Fats and Oils Handbook

Commodities and Export Projections Division
Economic Analysis and Projections Department

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I. THE CHARACTERISTIC OF THE PRODUCT

Fats and oils are glycerides of fatty acids. Numerous forms of these fatty acids exist in nature. The physical properties of the different types and their potential for substitution vary according to the type and proportions of the fatty acids they contain. Fatty acids are the essential constituents of natural fatty substances, making up 94-96 percent of the total weight of a molecule of fat.

All fatty acids consist of a chain of carbon atoms each bonded to the next and to 0, 1 or 2 hydrogen atoms. The essential difference between one fatty acid and another depends on the number of carbon atoms forming the chain (between 4 and 24 atoms in natural fats) and on the nature and position of the bond between the carbon atoms. When all the carbon atoms in the chain are bonded to two hydrogen atoms, the bond is said to be "simple" and the acid "saturated." When two or more carbon atoms in the chain are bonded to only one hydrogen atom or to none, double or triple bonds exist and the acid is said to be "unsaturated."

Technical properties of fats and oils are important in determining the range of end uses for various fats and oils. However, technological innovations have made it possible to alter certain chemical and physical properties of fats and oils so that the manufacturer of an end product now has a wider range of fats and oils to choose from as his inputs.

A. Technical Aspects

The most important technical property of fats and oils appears to be the degree of saturation of the fatty acids. The degree of saturation of a fat or oil is generally expressed by the iodine number associated with different fats and oils. Fats and oils with a high iodine number have a high percentage of unsaturated fatty acids and are generally liquid at room temperature in temperate climates. Such oils --soybean oil for example-- are also known as "soft" oils. A low iodine number is characterisitc of saturated fatty acids which have a solid or semi-solid form at room temperature. For edible uses the degree of saturation of fats and oils is important since it affects the form of the final product. Some food uses such as salad and

cooking oil require that the oil be in fluid form at room temperature. Unsaturated fats and oils are thus essential for the manufacture of these products. Other food items such as margarine and shortening must be in solid form at room temperature; they are, therefore, made from saturated fats and oils. Saturated fats and oils are also more stable and are less likely to deteriorate when stored.

Table I-1 classifies the major fats and oils into two groups according to their form: fluid or solid/semi-solid in descending order of their iodine number.

The drying oils are generally not used for human consumption although linseed oil is occasionally used in salad oils. The semi-drying oils are the most important group of edible oils. They constitute the bulk of the fats and oils consumed as food. The non-drying oils are used almost exclusively in human consumption. In group A of the solid or semi-solid fats and oils category, palm oil and lard are mainly used in food products while tallow is important in industrial uses. Group B represents oils of various tropical palm fruits: coconut, babassu, palm kernels, whose saturated fatty acids are essentially lauric. The foaming properties of lauric acid are essential in soapmaking and certain food items.

In food uses such as salad oils, spreads, frying, and cooking, all the edible fluid vegetable oils are theoretically interchangeable. These possibilities for substitution are limited to some extent by consumer preferences for particular oils, preferences for specific qualities such as smell or taste, dietary considerations, and the suitability of some of the non-hydrogenated semi-drying oils (especially corn oil, safflower oil, and sunflowerseed oil) for the industrial production of dressings, mayonnaise or margarine. Further, for frying and cooking uses, the oils must be stable and resist breakdown when heated, so the saturated fats and oils have traditionally been used for these purposes. Hydrogenation, 1/ blending, and other improvements in processing technology, however, have reduced the impact

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1/ Hydrogenation reduces the iodine number and changes the unsaturated fatty acids of the oils concerned to saturated acids. Thus all fluid oils can compete with the naturally saturated fats and oils in margarine and shortening production.

Table I-1: TECHNICAL CLASSIFICATION OF FATS AND OILS /a

Fats and Oils	Main acid	Iodine number	Solidification point
Fluid			
A) Drying oil	Linolenic		
Linseed		173-201	-27 to -16
Tung		166-170	-21 to -17
B) Semidrying oil	Linoleic		
Soybean		121-142	-18 to -8
Sunflowerseed		125-135	-19 to -16
Corn		111-128	-15 to 0
Cottonseed		101-107	+2 to +4
Rapeseed		94-105	0
Marine		110-180	-4 to +24
C) Nondrying oil	Oleic		
Sesame		100-108	-6 to -3
Peanut		84-105	-2 to +3
Olive		78- 95	-9 to 0
Solid or semisolid			
A) Group A	Stearic and Palmitic		
Palm		44-56	+24 to +30
Lard		53-77	+22 to +32
Tallow		45-55	+30 to +38
B) Group B	Lauric		
Coconut		7-10	+14 to +25
Palm kernel		16-23	+19 to +30

/a Source: United Nations (1971).

of many of these barriers to interchangeability. However, the conversion of saturated fatty acids to unsaturated form, i.e., dehydrogenation, has not proved economical on an industrial scale.

In industrial products interchangeability varies according to the type of use. Certain users have specific technical requirements in their demand for fats and oils because the different types confer different properties on the finished product. Soap manufacturers can use a wide variety of fatty acids, although a certain quantity of foaming fatty acid, such as lauric acid, is required. Fatty acid manufacturers base their choice of oils solely on the quantities of the one or more acids they can obtain by fractionation.

Thus technical interchangeability varies according to use. When fats and oils are used for food consumption, substitutability is high although tastes and habits often limit choice. In industrial use substitutability is high when fats and oils are used in mixed form, but technical requirements may restrict choice in particular usages.

Interchangeability between fats and oils: The ultimate interchangeability between fats and oils is determined at the processing level where the manufacturer is subject to the constraint of input prices relative to output prices. The effect of this economic constraint will be stronger or weaker according to the type of demand relationships in the markets for the different fats and oils. In markets with specific demands, end users attach high importance to certain natural characteristics which cannot be artifically reproduced and for which they are prepared to pay higher prices. Oils such as olive have important flavor, smell and other qualities associated with them. In this type of market there is little or no substitution among inputs and the price of each is determined independently of others.

In markets with interchangeable demands, end users are largely indifferent to manufacturers choice of inputs and they refuse to pay prices for the processed product inconsistent with least-cost formulation; for example, fats and oils used in oleic acid manufacture, soaps and margarine. This high degree of interchangeability in demand implies the prices of fats and oils in these markets are strongly interdependent.

The fact that most fats and oils have many possible end uses has sometimes led to the erroneous assumption that they are freely substitutable

in all uses. However, the substitution that does occur between the various fats and oils depends on both relative prices and their physical and chemical properties.

B. Economic Aspects

Fats and oils contain more calories than any other food. They provide about 9 large calories per gram, compared to about 4 calories from proteins and carbohydrates. Fats have also the highest caloric density of any food, since they are essentially water-free in comparison with proteins and carbohydrates, which contain large quantities of water.

Aside from being an important energy source, certain unsaturated fatty acids are essential components of a well-balanced diet. A lack of them results in a fat-deficient disease. Several vitamins are also dissolved by fat, so that fat deficiencies in a diet may also result in a lack of these vitamins.

In addition to being a food, fats and oils have several non-nutritional uses. Fats are used in frying to transfer heat rapidly and uniformly over the whole surface of the food. Compared to other methods of cooking, frying cooks food more rapidly. Most fast-food restaurants use deep frying as their major means of preparing meals. Since frying in deep fat does not increase the fat content substantially, the traditional prejudice against frying is fading away.

Fat is also essential for the manufacture of bakery goods. It can entrap and hold air, which expands under the influence of heat, thereby contributing to leavening.

Only a small portion of the world's output of fats and oils is consumed directly, however. The bulk of production reaches the consumer in some processed form or other. Fats and oils are a major ingredient in a wide variety of food and non-food products, 1/ the most important being: (a) margarines; (b) shortening for manufacturing bread, cakes and biscuits; (c) frying fats; (d) salad oil; (e) fats for specialized food manufacture,

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1/ The principal competition to fats and oils in the manufacture of non-food products is from synthetics.

confectionary, ice cream and imitation cream; (f) soap and detergents; (g) paints and (h) chemical products.

Margarine: Margarine was the result of a search for an inexpensive substitute for butter. The first margarines were made from beef fat and oleo oil. The latter was later supplemented by lard. For a long time, these two animal fats remained the principal raw materials in the manufacture of margarines. During World War I, coconut oil, palm kernel oil and babassu oil were used in increasing quantities in margarine; by the early 1930s they made up more than 60 percent of all fats and oils used in the margarine industry.

The development of the hydrogenation process made it possible to replace coconut oil with cheaper vegetable oils, mainly cottonseed and soybean. It was found that margarine made from hydrogenated vegetable oils was superior to that made from oleo oil, coconut oil or other hard oils. In addition, hydrogenation permitted the manufacture of fats that were stable, flavorless and uniform in consistency. 1/ The bulk of the margarine produced now in the US and Europe is made from hydrogenated vegetable oils. In the US, hydrogenated soybean oils are by far the most important source. However, the trend to use more polyunsaturated fatty acids has resulted in a substantial increase in the use of corn oil.

