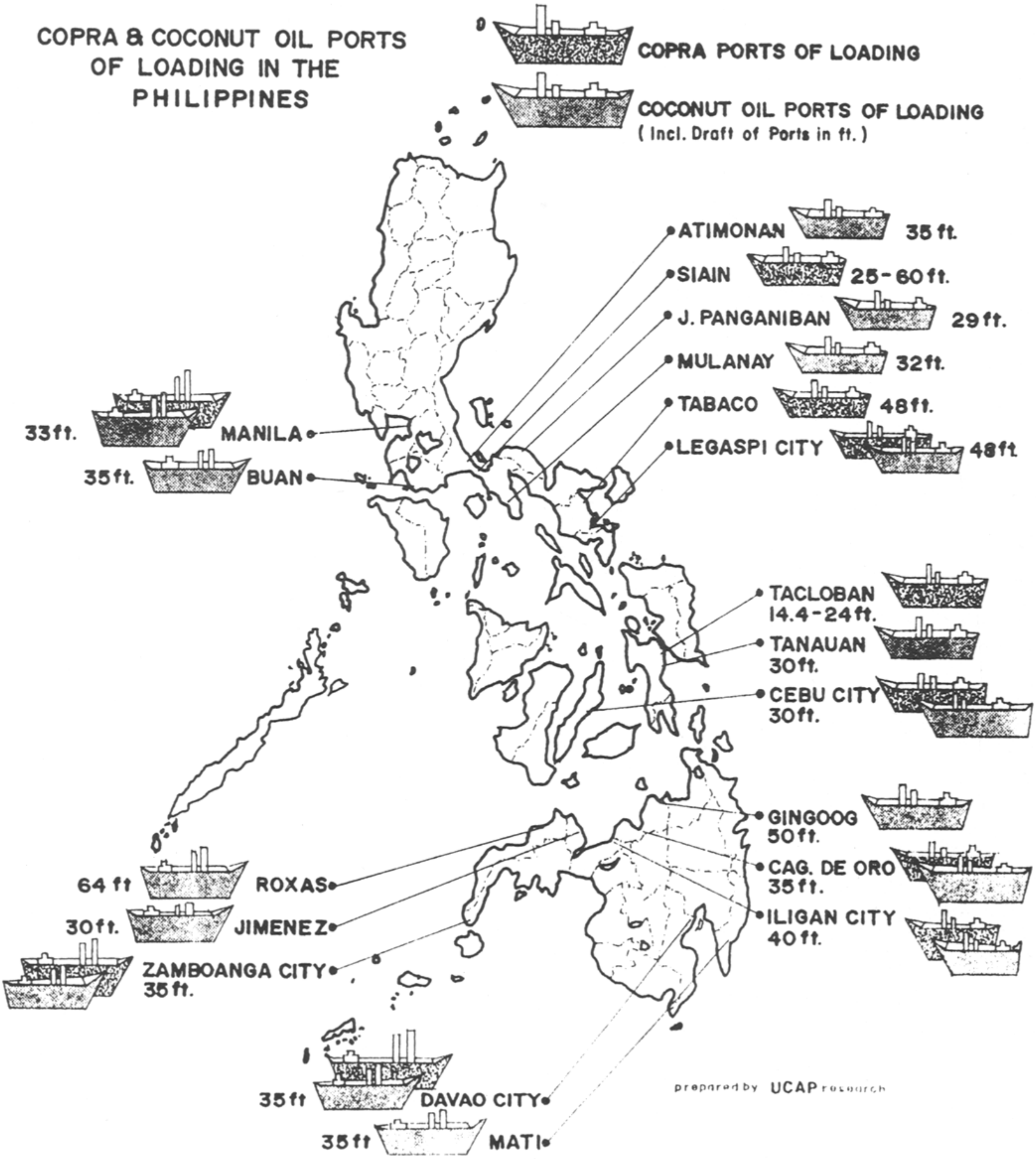

FIG. 2. Copra and coconut oil ports of loading in the Philippines.