Shortening: Like margarine, shortening is a substitute for butter. Unlike butter, it is not consumed directly as a spread or table fat. It is used for cooking and baking in place of butter. As the name "shortening" indicates, it gives baked goods a "short" or tender quality.

Consistency, melting behavio taste and other physical characteristics of shortening are determined largely by the fats and oils used in its preparation. In this respect, there is little difference between shortening and margarine. Originally, lard and other animal fats were the

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1/ Fish oils are not suited for the preparation of hydrogenated fats; their fishy flavor returns if they are not completely hydrogenated. In this respect whale oil is greatly superior to fish oil and has been extensively used in the manufacture of margarine in Europe.

principal edible fats used. Later, soft vegetable oils (e.g., cottonseed oil) replaced part of the animal fats. This yielded a semi-solid "compound" shortening.

The development of the hydrogenation process radically altered the demand for fats and oils in the shortening industry. Shortening manufacture is no longer restricted by the availability of animal fats. Most vegetable oils can now be used to prepare shortenings. In addition to soybean oil, which is by far the most important source of oil for shortening, others are cottonseed oil, corn oil, safflower oil, sunflower oil and palm oil. 1/ Most shortenings are made from two or more hydrogenated vegetable oils which are blended together. In addition, the extent of hydrogrenation of each oil may be varied to give the final product its desired characteristics. Thus the possibility of hydrogenation together with the availability of inexpensive vegetable oils gave shortening manufacturers greater flexibility in choosing their raw materials than they had before and, at the same time, strengthened their competitive position vis-a-vis butter.

Until the early 1960s, most oils used in the manufacture of margarines were highly saturated. They reduced the amount of hydrogenation needed and yielded a shortening that was highly stable. Growing consumer awareness about the relationship between cardiovascular disease and the consumption of saturated fatty acids led to a sharp increase in the use of polyunsaturated oils in the manufacture of shortenings. Most shortenings now contain about 30 percent unsaturated fatty acids.

In recent years, shortening manufacturers have developed a liquid shortening which is made from liquid and only lightly hydrogenated (soft) vegetable oils. These products contain between 30 and 50 percent polyunsaturated fatty acids. Liquid shortening is mainly used in the commercial production of bread and bakery products.

Frying fats: Frying fats have two functions. First, they act as a heat transfer medium. In deep fat frying, the fat may be at 180°C or above when the food is put in. Steam is created, cooking the food efficiently and usually

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1/ In the US and Europe, most of the imported palm oil is used for the manufacture of shortening.

producing a crisp texture on the outside. Second, a proportion of fat is absorbed by the food, mainly in the outer layers and, therefore, becomes a constituent of the fried product. The proportion can be as high as 35-40 percent, as in potato chips.

Palm oil has the great advantage in frying of a relatively low level of unsaturation and, therefore, good stability. In some cases a palm olein is preferred, either because of limitations of equipment or because of improved product characteristics. It has advantages in frying similar to palm oil.

Palm oil has been used for frying for many years in Europe and, recently, has become established on the west coast of the US, in competition with partly hydrogenated soybean oil.

Salad oils: In many countries, traditional cookery provides a large market for a liquid oil for domestic purposes. This oil is used as a salad dressing, for frying and for other purposes. In the Mediterranean basin, the traditional one was based on olive oil; in Japan on soybean and rapeseed oil, in some Eastern countries on groundnut oil. The domestic demand for liquid oils of this type is growing in Europe and the US. One important consumer requirement in those areas is that the oil remains clear even at relatively low winter temperatures. As formulated in the US, this requirement is called the "cold test" which states that no deposit must form during 5 1/2 hours storage at 0°C. Some oils such as cottonseed must be "winterized" before they conform; i.e., the deposit which would form at low temperatures has to be removed. The glycerides in palm oil all have melting points of 19°C or higher. Therefore, palm olein cannot meet the cold test specification in the US, although a proportion may be used in a salad oil blend with a more saturated oil such as soybean oil.

Fats for confectionaries: Among the more specialized food uses for fats, one of the most interesting is the use of palm oil in confectionary. The unique eating qualities of chocolate are the result of the precise chemical make-up of cocoa butter. It has a very high proportion of the glyceride palmito oleostearin, which imparts to chocolate its hard brittle texture at room temperature and its "sharp" melting point below body temperature. The fat content used in chocolate is higher than the natural proportion of fat present in the cocoa bean, and additional cocoa butter has to be used in manufacture

As a result, there is surplus cocoa powder from the process, which can be made into a very acceptable substitute chocolate by using fat from other sources with similar properties. Since cocoa butter has always been a very expensive fat, many efforts have been made to develop substitutes. A number of such substitutes are available. Some are based on the lauric oils--coconut and palm kernel. Others are based on the fractionation of oils which contain glycerides similar or identical with those that give cocoa butter its special properties. Palm oil is a suitable source of some of these glycerides, and several patents describe the preparation of a compatible cocoa butter substitute from palm oil.

Non-food uses of fats and oils: Soap is produced by a chemical reaction between fats and an alkali. The basic process of soapmaking has not changed much over time. The selection of fats and oils depends largely on the expected qualities of the final product, such as hardness, solubility and ease of lathering. A common mixture for toilet soaps is about 75 percent tallow and 25 percent coconut oil. The various fats are blended together before the actual saponification begins. Fats with a large portion of saturated fatty acids are usually preferred in soapmaking, since they saponify more readily than unsaturated fatty acids.

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II. THE LOCATION AND STRUCTURE OF THE INDUSTRY

A. Production

Since the early 1960s, world production of fats and oils has grown at an average rate of more than 3 percent. During this period, supplies of vegetable oils grew more rapidly than those of animal fats and marine oils, Table II-A1.

Vegetable Oils from Oilseeds

Soybeans: Soybeans are a subtropical crop. They grow best in a humid climate with plenty of rains during the growing season, whereas dry weather during the ripening period facilitates the harvest. The cultivation of soybeans reaches from the tropics and temperate zones up to a latitude of more than 50 degrees. 1/ Soybeans belong to the family of legumes which can use nitrogen in the atmosphere directly, reducing the demand for nitrogen fertilizer. 2/

Soybean production is concentrated in three countries: the US, China and Brazil. Together, they supply more than 90 percent of the world's soybean needs. However, only the US and Brazil are major exporters as China's production is consumed domestically.

Since the early 1960s, soybean production has grown at an average rate of about 6 percent a year, Table II-A2. Most of this expansion has taken place in the US and, more recently, in Brazil.

The bulk of the world's soybean production is processed into soybean oil and soybean meal, Table II-A3. The bulk of the soybean oil (usually partially hydrogenated) is used for edible purposes, mainly in the preparation of margarine and shortening, and also as liquid cooking oil and salad oil. Paints, varnishes, soaps and lubricants are the main industrial uses for soybean oil.

1/ Different growing conditions (climate, soils, day length, etc.) require different varieties of soybeans.

2/ Soybeans will produce their own nitrogen only if they are either properly inoculated with nodule bacteria at the time of planting or if the soil contains these bacteria.

Table II-A1: FATS AND OILS - WORLD PRODUCTION, BY MAJOR CATEGORIES

	1961	1965	1970	1974/76	1977	1978	1979	Growth Rates 1961-77	Growth Rates 1977-79
	('000 tons)							(% per annum)	
Vegetable oils	15,580	19,570	23,330	30,172	29,557	35,216	36,901	4.4	7.7
From:									
Annual oilseeds /a	10,785	14,703	17,727	22,363	21,261	25,965	27,161	4.1	8.5
Perennial tree crops /b	4,795	4,867	5,603	7,809	8,296	9,251	9,749	3.3	5.5
Animal fats & Marine oils	11,591	13,013	13,830	14,920	15,697	16,586	17,391	1.8	3.5
TOTAL	27,171	32,583	37,160	45,092	45,154	51,802	54,301	3.0	6.3

/a Includes soybean oil, sunflower oil, cottonseed oil, groundnut oil and rapeseed oil.
/b Includes olive oil, palm oil, coconut oil and palm kernel oil.

Source: Peter K. Pollak, "Market Prospects for Fats and Oils," 1979 (1961-1977); FAO, "Production And Trade of Oils/Fats And Cakes/Meals: Estimates for 1979 And Forecasts for 1980," CCP: OF/ST 80/4 Rev. 1, May 1980 (1978-79).

Table II-A2: SELECTED OILSEEDS, FATS AND OILS (FAT OR OIL EQUIVALENT) - WORLD PRODUCTION

	1961	1965	1970	1974/76	1977	1978	1979	Growth Rates 1961-77	Growth Rates 1977-79
	('000 tons)							(% per annum)	
Soybean oil	3,295	3,934	6,089	9,288	9,131	11,474	12,365	6.2	10.6
Sunflower oil	1,665	3,134	3,802	4,037	3,730	4,762	4,651	4.9	17.6
Cottonseed oil	2,165	2,755	2,600	3,065	2,945	3,137	2,929	1.8	0.8
Groundnut oil	2,555	3,384	3,302	3,315	3,184	3,361	3,573	1.3	3.9
Rapeseed oil	1,105	1,496	1,925	2,658	2,271	3,231	3,643	4.3	17.1
Olive oil	1,180	1,004	1,249	1,566	1,330	1,547	1,628	0.7	7.0
Palm oil	1,250	1,267	1,743	2,922	3,354	3,952	4,562	6.0	10.8
Coconut oil	1,925	2,160	2,172	2,809	3,059	2,993	2,747	2.7	-3.6
Palm kernel oil	440	436	439	512	553	759	812	1.3	13.7
Marine oils	953	1,138	1,253	1,154	1,032	1,197	1,289	0.5	7.7
Butter	3,855	4,201	4,124	4,578	4,879	5,638	5,613	1.4	4.8
Tallow	3,050	3,790	4,354	4,787	5,419	5,630	5,657	3.4	0.4
Lard	3,733	3,884	4,099	4,402	4,297	4,121	4,832	0.8	-4.0
TOTAL	27,171	32,583	37,160	45,093	45,184	51,802	54,301	3.1	6.3

Source: FAO, Production and Trade Yearbooks, and IBRD, Report No. 814, 1980.

Table II-A3: SELECTED HIGH-PROTEIN MEALS -- WORLD PRODUCTION

	1961	1965	1970	1974/76	1977	1978	1979	Growth Rates 1961-77	Growth Rates 1977-79
	('000 tons)							(% per annum)	
Soybean Meal	14,797	17,668	27,347	41,799	41,000	49,778	53,604	6.2	9.3
Sunflower Meal	2,157	3,134	3,593	3,583	3,908	4,411	4,423	3.6	4.2
Cottonseed Meal	6,148	7,852	7,480	8,565	7,753	9,109	8,644	1.4	3.7
Groundnut Meal	3,074	4,061	3,962	3,934	3,804	3,699	3973	1.3	1.5
Rapeseed Meal	1.893	2,501	3,019	3,625	3,868	4,153	5,599	4.3	13.1
Palm Kernel Meal	477	473	476	623	686	608	657	2.2	-1.4
Copra Meal	1,070	1,181	1,188	1,713	1,798	1,808	1,618	3.1	-3.5
Fish Meal	2,006	3,522	5,352	3,985	4,024	4,716	4,896	4.3	6.8
TOTAL	31,622	40,392	52,417	67,827	66,841	81,133	86,113	4.5	8.8

Source: Peter K. Pollak, "Market Prospects For Fats and Oils

Soybean meal is 48 percent protein with a highly balanced amino acid composition. It is widely used in the preparation of livestock feeds.

Sunflowerseeds: Although sunflowers can be grown over a wide range of climatic conditions--from the tropics up to a latitude of 50 degrees--the bulk of production takes place in countries with temperate climates.

The growing season of the sunflower ranges from 70 days (under favorable conditions) to four months for early maturing dwarf varieties. The bulk of the crop is now harvested mechanically.

The USSR is the largest producer of sunflowerseeds accounting, on the average, for about 60 percent of world production. The combined output of the USSR and other centrally planned economies raises this share to about 75 percent. Although this figure has declined slightly during the past two decades, as sunflower production has expanded in the US, Australia, Spain, etc., world production still largely reflects fluctuations in the USSR's harvest. The fluctuations are primarily caused by weather conditions.

Cottonseeds: Cotton is grown in a large number of countries. The largest producers are the US, the USSR and China, followed by India, Pakistan and Brazil.

The cotton plant is grown primarily for its fiber; cottonseeds are essentially a by-product. During the ginning operation, the long fibers (staple or lint cotton) are removed, while the short fibers (linters) remain attached to the cottonseeds. Commercial seed cotton consists of about 10-15 percent linters, 35-40 percent hulls and 50-55 percent kernels.

Groundnuts: The production of groundnuts is concentrated in three climatic regions: humid subtropical, tropical savanna and monsoon climates.

India, China and the US produce about half the world's output of groundnuts. Year-to-year fluctuations in world groundnut production can be traced back to harvests in these countries. India's production fluctuates widely around a level of about 5 million tons, largely reflecting weather conditions during the growing season. Since groundnuts need plenty of moisture while growing and dry weather during the harvest, a slight shift in the pattern of the monsoons has a decisive impact on yields.

Production in the other two major producing countries has been trending steadily upwards. Since the US has imposed controls over acreage,

growth in output is largely the result of increases in yields. Production of groundnuts ir West African countries has declined during the past two decades.

Traditionally, the oilseed crushing industry has absorbed the bulk of the world's groundnut production. Of the two products recovered in the extraction process--groundnut oil and meal--the value of the oil is usually twice that of the meal. The fats and oils market has, therefore, a stronger impact on groundnut prices than the market for high-protein meals.

Rapeseed: The rape plant includes annual as well as biennial varieties. It grows best in temperate climates and in the subtropics during the cool season. Production is concentrated in three countries: India, Canada and China. Together, they supply about 60 percent of world production.

Rapeseed production has grown almost as rapidly as soybean production --at an average rate of 5.6 percent a year since the early 1960s. Most of this expansion is the result of increased plantings in Canada and France. India, the main producer, expanded its rapeseed plantings at a rate below that of the world average.

Vegetable Oils from Tree Crops

Olive Oil: The olive tree thrives in the warm and dry areas of temperate and subtropical climates. It needs mild winters--frost can cause serious damage --and prefers little rain during flowering and as the fruit ripens. Therefore, olive trees are often planted in areas bordering deserts, where rainfall is irregular. Production and also consumption of olives is concentrated in the Mediterranean region, with its dry summers, mild winters and even temperatures. Italy and Spain each produce about one-third of the world's olive oil.

About 90 percent of the olives harvested is used for oil extraction. The remaining 10 percent is marketed as table olives. Olive oil is almost used exclusively for edible purposes, mainly cooking and salad oil.

Palm oil and palm kernel oil: 1/ Oil palms are a tropical tree crop requiring between 1,800-2,000 mm of rainfall distributed regularly over the year, and about 2,000 hours of sunshine.

1/ For more details see Handbook on Palm Oil.

During the 1960s, palm oil production grew at about 2.4 percent annually. Since 1977, the rate of growth has accelerated to more than 10 percent a year, Table II-A2. This steep increase reflects the rapid expansion of oil palm plantings in Malaysia, Indonesia and the Ivory Coast. During the late 1950s, about two-thirds of the world's palm oil output was produced in Africa; two countries, Nigeria and Zaire, then, supplied more than half the world's palm oil. Although still major producers, the combined share of these countries had dropped to about 30 percent by 1974, slightly less than Malaysia's share.

The palm fruit yields two oils: palm oil, which is contained in the fleshy outer part (mesocarp), and palm kernel oil which is extracted from the hard core or kernel.

Coconut Oil: The coconut palm requires a warm sunny climate with an even temperature of about 29°C. It grows best in areas with an evenly distributed rainfall of 1,300-2,300 mm a year. Coconut palms, therefore, are grown in a belt that extends about 20 degrees on either side of the equator.

The Philippines and Indonesia dominate the production and trade of coconut and coconut products, Tables II-A2 and II-A3. Their combined production of coconuts (copra equivalent) amounts to more than 60 percent of the world's production.

Animal fats and marine oils

Fish oil: The production of fish oil is closely tied to the commercial catch of five species: herring, menhaden, plichard, sardine and whale. During the first half of the 1960s, fish catch and thus oil production grew steeply -- at an average annual rate of 8.2 percent. Then, during the latter part of the 1960s production of oil levelled off at about 1 million tons, dropping slightly during the early 1970s, Table II-A2. The sudden decline in the catch of anchovies off the Peruvian coast accounts for a part of the drop in production. Nevertheless, Peru remains the leading producer of fish oil.

Fish used for the extraction of fish oil yields about 10-20 percent oil. The remaining solid waste is further processed into fish meal. Fish meal has the highest protein content of all major high-protein meals and is an important ingredient in many livestock feeds.

Lard and tallow: The fatty tissues of hogs provide lard, those of cattle provide tallow. Yields of lard and tallow differ by breed of hog and cattle, and production of these two fats is tied closely to animal production. Consumer preference in the US and other industrialized countries for leaner pork and beef combined with a decline in the prices for lard and tallow relative to those for pork and beef have provided a strong incentive to livestock producers to raise leaner animals. Thus US production of lard and tallow has declined steadily since the early 1960s. However, lard and tallow production has increased in the USSR and China.

Butter: Butter continues to occupy a prominent position among the various fats and oils. Despite its comparatively high price and the growing competition from fat products (e.g. margarine and shortening) made from vegetable oils, the share of butter in the production of all fats and oils has declined only slightly during the last two decades. In absolute terms production has even increased.

While the bulk of world butter production is produced from cow's milk, a significant portion is made from the milk of other animals such as buffaloes and goats. In industrialized countries, butter is increasingly produced in creameries rather than farms. In the US, for example, about 98 percent of total butter production is from creameries. In the tropical regions of Asia and Africa, butter is used mainly in the form of butterfat, which is obtained by heating and separating the fat from the milk serum of the butter. The resulting butterfat is usually refined to dry butter or ghee.