TABLE I

Imports of Major Oils (in 000 Tons)*

	1978-82	1983-87	1988-92	1993-97	1998-2002
Palm oil	3,384	4,982	7,700	10,400	13,560
Soybean oil	3,236	3,931	4,880	5,600	6,950
Sunflowerseed oil	1,045	1,494	1,605	1,775	1,830
Coconut oil	1,264	1,435	1,595	1,800	2,050
Rapeseed oil	708	980	1,090	1.240	1,340
Palm kernel oil	372	676	985	1,275	1,540
Cottonseed oil	445	469	567	545	533
Groundnut oil	448	440	425	430	430
Other oils	5,739	5,867	6,064	6,294	6,334
Total	16,641	20,274	24,911	29,519	34,567

*Source of data: OIL WORLD, ISTA Mielke, Hamburg, West Germany (1983).

TABLE II

Disappearance of Major Oils (in 000 Tons)*

	1978-82	1983-87	1988-92	1993-97	1998-2002
Soybean oil	12,461	14,328	17,192	19,188	22,165
Palm oil	4,409	6,787	10,249	13,774	17,788
Sunflowerseed oil	4,916	6,124	6,760	7,342	7,935
Rapeseed oil	3,721	5,331	6,266	6,827	7,664
Cottonseed oil	3,047	3,449	3,739	3,891	4,122
Coconut oil	2,747	2,938	3,210	3,565	4,016
Groundnut oil	2,613	2,613	2,700	2,714	2,825
Palm kernel oil	602	926	1,309	1.671	2,109
Other oils	21,205	22,573	23,823	25,093	26,222
Total	55,721	65,069	75,248	84,065	94,846

*Source of data: OIL WORLD, ISTA Mielke, Hamburg, West Germany (1983).

imports would rise (+11.1%) to 1.595 million MT and consumption (+9.3%) to 3.210 million MT where residual disappearance also rises (+6.9%) to 1.529 million MT. By mid-90s (1993-97), imports would rise (+12.85%) to 1.8 million MT and consumption scales (+11%) to 3.565 million MT, while residual consumption also moves up (+9.2%) to 1.67 million MT. By year 2000 (1998-2002), import levels would rise (+13.9%) to 2.05 million MT and disappearance climb (+12.7%) to 4.016 million MT, indicating a residual consumption of 1.844 million MT for a 10.4% increase.

Large producers of coconut oil like India, Indonesia and Sri Lanka are expected to be absent from the marketplace at least within this decade in view of their burgeoning internal consumption. Nevertheless, *Oil World* projections indicate the Philippines is able to meet the demand of the major consumers: Western Europe, mainly West Germany, The Netherlands, the United Kingdom, France and Italy; North America, mainly the United States and Canada; the USSR; Japan; China, and South Korea. Residual volume can satisfy demand from Taiwan, Singapore, Indonesia and Australia. Other low volume markets can be serviced by the South Pacific island nations, mainly Papua, New Guinea, and Western Samoa, and from Africa, the Ivory Coast and Malagasy.

IMPROVING SUPPLY

Coconut producing countries like the Philippines long have realized the problems of supply volatility to both consuming and supplying countries. Sudden and drastic production drops invariably cause prices to shoot up, thus causing their manufacturers to reduce coconut oil consumption by reformulating raw materials for their products. At times they phase out its use where possible with a cheaper substitute, or even broaden the range and extent of the substitution in products where lauric oils are a critical content. This capability, enhanced by product research and development, has a tendency to sharpen price drops when production levels off above critical raw material demand levels. This is most true in edible products and to a certain extent in inedible products. This would be exacerbated by the development of substitute plant sources of the lauric acids or alcohols or the "coconut range" materials they need.