B. Consumption

Fats and oils can be consumed directly in the form of cooking oil, margarine, shortening, etc., or indirectly through the consumption of livestock products and vegetables. The first type of fat consumption is usually referred to as "visible," the second as "invisible." In the US, visible consumption accounts for about 40 percent of the total fat intake; the remaining 60 percent involves consumption of oils that are contained in animal tissues (e.g., meat, fish, poultry and dairy products) or in the form of oil-bearing seeds (e.g., nuts). In this handbook consumption refers only to the visible portion of fats and oils consumed.

Fats and Oils: Worldwide, consumption of fats and oils grew steadily at an average rate of 3.2 percent a year from 1961-1975, Table II-B1. Industrialized countries account for slightly less than half of world consumption. During the early 1960s developing countries consumed about 28 percent of total world production of fats and oils. This share has grown to more than 30 percent in recent years. Among the developing regions, Asia and the Pacific region consume about 15 percent of total world production of fats and oils; the corresponding shares for Africa and Latin America are approximately 9 percent and 6 percent, respectively. Fats and oils consumption has grown faster in North Africa and the Middle East (6.6 percent) than in any other region; south Asia (2.9 percent) and West Africa (1.9) recorded the lowest growth rates.

Regional consumption patterns of fats and oils generally reflect regional production patterns and natural storage conditions. Economic protection and lower transport costs play an important role in the preference for locally produced fats and oils. In temperate zones, soybeans and other annual oilseed crops supply most of the oils needed in the manufacture of margarine, shortening and other fat products. In temperate zones, soybeans and other annual oilseed crops supply most of the oils needed in the manufacture of margarine, shortening and other fat products. In tropical and semi-tropical zones, coconut oil and groundnut oil dominate vegetable oil consumption. In the East Asia Pacific region, coconut oil supplies more than 60 percent of the regional demand for fats and oils; in West Africa, palm oil (64 percent) and groundnut oil (22 percent) dominate consumption.

During the past decade there have been significant shifts in the consumption of fats and oils, away from animal fats and in favor of vegetable oils, from hard to soft oils. These changes reflect partly increased supplies and relatively lower prices of vegetable oils and partly growing consumer awareness, in industrialized countries, of potential health risks associated with the consumption of highly saturated fats and oils.

Per capita consumption of fats and oils depends largely on income. In several developing countries annual per capita consumption is less than 5 kilograms, Table II-B2. In most industrialized countries it ranges from 25 to 30 kilograms--which is considered close to the saturation level. Statistical analysis of fats and oils consumption indicates that demand

Table II-B1: ESTIMATED FATS AND OILS CONSUMPTION BY REGION, FIVE-YEAR AVERAGES, 1961-75

Region	Consumption			Growth Rates		
	1961-65	1966-70	1971-75	1961-70	1966-75	1961-75
	('000 Mt)			(percent)		
Industrialized countries	13,689	16,119	18,318	3.3	2.6	3.0
Centrally Planned Economies	8,063	8,573	10,601	1.2	4.3	2.8
Latin America	1,786	2,092	2,740	3.2	5.6	4.4
East Africa	418	562	774	6.1	6.6	6.4
West Africa	978	965	1,176	-0.3	4.0	1.9
North Africa-Middle East	829	1,075	1,572	5.3	7.9	6.6
South Asia	3,651	4,032	4,843	2.0	3.7	2.9
East Asia-Pacific	766	916	1,278	3.6	6.9	5.3
WORLD TOTAL	30,180	34,334	41,302	2.6	3.8	3.2

Source: Estimated from USDA and FAO statistics.

Table II-B2: PER CAPITA CONSUMPTION OF FATS AND OILS BY REGION, FIVE-YEAR AVERAGES AND ANNUAL GROWTH RATES

Region	Per Capita Consumption			Growth Rates		
	1961-65	1966-70	1971-75	1961-65/ 1966-70	1966-70/ 1971-75	1961-65/ 1971-75
	(kg)			(percent)		
Industrialized countries	19.3	21.5	23.3	2.2	1.6	1.9
Centrally Planned Economies	7.1	7.6	9.1	1.4	3.7	2.5
Latin America	8.1	8.3	9.5	0.5	2.7	1.6
West Africa	9.1	7.9	8.6	-2.8	1.7	-0.6
East Africa	3.5	4.1	5.2	3.2	4.9	4.0
North Africa	6.7	7.5	9.6	2.3	5.1	3.7
South Asia	5.9	6.0	6.2	0.3	0.7	0.5
East Asia-Pacific	3.6	3.7	4.6	0.6	4.5	2.5

Source: Estimated from USDA and FAO statistics.

increases rapidly with income at low income levels. At high income levels--roughly those now reached in the US and some European countries--demand becomes less responsive to increases in income and levels off at about 30 kilograms per capita.

In many industrialized countries, where per capita consumption of fats and oils is close to saturation level, no large increase in overall demand is likely unless new products and end uses are developed. As the potential for expanding consumption declines in industrialized countries, an increasing share of world production of fats and oils will have to be marketed in developing countries. Centrally planned economies are expected to continue to consume about one-fourth of the world output of fats and oils.

Oilseed Meals: Oilseeds meals with their high-protein content are important ingredients in livestock feeds. The market prospects for oilseed meals are, therefore, closely linked to the prospects for livestock and dairy products as well as feedgrains, the other major ingredient of livestock feeds. The demand for livestock products depends to a large extent on per capita income. The income elasticity for high-protein meals, derived from the high income elasticity for livestock products, exceeds that for fats and oils. Therefore, as incomes rise, the demand for oilseed meals continues to grow long after per capita consumption of fats and oils has reached its saturation level.

C. Trade

Fats and oils enter international markets in two forms--unprocessed (e.g., as oilseeds) or processed (e.g., in the form of oil). 1/ The proportion of oilseed to oil exports varies widely among fats and oils and over time. These different proportions largely reflect the relative profitability of oilseed processing (oil extraction) in producing and importing countries. The structure of freight rates and tariffs in importing countries favors the trade in oilseeds over the trade in fats and oils. The bulk of soybean oil exports enters international markets in the form of unprocessed beans, mainly because importing countries protect their oilseed processing industry through

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1/ Some oils, such as palm oil, can only be exported in processed form, since the oil-bearing raw material, the palm fruit, "spoils" within hours after harvesting.

tariffs on imports of vegetable oils. Usually oilseeds can be imported duty free. Since the domestic demand for oils and meals rarely corresponds to the ratio of oil and meal extracted from imported soybeans, many importing countries, e.g., Spain, have become exporters of either soybean meal or oil. Industrialized countries import the bulk of the world's supplies of soybeans and meal, while developing countries import mainly soybean oil. However, in recent years, oilseed exporting countries have begun to set up their own processing facilities or to expand existing ones. This has changed the structure of the trade in oilseeds and oilseed products, tilting the ratio of fats and oils exports to oilseed exports in favor of the former.

The trade in fats, oils and high-protein meals, Tables II-C1 an II-C2, mirrors their supplies. Since the consumption growth of oilseed products is normally highly stable in most producing countries, growing exports of oilseed products are usually related to growing supplies. The production of palm oil in Southeast Asia provides an example; only a small portion of the palm oil is consumed in producing countries--the bulk flows into international trade.

Since the early 1960s the trade in fats and oils, as a group, has grown faster than their production. Thus consumers in importing countries (mainly industrialized countries) now have access to a wider range of fats and oils than before. Although most individual fats and oils followed this trend, exports of oils from perennial crops, as a group, grew at a slightly lower rate than their production. The growing domestic demand for these oils (mainly lauric oils in parts of Southeast Asia and palm oil in West Africa) has slowed down the rapid expansion of their trade.

Table II-C1: SELECTED OILSEEDS, FATS AND OILS (FAT OR OIL EQUIVALENT) - WORLD EXPORTS

	1961	1965	1970	1974/76	1977	1978	1979	Growth Rates 1961-77	Growth Rates 1977-79
	('000 tons)							(% per annum)	
Soybean oil	1,440	1,769	2,938	3,946	2,104	2,607	2,949	7.4	11.9
Sunflowerseed oil	245	405	825	768	692	798	799	7.6	4.9
Cottonseed oil	294	411	319	387	380	388	363	1.9	-1.5
Groundnut oil	826	993	826	799	579	436	448	0.1	-6.2
Rapeseed oil	92	282	513	712	668	520	624	14.3	-2.2
Olive oil	69	52	94	94	254	261	300	0.9	5.7
Palm oil	587	550	741	1,709	2,176	2,114	2,032	7.4	-2.3
Coconut oil	1,152	1,288	1,138	1,386	1,096	1,329	1,137	1.3	1.2
Palm kernel oil	407	367	320	393	244	266	340	-0.9	11.7
Marine oils	491	694	652	561	598	361	300	0.9	-20.5
Butter	426	537	740	775	1,039	1,025	1,263	3.9	6.7
Tallow	1,076	1,302	1,584	1,569	2,275	2,296	2,423	3.9	2.1
Lard	407	317	463	505	600	586	559	1.1	-2.3
TOTAL	7,512	8,967	11,153	13,603	12,705	12,987	13,567	4.4	2.2

Source: FAO, Production and Trade Yearbooks, and IBRD, Report No. 814, 1980.

Table II-C2: SELECTED HIGH-PROTEIN MEALS (MEAL EQUIVALENT) - WORLD EXPORTS

	1961	1965	1970	1974/76	1977	1978	1979	Growth Rates 1961-77	Growth Rates 1977-79
	('000 tons)							(% per annum)	
Soybean Meal	4,751	7,542	14,305	21,787	11,848	14,962	14,852	10.4	7.8
Sunflower Meal	620	510	726	549	507	728	799	1.8	16.3
Cottonseed Meal	956	1,426	1,426	955	834	895	980	-0.2	5.5
Groundnut Meal	1,521	2,234	2,112	1,925	1,569	903	1,373	1.4	-4.4
Rapeseed Meal	175	413	631	738	560	606	654	10.6	5.3
Palm kernel Meal	434	393	350	454	348	319	504	0.2	13.1
Copra Meal	723	865	836	1,051	870	992	1,008	2.5	5.0
Fish Meal	964	2,140	2,805	1,774	2,043	2,102	2,265	3.2	3.5
TOTAL	10,144	15,523	23,191	29,233	18,579	21,507	22,435	7.3	6.7

Source: IBRD, Report No. 814, 1980.

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2. Tan, B.T., "Prices and Trade Prospects for Malaysian Palm Oil," Ph.D. Thesis, North Carolina State University, 1973.

3. UNIDO, Draft World-Wide Study on the Vegetable Oils and Fats Industry: 1975-2000, UNIDO/ICIS.46, September 16, 1977.

III. MARKET PARAMETERS

A. Supply Elasticities

The supply of fats and oils as a group is highly price inelastic in the short run for two reasons. First, the supply of oils from tree crops, such as palm oil, coconut oil and palm kernel oil is highly price inelastic; and second, many fats and oils are recovered as by-products in the processing of oilbearing materials (such as meals and meat). Though demand for each of these products is affected by different market forces, their supply reflects the demand for both products. Thus the response to rapidly growing demand for one product, for example, oilseed meals, increases the supplies of the other product, vegetable oil.

Available estimates of price elasticities of supply of the various fats and oils indicate that both in the short- and long-run the production of annuals is more responsive to price changes than tree crops. Thus while the direct short-run price elasticity of supply of soybeans in the US was estimated to be 0.84, 1/ the short- and long-run price elasticity coefficients of palm oil production in Malaysia were found to be highly inelastic. 2/ A corollary of this is that countries growing tree crops are not generally well-placed to take advantage quickly of any improvements in market conditions for fats and oils.

B. Demand Elasticities

While the world demand for fats and oils as a group is highly price inelastic (0.4 in 1975), 3/ the results from a number of studies indicate that the elasticities for individual fats and oils are rather high, Table III-1.

A recent study by Chow attempted to estimate direct and cross price elasticities of (export) demand for 13 fats and oils. The results as presented in Table III-2 indicate that the direct price elasticities for each of the fats and oils are of the expected (negative) sign. Of these, sunflowerseed oil and rapeseed oil have the highest values. The cross price elasticities display both positive and negative signs, suggesting that there are both complementary and competitive forces in the fats and oils market.

1/ Houck, et al.
2/ H. Khera, p. 197.
3/ FAO.

Table III-1: DIRECT DEMAND PRICE ELASTICITIES ESTIMATED IN VARIOUS STUDIES
(Annual Data)

Oils	Direct Price Elasticities /a												
	United States									World			
	A	B	C	D	E	F	G	H	K	C /b	F /c	I	J /d
Cottonseed oil	-2.11 (2.15)												-7.14 (0.74)
Fish oil													-0.98 (2.91)
Grease													-2.70 (1.61)
Groundnut oil													-0.76 (3.0)
Lard	-0.97 (2.15)			-0.34 (2.0)									
Lauric oil		-0.90	-0.22 (3.14)			-0.16 (2.25)				-0.58 (3.02)	-0.31 (4.11)	-0.95 (5.59)	-0.42 (3.37)
Palm oil										E /b			-3.33 (2.0)
Soybean oil	-0.81 (2.65)				-0.28 (2.70)		-0.51	-0.43 (2.66)	-2.50	-2.61			-1.39 (5.14)

/a Values in parentheses are "t" values where available.
/b Demand in Western Europe.
/c Demand in EEC = -6.
/d Demand in industrialized countries.

Sources: See following page.

Sources:

A. Computed by inverting price flexibilities, 1948-1964. M.A. Jacobson, "Basic Competitive Price Relationships Among Major Food Fats and Oils, Unpublished Ph.D. dissertation, Purdue University, 1968, p. 62.

B. Computed for 1953-1963. G.W. Kromer, "The U.S. Coconut Oil Situation, "Fats and Oils Situation, U.S. Department of Agriculture Economic Research Service, Washington, D.C., April 1968.

C. Computed for 1953-1967. A.V. Nyberg, "The Philippine Coconut Industry," Unpublished Ph.D. dissertation, Cornell University, 1968, p. 144.

D. Computed for 1931-1960. A.E. Drake and V.I. West, Econometric Analysis of the Edible Fats and Oils Economy, Bulletin 695, University of Illinois Agricultural Experiment Station, Urbana, June 1963, p. 33.

E. Computed for 1945-1966. The equivalent elasticity value for export oil demand is -0.61. J.P. Houck, M.E. Ryan and A. Subotnik, Soybeans and their Products (Minneapolis: University of Minnesota Press, 1972) p. 86.

F. Computed for 1954-1967. W.C. Labys, Dynamic Commodity Models: Specification, Estimation and Simulation (Lexington: Health Lexington Books, (1973), p. 32.

G. Computed for 1946-1964. J.P. Houck and J.S. Mann, Domestic and Foreign Demand for U.S. Soybeans and Soybean Products, Techn. Bull. No. 256, University of Minnesota Agricultural Experiment Station, St. Paul, 1968, p. 20.

H. Computed for 1948-1964. R.J. Vandenborre, Economic Analysis of Relationships in the International Vegetable Oil and Meal Sector, Bulletin 106, University of Illinois Agricultural Experiment Station, Urbana, 1970, p. 43.

I. Computed from linearized coefficients based on a nonlinear price relationship, 1950-1967. A.E. Recto. "An Analysis of the International Demand for Philippine Coconut Products," Unpublished Ph.D. dissertation, University of Minnesota, 1971, p. 105.

J. Computed by inverting price flexibilities, 1955-1964, D. Bachelet, Analyze Econometrique du Marche des Olieagineux Tropicaux. Prepared by METRA International for the EEC, Brussels, 1968.

K. Computed for 1947-1956. J.P. Houck, Demand and Price Analysis for the U.S. Soybean Market. Tech. Bull. No. 244, University of Minnesota Agricultural Experiment Station, St. Paul, 1963.

Table III-2: SUMMARY OF REGRESSIONS FOR EXPORTS OF OILS AND FATS ON THEIR PRICES (EQUATION 1)

Prices	Independent variables												
	Palm (1)	Palm kernel (2)	Soybean (3)	Sunflower-seed (4)	Cottonseed (5)	Groundnut (6)	Rapeseed (7)	Olive (8)	Coconut (9)	Lard (10)	Tallow (11)	Butter (12)	Fish (13)
Palm	$\underline{-0.819}^{***}$	-0.498^{***}	0.708^{*}	0.999^{*}	-1.762^{**}	0.570^{*}	1.806^{***}	1.372^{+}	0.879^{*}	-1.167^{*}	0.466^{**}	0.530^{**}	0.366^{**}
Palm kernel	–	$\underline{-0.042}^{NS}$	0.160^{NS}	–	1.297^{***}	-0.186^{*}	–	-0.507^{+}	0.405^{+}	0.234^{NS}	–	–	0.078^{+}
Soybean	-0.173^{NS}	-0.418^{***}	$\underline{-0.490}^{*}$	1.110^{*}	–	-0.848^{***}	1.349^{**}	-3.570^{**}	–	-0.942^{*}	-0.198^{NS}	$\underline{-0.532}^{*}$	0.965^{***}
Sunflowerseed	–	0.949^{***}	–	$\underline{-2.287}^{***}$	–	–	–	1.770^{*}	-1.082^{**}	–	–	0.937^{+}	-0.140^{+}
Cottonseed	0.636^{***}	0.375^{**}	–	1.150^{**}	$\underline{-1.015}^{**}$	– –	0.445^{+}	–	1.285^{**}	-0.566^{*}	-0.095^{NS}	–	-0.110^{+}
Groundnut	–	-0.072^{NS}	-0.317^{NS}	–	–	$\underline{-0.415}^{*}$	-1.134^{**}	1.041^{+}	–	–	-0.194^{+}	-0.941^{***}	–
Rapeseed	–	-0.741^{***}	–	–	1.400^{**}	–	$\underline{-2.681}^{***}$	–	-0.399^{NS}	2.143^{***}	0.315^{NS}	0.737^{*}	-0.824^{***}
Olive	–	–	-0.192^{+}	-0.296^{+}	–	0.312^{**}	-0.718^{***}	$\underline{-1.535}^{***}$	-0.139^{NS}	0.317^{*}	-0.107^{+}	–	$\underline{-0.075}^{**}$
Coconut	–	0.160^{*}	–	–	-0.820^{*}	–	–	–	$\underline{-1.337}^{***}$	0.260^{NS}	–	–	0.049^{NS}
Lard	–	0.276^{**}	–	–	0.861^{*}	0.814^{**}	0.522^{+}	–	-0.571^{+}	$\underline{-0.577}^{+}$	-0.528^{**}	-0.904^{***}	-0.134^{+}
Tallow	0.363^{*}	0.079^{NS}	–	-0.845^{*}	0.990^{**}	–	–	2.076^{**}	0.232^{NS}	–	$\underline{-0.237}^{+}$	0.309^{+}	-0.305^{**}
Butter	0.490^{***}	0.045^{NS}	0.386^{+}	–	1.143^{***}	-0.467^{***}	0.627^{**}	-1.327^{*}	0.372^{**}	0.359^{+}	-0.196^{*}	$\underline{-0.145}^{NS}$	0.202^{**}
Fish	0.244^{*}	0.201^{**}	–	–	-0.425^{+}	-0.266^{*}	–	-1.102^{**}	0.485^{**}	–	0.274^{*}	0.238^{*}	$\underline{-0.222}^{**}$

Note: NS, +, *, **, *** for non-significant, significant at the 10%, 5%, 1% and 0.1% probability level respectively.