It is for this reason that serious rejuvenation or replanting programs have been launched by coconut producing countries. Sri Lanka, Indonesia and India have inaugurated productivity schemes with the use of indigenous high yielding hybrids. In the case of the Solomon Islands and the Philippines, they have resorted to non-indigenous varieties crossing West African, Rennell or Cameroon talls with Malaysian dwarfs. The Philippines is propagating in scale the MAWA hybrid (Malaysian Dwarf x West African tall). Although research stations and scientific farms have proven the viability and proximate output potentials of such indigenous crosses as the Tagnanan tall x Catigan dwarf or the Tagnanan tall x Belaka dwarf, it is the MAWA seedlings that presently are available in quantity for massive cultivation of the prolific hybrid.

Aside from the ideal of overall high output of coconut lands, another object of this enterprise is to assure that the basic minimum requirements of consumers at competitive price levels both at home and abroad are always topped. Thus, the price variations would cease to be as radical as this year when prices jumped from 46 cents per lb at the start of the year to a record high of 69 cents on June 15, or, in 1974, when it jumped from 41 cents in January to 62.75 cents per lb on Feb. 26.

TABLE III

Projected Availability of Coconut Oil to Principal Buyers, 1978-2002

	USA	Canada	West Europe	USSR	Japan	China	Total 6 Major	RP Export	Excess (Deficit)
1978-82	451	22	458	67	36	22	1,056	1,269	213
1983-87	480	24	571	70	40	25	1,210	1,433	223
1988-92	510	26	640	80	45	27	1,328	1,595	267
1983-97	540	28	712	90	50	30	1,450	1,806	356
1988-2002	570	29	789	100	57	32	1,577	2.046	469

Source of data: OIL WORLD, ISTA Mielke, Hamburg, West Germany.
Prepared by: UCAP Research, Manila, Philippines

By this process, it is felt that an ideal market share of 8-12% of world oils/fats cum oleochemicals trade could be maintained over a range of time.

For the producing countries, productivity would help assure them that their coconut producers would be able to derive viable levels of farm income albeit coupled with intercrop or parallel cultivation output and other non-crop activities.

PHILIPPINE PROGRAM

To rejuvenate the Philippine coconut tree stands with high yielding varieties on a broad scale, the National Coconut Replanting Program (NCRP) was launched in 1979. Infrastructure was initially made up of 133 hybrid pilot farms and 8 hybrid nursery stations strategically distributed, as well as a 1,000- hectare seed garden on Bugsuk Island, south Palawan province.

The pilot farms cover 325.3 hectares. Today after 5 yr, good results have been experienced with nut production at 0.8 MT copra equivalent the 6th year after planting, 1.25 MT the 7th year, 1.5 MT the 8th year, 2.0 MT the 9th year and 2.5 MT the 10th year up to genetic maximums.

The program today, aside from the pilot farms, has planted 48,000 hectares to the MAWA hybrid cultivation but is location specific. Results on Luzon did not approximate the excellent results obtained on Mindanao. In the south, some results far exceeded those obtained even in Malaysia or the Ivory Coast, where the MAWA was developed. In one particular instance, a 4-hectare hybrid farm in Maguindanao province already attained a yield of 8 MT per hectare in year 6. Average output in that province comes to 5 MT per hectare of hybrid trees.

TABLE IV

Philippine Coconut Producing Areas 1983

	Hectares (in 000)	Tree population (in million)	Nut harvest (in million)
Luzon	900	131	3,882
S. Tagalog	543	92	3,084
Other Luzon	357	39	798
Visayas	632	94	2,249
Mindanao	1,677	186	6,678
Western	454	51	1,441
Northern	369	46	1,033
Southern	854	89	4,204
Total	3,209	411	12,809

It is unfortunate that program resources have been curtailed by suspension of the coconut levy or cess for this purpose. Otherwise, by 1990, HYVs would be contributing 247 thousand MT more copra (+156 thousand T oil) when compared to output from indigenous varieties projected at 2.73 million MT copra (1.72 million T oil). This would easily have brought world export availability to 1.75 million MT coconut oil. Where the Philippines would contribute 1.5 million MT and the rest of the world .25 million MT.

Changing Pattern of Consumption

Coconut oil has started to capture an increased segment of non-food uses. This is more true in the U.S., where on average more than ½ (52%) has been used in non-edible applications in the last decade. Edible uses take up 48% of the supply.