Source: Chow and Yusof (1981).

IV. MARKET PRICES

A. Price Determining Mechanism

The prices for oilseeds and their products are determined in the main by the interaction of market forces. 1/ In general, prices for oilseeds reflect the relative strength of the markets for oils and meals. Over the long-term, oilseed prices may be viewed as the weighted average of the oils and meals contained in them, corrected for the cost of oil extraction (crushing margin).

Though technically most fats and oils are interchangeable, costs of refining and specific end use requirements limit the range within which individual fats and oils actually are substituted. As noted earlier, the need for certain chemical components (e.g., fatty acids) or certain physical properties (e.g., flavor, color, smell, melting point) in a specific end use gives the oil or fat which has these components or properties a competitive advantage over other fats and oils for that end use ("specific demand"). Thus, each oil or fat has two distinct markets: first, the market in which it has a qualitative advantage over other fats and oils; and second, the market in which it competes directly with other fats and oils. The size of the first market varies with the demand for the end-products which need its special properties. The demand in this market is less price-elastic than demand in the second market.

An increase in the supply of an individual fat or oil tends to depress its price relative to those of other fats and oils. This is because

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1/ Non-market forces or protectionist measures are also of some importance (see Section III for details).

the demand schedule becomes increasingly inelastic as the supplies from an individual oil increase. 1/

Table IV-1 shows the prices of oils that are important in world trade. (Olive oil is excluded from the table because there is a strong preference for olive oil in certain food uses and its price is likely to be determined independently of other oils.) On the basis of average prices, it is possible to classify those oils into three major groups: groundnut, cottonseed and lauric oils are the highest priced oils; sunflowerseed, rapeseed, palm and soybean oils are the medium priced oils; marine or fish oils are the cheapest available. The prices of high-protein meals are similarly shown in Table IV-2.

Another indication of the degree of substitution prevailing among various oils (meals) is given by the price correlation coefficient. Prices of oils (meals) that can be readily interchanged with each other in their main uses are likely to be highly correlated. On the other hand, price correlation with other oils (meals) where substitution possibilities are remote is likely to be low. Tables IV-3 an IV-4, which give the correlation coefficients that were estimated for oil and meal prices illustrate the close relationship that exists between the prices, within these two commodity groups.

1/ There is some evidence that this schedule becomes more elastic over time if the supplies of an oil continue to grow. Palm oil provides an example. During the early 1960s palm oil became available in increasing quantities, and its price dropped sharply relative to that of soybean oil and other competing fats and oils. However, as the producers of fat products, such as margarine, shortening and soap, adjusted the formulations of their products to use more of the comparatively cheaper palm oil, its price began to approach that of competing oils. Today, palm oil prices have reached—and at times even exceeded—soybean oil prices.

Table IV-1: PRICES OF SELECTED FATS AND OILS /a CIF EUROPE, 1960-1980
(in US Dollars per metric ton)

Year	Soybean	Sunflower	Cottonseed	Groundnut	Rapeseed	Olive	Palm	Coconut	Palm kernel	Fish	Lard	Butter	Tallow
1960	225	243	235	326	219	585	228	312	317	155	214	851	142
1961	287	311	305	331	280	561	232	254	263	139	225	706	158
1962	227	246	266	275	221	633	216	251	255	104	218	822	137
1963	223	236	243	268	215	871	222	286	287	160	216	900	141
1964	205	255	250	315	252	586	240	297	299	203	251	931	168
1965	270	294	278	324	263	663	273	348	353	217	293	918	200
1966	261	263	333	296	244	661	236	324	271	196	282	833	180
1967	216	212	378	283	206	690	224	328	249	127	205	817	144
1968	178	172	305	271	161	681	169	399	367	99	169	709	129
1969	228	213	291	332	200	666	181	361	306	150	216	709	166
1970	307	331	354	379	293	699	260	397	429	248	271	733	202
1971	323	375	392	441	295	727	261	371	225	221	262	1,048	196
1972	270	326	324	426	232	916	217	234	244	182	251	1,209	179
1973	465	480	500	546	395	1,399	378	513	491	342	373	975	356
1974	795	983	939	1,077	745	2,174	669	998	1,010	559	602	1,216	448
1975	619	739	726	857	551	2,436	434	393	439	344	479	1,669	340
1976	438	581	593	741	415	2,166	406	418	433	372	480	1,740	371
1977	576	639	622	852	584	2,234	530	578	620	472	618	2,247	421
1978	607	665	661	1,079	597	2,427	600	683	764	451	626	1,982	483
1979	662	772	798	889	621	2,701	654	484	992	450	693	2,698	612
1980	598	632	657	863	540	2,500	673	673	669	450	644	2,352	487

/a Descriptions:

Soybean oil: Crude, US, CIF Rotterdam
Sunflower oil: Any origin, ex-tank Rotterdam
Cottonseed oil: US, PBSY, CIF Rotterdam
Groundnut oil: Nigerian/Gambian/Any origin, CIF Europe
Rapeseed oil: Dutch, FOB ex-mill.
Olive oil: Spanish, edible, 1% drums.
Palm oil: Malaysian, 5%, CIF UK
Coconut oil: Philippines/Indonesian, bulk, CIF Rotterdam. For 1973, Dutch, 5%, ex-mill; prior to 1973, White Ceylon, 1%, bulk, ex-mill Rotterdam.
Palm Kernel oil: West African, CIF UK.
Fish oil: Any origin, crude, CIF Europe. Prior to March 1973, Peruvian, semi-refined.
Lard: EEC refining quality, CIF UK. Prior to February 1973, US, Prime Steam, CIF UK.
Butter: Dutch, bulk, unsalted, UK markets.
Tallow: US, bulk, bleachable fancy, CIF Rotterdam.

Table IV-2: SELECTED HIGH-PROTEIN MEAL - PRICES 1960-80.
(C.i.f. Europe, current $/ton)

Year	Soybean Meal	Sunflower Pellets	Cottonseed Expeller	Groundnut Meal	Rapeseed Meal	Coconut Pellets	Fish Meal
1960	78	69	79	98	65	88	116
1961	81	67	78	93	69	71	131
1962	89	81	83	102	71	77	149
1963	91	89	93	196	72	77	145
1964	89	88	102	108	71	76	161
1965	94	84	96	119	74	96	190
1966	101	83	94	111	68	103	160
1967	98	82	95	127	70	98	134
1968	98	79	95	112	73	94	129
1969	95	80	90	111	75	90	172
1970	103	86	96	123	84	91	197
1971	102	86	93	98	71	81	167
1972	129	101	106	122	90	91	239
1973	302	217	225	266	178	153	542
1974	184	150	179	174	143	118	372
1975	155	135	153	140	128	145	245
1976	198	163	201	178	154	155	376
1977	230	175	205	218	169	178	454
1978	213	156	167	204	168	176	410
1979	243	183	190	211	187	214	395
1980	259	196	212/a	240/a	204	214	504

/a Incomplete

Quotations: Soybean Meal: US 44%, CIF Rotterdam.
Sunflower Pellets: Argentina/Uruguay, 37-38%, CIF Rotterdam.
Cottonseed Expeller: 38%, CIF Denmark.
Groundnut Meal: 48%, Indian, CIF Rotterdam.
Rapeseed Meal: Any origin, 34%, FOB ex-mill, Hamburg.
Coconut Pellets: Philippine, 26%, CIF Hamburg.
Fish Meal: Any origin, 64-65%, CIF Hamburg.

Source: Oil World Weekly (various issues).

Table IV-3: CORRELATION MATRIX OF PRICES FOR SELECTED FATS AND OILS /a

	Sunflower Oil	Groundnut Oil	Cottonseed Oil	Rapeseed Oil	Olive Oil	Palm Oil	Coconut Oil	Palm kernel Oil	Fish Oil	Butter	Tallow	Lard
Soybean oil	.99	.97	.98	.99	.93	.96	.87	.90	.96	.78	.93	.94
Sunflower oil		.96	.98	.98	.92	.93	.85	.88	.95	.75	.90	.92
Groundnut Oil			.95	.97	.95	.95	.83	.88	.95	.82	.93	.95
Cottonseed oil				.96	.92	.93	.88	.89	.93	.76	.91	.92
Rapeseed oil					.93	.97	.87	.91	.97	.80	.93	.96
Olive oil						.93	.78	.84	.91	.91	.95	.96
Palm oil							.90	.95	.96	.86	.97	.98
Coconut oil								.99	.86	.69	.89	.85
Palm kernel oil									.90	.75	.92	.91
Fish oil										.80	.94	.96
Butter											.90	.91
Tallow												.98

/a Calculated from data shown on Table 3.
*Observation covers 1960-1980.

Table IV-4: CORRELATION MATRIX OF PRICES FOR SELECTED HIGH-PROTEIN MEALS /a

	Sunflower Pellets	Cottonseed Expeller	Groundnut Meal	Rapeseed Meal	Coconut Pellets	Fish Meal
Soybean Meal	.9917	.9726	.9117	.9626	.8877	.9769
Sunflower Pellets		.9871	.9219	.9763	.8990	.9796
Cottonseed Expeller			.8913	.9681	.8890	.9695
Groundnut Meal				.8902	.8130	.9067
Rapeseed Meal					.9516	.9664
Coconut Pellets						.8720

/a Computed from prices in the European Markets for the period 1960-1980.

Selected References

1. Augusto, S. and Pollak. P., "Structure and Prospects of the World Fats and Oils Economy," World Bank Commodity Models Vol.I, World Bank Staff Commodity Working Paper No.6, 1981.

2. Griffith, G.R. and Meilke, K.D., "Relationships among North American Fats and Oils Prices," American Journal of Agricultural Economics, May 1979.

3. Tan, B.T., Prices and Trade Prospects for Malaysian Palm Oil, Ph.D. Thesis, North Carolina State University, 1973.

V. SPECIAL ISSUES

A. Protectionism in the Oilseeds, Oils and Oilmeals Sector [1/]

Even though a significant portion of world trade in oilseeds, oils and oilmeals takes place under duty-free conditions, the incidence of protectionist measures affecting international trade in this sector is considerable.

The main protectionist measures in the sector are designed to favor domestic production and also domestic processing. Those measures which favor domestic production are generally related, especially in industrialized countries, to wider policy objectives of bringing living standards and incomes in the agricultural sector more in line with those in the rest of the economy. Measures favoring domestic processing industries generally take the form of escalating tariffs with the degree of processing. In developing countries, important factors underlying protectionist policies are self-sufficiency objectives often related to foreign exchange constraints and the need to raise revenue.

As regards tariffs, imports of oilseeds and oilmeals into most industrialized countries are duty-free, while import duties are generally charged on imports of fats and oils by both industrialized and developing countries. Many countries have tariffs on most fats and oils which escalate with the degree of refining, and the effective protection given to domestic industries is high since the value added in oilseed crushing and refining is relatively low. This protection is reduced or eliminated with respect to

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1/ This section is based on FAO "Protectionism in the Oilseeds, Oils and Oilmeals Sector," CCP: OF 81/2, January 1981.

import originating from certain countries into those importing countries operating preferential schemes, 1/ including Generalized System of Preference (GSP) schemes.

Non-tariff barriers are applied by several industrialized countries on a variety of individual commodities; these barriers include quantitative restrictions (especially for butter) or variable levies, or health and sanitary regulations, or state monopolies. State trading practices are a normal feature in centrally planned countries and are also frequently used by developing countries, many of which also control imports by imposing import quotas.

Production policies followed by some industrialized countries for certain oilseeds, fats and oils give support to domestic production at prices significantly above world prices and consequently affect the volume and the pattern of international trade. The high prices have often encouraged domestic production and discouraged consumption, and thus reduce import demand. An additional consequence has been in some cases the accumulation of surpluses and the need to subsidize their disposal in domestic and/or export markets. Butter is widely subject to the measures described above in North Amnerica and Europe; other commodities include groundnuts in the U.S. as well as olive oil, rapeseed and sunflowerseed in the EC and other European countries.

Some progress has been made in recent years towards reduced protectionism. But there have been developments in the opposite direction too. Although the degree of protection to domestic producers has been reduced in some cases, the high-price production support policies have been extended in some other cases to additional commodities. In several countries, production of traditionally supported commodities has increased together with the costs involved in supporting prices and in subsidizing the disposal of surpluses.

In the field of trade policies, limited progress has been made at the GATT Tokyo Round of Multilateral Trade Negotiations (MTN) with regard to

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1/ Under the second Lome' Convention, preferential treatment is granted by the EC to 60 countries in Africa, the Caribbean and the Pacific (ACP). While a number of large developing exporters of fats and oils in Asia and Latin America are excluded, the product coverage is wider than that of GSP schemes and the margins of preference more favorable since duty-free treatment is granted to all fats and oils, both crude and further processed.

tariffs and non-tariff barriers to trade, although the problem of tariff escalation remains. Some progress has also been made in GSP schemes with regard to commodity coverage and margins of preference granted to developing countries, but these may be eroded in some cases with the future implementation of MTN concessions. Also a number of developing countries have liberalized their import policies. Table V-A1 provides a comparison of nominal and effective protection rates for vegetable oils in the EC, Japan and the US, while a number of selected measures other than tariffs affecting imports/exports of oilseeds, oils, fats and oilmeals into/from selected market economy countries is given in Table V-A2.

Table V-A1: COMPARISON OF NOMINAL AND EFFECTIVE RATES OF PROTECTION FOR SELECTED VEGETABLE OILS IN THE EUROPEAN ECONOMIC COMMUNITY, JAPAN AND THE UNITED STATES

Product	European Economic Community			Japan		United States	
	Tariff Rate		Effective Protection /a	Nominal Protection	Effective Protection /a	Nominal Protection	Effective Tariff Protection
	Nominal	Effective					
	(percent)						
Coconut oil	11.5	132.9	132.9	9.0	49.2	9.4	16.3
Cottonseed oil	11.0	79.0	79.0	25.8	200.3	59.6	465.9
Groundnut oil	11.3	139.7	139.7	14.2	96.5	15.0	6.7
Soybean oil	11.0	148.1	148.1	25.4	268.3	22.5	252.9
Rapeseed oil	9.0	57.2	57.2	15.1	22.3	20.8	60.9
Palm kernel oil	10.5	141.5	141.5	7.2	49.2	3.8	29.2

/a Includes levies and other special charges.

Source: UNCTAD document TD/B/C.1/207 Add. 2 of 14 August 1980, "The Influence of Protectionism on Trade in Primary and Processed Commodities: the Results of the Multilateral Trade Negotiations and Areas for Further International Cooperation Action." Table adapted from Alexander J. Yeats, "Effective Protection for Processed Agricultural Products: A Comparison of Industrial Countries," Journal of Economics and Businesses, Fall 1976, Table 1 (p. 35).

Table V-A2: SUMMARY OF SELECTED MEASURES OTHER THAN TARIFFS AFFECTING IMPORTS/EXPORTS OF OILSEEDS, OILS, FATS AND OILMEALS INTO/FROM SELECTED MARKET ECONOMY COUNTRIES

	Many Oilseeds or Related Products	Oilseeds	Vegetable Oils	Margarine	Oilmeals	Butter	Lard
Measures on Imports							
Discretionary licensing	BGD/IND KOR/PAK	JPN (gn) /a	PRT (olo)			AUT/CAN/FIN NOR	AUT/NOR CHE /b
Health and sanitary regulations	AUS/CAN	JPN (sb,gn,sb /c)	JPN (cco,pko,pmo)	JPN	EEC/JPN/ USA		
Import levies		ESP (gn,sb)/CHE	CHE /d /ESP (gno) SWE /d		CHE/ESP SWE	CHE/EEC/FIN	EEC
Import prohibition				CAN /e			
Import quotas	D'ING-9	CHE/USA(gn)/ JPN (gn)		USA /f	CHE	USA	
Import restrictions						CHE/PRT	
State trading	D'ING-10	PRT	PRT /g	NOR /h PRT PHI (sbo)	CHE/JPN		
Measures on Exports							
Export aids	USA	EEC (rp,sf)	EEC (olo) URY(lso,sbo,sfo)		URY (sbo)	AUT/EEC/ FIN/SWE	EEC
Export controls	ARG/IDN						
Export prohibition		BRA (bab,sb,ct)					
Export quotas		BRA (sb)/IND (gn)	BRA (sbo)		BRA (sbo) IND (gnc)		
Export taxes	D'ING-5						
State trading		IND (gn, ss)	BRA (cbo)/IND (cbo)		IND (gnc) PER (fm)		
Measures on Production							
Deficiency payments		EEC (rp,sf)/ESP (sb) JPN (rp,sb)	EEC (olo) ESP (olo)				
Production aids		EEC (sb,ct,ln,sb)					
Production restraints		CHE (rp)/USA (gn)					
Support/intervention prices		CHE (rp)/PRT (saf,sf) ESP (rp,saf,sf) SWE (rp)/USA (gn)	PRT (olo)			AUT/CAN/EEC FIN/USA	
Measures on Consumption							
Consumption restraints			ESP (sbo)				
Consumer subsidies	MAR/MEX SAU/VEN		CHE (rp)/EEC (olo) PRT /i	NOR		AUT/CHE/EEC FIN/MEX	

/a Groundnuts other than for oil extraction.
/b Lard other than for industrial use.
/c Health and sanitary regulations enforced on castorbeans, groundnuts other than for oil extraction, and soybeans.
/d Levies charged on imports of fats and oils for human consumption.
/e Prohibition only applies to oleomargarine, butterine or other similar substitutes for butter or processed butter, with exceptions (e.g., for personal use).
/f Quota only applies to butter substitutes containing over 45 percent butterfat.
/g Import monopoly applies to all vegetable oils except olive oil.
/h Including fishmeal.
/i All edible oils excluding olive oil.