The pattern in Europe varies. In the case of West Germany, the USSR and Italy, non-food uses dominate, while in the U.K., France and The Netherlands food utilization has the edge.

Japan's utilization also is mainly in the inedible field, as is Australia's. India's preponderant emphasis remains in the edible field for both its domestic production and imports during periods of shortage. The same is true for Indonesia and Sri Lanka, but in a different way. Their method of consumption is mainly via the foodnut or coconut cream route.

The implicit totals of consumption in the major external markets of coconut oil now is in favor of inedible uses, especially considering the premium quality coconut oil imparts for toiletries, cosmetics and other personal care products.

Since price is the main determinant of the viability of a given raw material in a product formulation, especially where a spectrum of substitute oils and fats could be used in varying proportions to meet product quality, long term

TABLE IVa

Hybrid Plantings in the Philippines

	No. of hybrid pilot farms	Area (hectares)	Hybrid seednuts planted
Quezon-Batangas-Laguna area	56	120.00	17,819
Other Luzon	47	89.46	13,385
Visayas	12	47.00	6,987
Mindanao	18	68.84	9,987
Total	133	325.30	48,178

TABLE V

U.S. Average Utilization of 5 Major Vegetable Oils in Products*

		Food uses					Non-food uses							
Year	Total disappear.	Shortening	Margarine	Salad & cooking oils	Others	Total food	Soap	Fatty acids	Paints & varnish	Resins & plastics	Other drying oils pdt's	Foot & loss	Others	Total non-food
1968-72														
Coconut	815	54	10	9	327	400	163	77	—	—	7	37	131	415
Palm	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Soya	5,974	2,060	1,346	2,082	37	5,505	—	4	86	78	7	251	43	469
Cottonseed	952	217	66	530	50	863	—	—	—	—	—	77	12	89
Corn	437	9	180	201	7	397	—	—	—	—	—	39	1	40
Total	8,178	2,340	1,602	2,802	421	7,165	163	81	86	78	14	404	187	1,013
1973-77														
Coconut	869	92	8	30	286	416	180	98	—	—	5	39	131	453
Palm	568	459	25	41	22	547	21	—	—	—	—	—	—	21
Soya	7,169	2,208	1,550	2,894	28	6,680	—	17	87	68	5	276	36	489
Cottonseed	716	167	50	356	55	628	—	—	—	—	—	80	8	88
Corn	496	5	207	239	2	453	—	—	—	—	—	42	1	43
Total	9,818	2,931	1,840	3,560	393	8,724	201	115	87	68	10	437	176	1,094
1978-82														
Coconut	877	92	5	35	286	418	185	103	—	—	5	33	133	459
Palm	235	154	17	34	14	219	16	—	—	—	—	—	—	16
Soya	8,873	2,573	1,631	3,912	142	8,258	—	47	92	90	5	334	47	615
Cottonseed	670	171	17	417	—	605	—	—	—	—	—	58	7	65
Corn	626	7	231	328	7	573	—			—	—	52	1	53
Total	11,281	2,997	1,901	4,726	449	10,073	201	150	92	90	10	477	188	1,208

*Source: Commodity Yearbook, 1983, 1980, 1978, Commodity Research Bureau, New York, N.Y., U.S.A.

TABLE VI

U.S. Consumption of Coconut Oil - 1979 - by Major Use

	In million lbs	Per cent of total U.S. consumption
Edible		
Spray coating	133	18
Non-dairy foods	85	11
Other	73	10
Total edible	291	39
Inedible		
Fatty acids/salts	272	37
Methyl esters derivatives	90	12
Detergent-range alcohols	60	8
Amines and other	30	4
Total inedible	452	61
Total consumption	743	100

Source of data: MRA, Minneapolis, Minnesota, U.S.A.