Country abbreviations

ALG - Algeria
ARG - Argentina
AUS - Australia
AUT - Austria
BGD - Bangladesh
BRA - Brazil
CAN - Canada
CHE - Switzerland
EEC - European Economic Community
EGY - Egypt
ESP - Spain
FIN - Finland
IDN - Indonesia
IND - India
IRN - Iran
IRQ - Iraq
JPN - Japan
KOR - Korea, Rep.
MAR - Morocco
MEX - Mexico
MYS - Malaysia
NOR - Norway
PAK - Pakistan
PER - Peru
PHI - Philippines
PRT - Portugal
SAU - Saudi Arabia
SWE - Sweden
URY - Uruguay
USA - United States
VEN - Venezuela

D'ING-5 - ARG/BRA/IDN MYS/PHI
D'ING-9 - ALG/BGD/EGY/IRN IRQ/KOR/MEX/PAK/PER
D'ING-10 - ALG/BGD/EGY/IND IRN/IRQ/MAR/MEX PAK/PER

Product abbreviations

bab - Babassu nuts
cb - Castorbeanbs
cbo - Castor oil
cco - Coconut oil
ct - Cottonseed
fm - Fishmeal
gn - Groundnuts
gnc - Groundnut cake
gno - Groundnut oil
ln - Linseed
lso - Linseed oil
olo - Olive oil
pko - Palm karnal oil
pmo - Palm oil
rp - Rapeseed
sb - Soybeans
sbo - Soybean meal
sbo - Soybean oil
saf - Safflowerseed
sf - Sunflowerseed
sfo - Sunflowerseed oil
ss - Sesameseed

Source: FAO, Report CCP: OF 81/2, January 1981.

B. Conversion Factors

Oilseeds are converted into crude oil and oilmeals. Table V-B1 gives the percentage of oilseed crops assumed crushed for oil and meal production, by country, while Tables V-B2 and V-B3 give the conversion rates for oilseeds to oil equivalent and meal equivalent, respectively.

Table V-B1: PERCENTAGE OF OILSEED CROPS ASSUMED CRUSHED FOR OIL AND MEAL PRODUCTION, BY COUNTRY

Type of seed	Country	Percentage of the crop at present assumed to be crushed for oil
Copra	All countries	/a 100
Cottonseed	India	75
	Pakistan	60
	China (Mainland)	25
	U.A.R.	80
	Brazil	65
	Argentina	90
	Europe	90
	Uganda	80
	United States	95
	U.S.S.R.	85
	All other countries	75
Flaxseed	Europe	85
	Mexico	92
	United States	93
	All other countries	90
Palm kernels	All countries	/a 100
Peanuts (in shell)	Argentina	80
	Brazil	80
	China (Mainland)	50
	Former French West Africa	75
	Gambia	90
	Indonesia	20
	India	75
	Nigeria	75
	South Africa, Rep. of	75
	United States	28
	All other countries	15
Rapeseed	All countries	90
Soybeans	Canada	92
	China (Mainland)	45
	Indonesia	nil
	Japan	35
	Korea	nil
	United States	94
	All other countries	50
Sunflowerseed	All countries	90

/a Applied to commercial production.

Source: Fats and Oils Division, Foreign Agricultural Service, U.S. Department of Agriculture.

Table V-B2: CONVERSION RATES FOR OILSEEDS TO OIL EQUIVALENT

Region /a	Unshelled peanuts	Shelled peanuts	Copra	Palm kernels	Soy-beans	Flax-seed	Cotton-seed	Rape-seed	Sunflower seed
	(percent)								
United States	31	43	64	45	17	35	17	35	44
Canada	31	43	64	45	17	35	17	35	44
EC	31	43	64	49	17	35	20	35	44
EFTA	31	43	64	47	15	32	17	35	44
O.W.E.	30	42	64	47	15	28	15	35	44
Japan	31	43	64	45	14	35	17	35	44
Australia and New Zealand	29	40	62	45	15	36	19	35	44
South Africa, Rep. of	29	40	62	45	15	36	19	35	44
Eastern Europe	31	43	63	45	15	32	17	35	44
USSR	31	43	64	45	15	32	17	35	44
Communist Asia	31	43	64	45	15	32	16	35	44
Mexico and Central America	28	39	59	45	17	32	20	35	44
South America	28	39	59	45	17	32	20	35	44
West Africa	27	38	62	45	15	32	18	35	44
East Africa	27	38	62	45	15	32	18	35	44
North Africa	27	38	62	45	15	32	18	35	44
West Asia	28	39	62	45	15	32	15	35	44
South Asia	28	39	62	45	15	38	15	25	44
South East Asia	28	39	49	45	13	32	15	35	44
Other East Asia	28	39	60	45	13	32	15	35	44
Far East Asia and Oceania	31	43	62	45	17	32	15	35	44

/a Oil equivalents were computed on the basis of these regions. The totals were then regrouped into the regions used in this study.

Source: Foreign Agricultural Service, USDA, Washington, D.C., and "Technical Conversion Factors for Agricultural Commodities," FAO, Rome, 1960.

Table V-B3: CONVERSION RATES FOR OILSEEDS TO MEAL EQUIVALENT

Region /a	Unshelled peanuts	Shelled peanuts	Copra	Palm kernels	Soy beans	Flax-seed	Cotton-seed	Rape-seed	Sunflower-seed
	(yield percentage)								
United States	39.5	55.4	35.0	53.0	80.5	62.0	45.5	62.0	40.0
Canada	39.5	55.4	35.0	53.0	80.5	62.0	45.5	62.0	40.0
EC	39.5	55.4	35.0	49.0	80.5	62.0	42.5	62.0	40.0
EFTA	59.5	55.4	35.0	51.0	82.5	65.0	45.5	62.0	40.0
O.W.E.	40.5	56.8	35.0	51.0	82.5	69.0	47.5	62.0	40.0
Japan	40.5	56.8	35.0	51.0	82.5	69.0	47.5	62.0	40.0
Australia and New Zealand	41.5	58.2	37.0	53.0	82.5	61.0	43.5	62.0	40.0
South Africa, Republic of	41.5	58.2	37.0	53.0	82.5	61.0	43.5	62.0	40.0
Eastern Europe	39.5	55.4	36.0	53.0	82.5	65.0	45.5	62.0	40.0
U.S.S.R.	39.5	55.4	35.0	53.0	82.5	65.0	45.5	62.0	40.0
Communist Asia	39.5	55.4	35.0	53.0	82.5	65.0	46.5	62.0	44.0
Mexico and Central America	42.5	59.6	40.0	53.0	80.5	65.0	42.5	62.0	40.0
South America	42.5	59.6	40.0	53.0	80.5	65.0	42.5	62.0	40.0
West Africa	43.5	61.0	37.0	53.0	82.5	65.0	44.5	62.0	40.0
East Africa	43.5	61.0	37.0	53.0	82.5	65.0	44.5	62.0	40.0
North Africa	43.5	61.0	37.0	53.0	82.5	65.0	44.5	62.0	40.0
West Asia	42.5	59.6	37.0	53.0	82.5	65.0	47.5	62.0	40.0
South Asia	42.5	59.6	37.0	53.0	82.5	59.0	47.5	62.0	40.0
South East Asia	42.5	59.6	50.0	53.0	84.5	65.0	47.5	62.0	40.0
Other East Asia	42.5	59.6	39.0	53.0	84.5	65.0	47.5	62.0	40.0
Far East Asia and Oceania	39.5	55.4	37.0	53.0	80.5	65.0	47.5	62.0	40.0

/a Meal equivalents were computed on the basis of these regions. The totals were then regrouped into the regions used in this study.

Source: Same as for Table V-A3. The meal yield percentages here and the oil yield percentages in Table V-A3 do not add to 100 because a waste factor is included.

Selected References

1. FAO Protectionism in the Oilseeds, Oils and Oilmeals Sector, CCP: OF 81/2. January 1981.

2. FAO, Technical Conversion Factors for Agricultural Commodities, Rome 1972.

3. USDA, World Supply and Demand Prospects for Oilseeds and Oilseed Products in 1980, Foreign Agricultural Economic Report No. 71.