TABLE VII

West European Consumption of Coconut Oil by End-Use

End-use	Million lbs	Per cent
Edible		
Margarine	235	23
Other edible	353	34
Total edible	588	57
Inedible		
Soaps	206	20
Fatty acids	158	15
Fatty alcohols	47	5
Other products	29	3
Total inedible	440	43
TOTAL	1,028	100

Source of data: MRA, Minneapolis, Minnesota, U.S.A.

TABLE VIII

U.S. Consumption of Coconut Oil Estimated Use by Customer, 1979*

	Million lbs	Per cent of total consumption
1. Procter & Gamble	220	30
2. Lever	90	12
3. Quaker Oats	55	7
4. Stepan Chemical	32	4
5. General Foods	28	4
6. Carnation	27	4
7. Keebler	25	3
8. Armour-Dial	23	3
9. Colgate Palmolive	17	2
10. Emery Industries	15	2
Total top ten	532	71
Total U.S.	743	100

*Source of data: MRA, Minneapolis, Minnesota, U.S.A.

competitiveness and availability is being addressed by coconut producing countries. Oils/fats compounding and restructuring now is standard procedure in industrial uses, food and non-food. Price stability apparently determined the long term share of a particular oil in a given product.

About the only element which mitigates prices as a deterrent to oil utilization is the quality derived from latent premium qualities of an oil. In the case of toiletries and other personal care products, we know the value of

TABLE IX

West European Consumption of Coconut Oil by Customer, 1979*

Ranking/Customer	Quantity (million lbs)	Per cent
1. Unilever	338	33
2. Henkel	317	31
3. Procter & Gamble	66	6
4. Akzo Chemie	35	3
5. Oleofina	25	3
6. Unipol	24	2
7. Colgate-Palmolive	21	2
8. Caila & Pares	19	2
9. Marchon (Albright & Wilson)	18	2
10. Nestle	10	1
All others	155	15
Total consumption	1,028	100

*Source of data: MRA, Minneapolis, Minnesota, U.S.A.
Condea (joint venture of Continental Oil and Deutsche Texaco) onstream with a fatty alcohol plant in May 1980–estimated annual requirement for 15 million lb coconut oil.

stability, lather, non-abrasiveness and biodegradability. Thus, while price may be comparatively high the need to impart certain critical properties of coconut oil performed by a minimal proportion of the formulation apparently compels its preference.

This also is true of its use in edible products where body, mouth feeling and slow melt are needed in confections and bakery products. To impart these would require maintaining a certain proportion of coconut oil in the formulation.

Looking at this the other way around will show that a higher price plateau for coconut oil (palm kernel oil, too) would be the point for total substitution to occur. Where petro-based substitutes are contemplated, cost-to-make and long term availability become the critical factors. This is especially true of inedible chemical-based products using lauric oils (coconut and palm kernel). Chemical formula products invariably are priced at levels which can afford their premium prices.

The stability of certain utilizations of lauric oils in the U.S. (mainly coconut oil) indicate its continued preference to maintain product quality. Data compiled by the Commodity Research Bureau (New York) on soaps provide indications of only a very slight change in the pattern of oil admixture from solely coconut oil in the period 1968-72, to a 90/10 coco oil/palm oil admixture in the next period 1973-77, and a 92/8 coco/palm oil composition in the most recent half-decade, 1978-82. In the case of fatty acids, mainly for toiletries, the oil admixture was 95/5 coconut oil/soy oil in 1968-72, down to an 85/15 coco/soy oil ratio in 1973-77, and recently significantly reformulated to 69/31 coco/soy oil utilization in 1978-82.

Paints and varnishes, as well as resins and plastics, remain strongholds of soy oil but in drying oil products a 50/50 coconut/soy oil utilization is recorded for the last 15 years (1968-82).

The utilization of oils in non-food products in the U.S. averaged 1,013 million lbs (459,619 MT) yearly in 1968-72 wherein soy oil averaged 46%, coconut oil 41%, cottonseed oil 9%, corn oil 4% and palm oil nil. In 1973-77 consumption averaged 1,094 million lbs (496,390 MT) yearly and shares were soy oil 45%, coconut oil 41%, cottonseed oil 8%, corn oil 4% and palm oil 2%. In the recent half-decade (1977-82) yearly utilization averaged 1,208 million lbs (548,094 MT), and shares were soy oil 51%, coconut oil 38%, cottonseed oil 6%, corn oil 4% and palm oil 1%. While the U.S. imported significant quantities of palm kernel oil, the CRB and USDA data do not provide its utilization breakdowns to form part of this paper.

In the U.S. food uses of oils, soy oil continued to dominate formulations for shortening, margarine, and salad and cooking oils. Coconut oil is strongest in the "other uses" category such as filler creams or coffee whiteners. Palm oil participates significantly in shortening formulations.

Since coconut oil utilization breakdowns have not been available to CRB Jersey City partially in 1978-79 and almost completely in 1980-83 and totally in 1984 we must depend on private research institutions like the one our industry commissioned. The data derived therefrom for 1979 is tabulated herein and graphed.

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The Biotechnology of Oilseed Crops

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ABSTRACT

A general summary of possibilities and limitations application of biotechnology processes to processing and/or production of fats and oils is presented. Enzymatic processes, cloning of premium perennial oil crops and genetic manipulation of oilseed compositions are discussed.

INTRODUCTION

The last five years have seen many imaginative ideas on, and the beginning of commercial exploitation of, biological methods for control of the composition of natural oils and fats, with the aim of providing tailor-made fats for defined end uses.

The processes involved are different. In order of complexity, they are: use of isolated enzymes as catalysts; use of fermentation systems using microorganisms, plant cells and animal cells (using recombinant DNA techniques for transfer of biosynthetic sequences); and use of plant propagation by plant tissue culture, somaclonal variation, and genetic engineering of oil seed crops to generate improved plants. Each of these is considered separately as they have different advantages and disadvantages. Each will have a different effect on the various types of commercial oil seeds and their products. Table I shows the world production of plant oils and fats in 1981. The next fifteen years may see major changes in the exploitation of these materials.

TABLE I

World Production of Vegetable Oils (in terms of oil or fat)

	1980/1981 (Provisional) (thousand tons)
Edible oils	
Cottonseed	3,100
Groundnut	2,810
Soybean	14.530
Sunflower	4,600
Olive	1,905
Rapeseed	3,685
Palm oil	4,590
Coconut	3,020
Other	3,120
Total edible	41,360
Industrial oils	
Linseed	740
Castor bean	350
Other	135
Total industrial	1,225
World totals	42,585

ISOLATED ENZYMES AND PRODUCTION CATALYSTS FOR SYNTHESIS OF SPECIALIZED OILS AND FATS

The ability to use a triglyceride 1:3 specific lipase as a catalyst to exchange acyl groups between triglycerides and free fatty acids and between triglyceride classes (1) has opened up a new area for production of specialized oils and fats.

The first major commercial exploitation lies in the conversion of palm oil fractions rich in POP triglycerides to a mixture of POP, POS and SOS triglycerides. The product mix is then fractionated and recycled (Fig. 1).

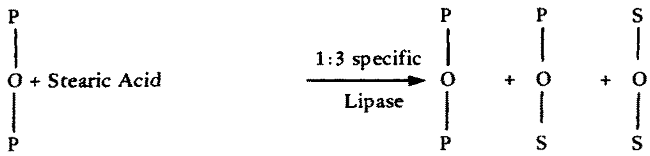

FIG. 1. Exchange of triglycerides and fatty acid.

Clearly, such acyl exchange can be exploited in a variety of ways for a variety of products. The process is extremely flexible and can be accurately controlled to give a range of specialized triglycerides. The larger part of plant costs are found in the downstream processing end, not in the primary reactor. This will frequently be the case when an enzyme is used to get rapidly to a new chemical equilibrium state. The overall process is not cheap and is therefore applicable only to high added-value products such as specialized fats and is dependent on both a cheap flexible feed stock and a cheap source of free fatty acid of reasonable purity. Palm oil is a major contender as such a feed stock.