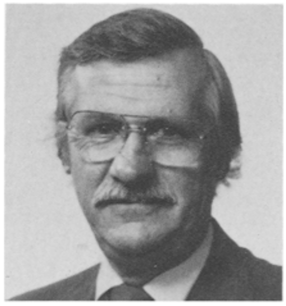
Changes in Commercial Fat and Oil Products by the Year 2000



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ABSTRACT

The best way to look at the year 2000 and beyond is to comprehend our historical developments and current practices. For food, the world depends on comparatively few fat and oil sources and that, basically, is not likely to change. We can, however, expect to see significant shifts within these sources as the world strives to meet its basic dietary needs. Pritein demands, for both direct and indirect consumption, will continue as the most immediate controlling factor. This is impacted by political and socioeconomic influences, and changes in eating habits where functional performance requirements are superimposed on basic caloric needs. Technological advances, both via conventional and genetic engineering, will be significant in tailoring these traditional oil sources. Biotechnology can change compositions and even traditional growing latitudes. What we will have from these new technologies in the more distant future will still depend on what we want and what we will allow to happen. Food fat systems for this futuristic period as defined by functional characteristics will be recognizably unchanged, being reasonably adaptable to any changes in fat and oil sources or their compositions.

Three new occupations have enjoyed unprecedented popularity during the last ten years. They are futurists, risk analysts and conference organizers specializing in "the future." Unfortunately, this preoccupation with the future has not as yet produced any new or more accurate means for prediction (1). Technology abounds and, by comparison, our predictive capabilities appear medieval (2).

Predicting the future is at once simple and humbling. The abstract for this presentation suggested that, the more things remain the same, the greater is the change. The best predictions require hindsight, which by definition does not exist before the fact, at the time that the prediction or predictions are being made. An old sage (or was it Confucius?) said: "He who does not understand history is doomed to relive it." This sounds like profound advice, suggesting that a historical perspective of where we are and how we got there will help us understand our future course. What is a true historical perspective?

One needs to be aware of past fats and oil' production data. However, if we had looked too narrowly at past world fats and oils' production data, accumulatively at any point in time or its linear trend extrapolations, we would have missed predicting the onset of soybean oil, the explosion curve growth of palm oil and the fact that palm oil production is probably now peaking out.

Predicting the future, the long-range future for fats and oils can be likened to the classical problem facing the group of blind wizards standing around an elephant, each attempting to describe the whole animal by touching only one part. Even touching the same spot can produce different images. A sighted person would look at the animal and conclude: "Elephant," and the prediction would be correct. However, sightedness in this case, is akin to hindsight and it is not available when we need it. Obviously, if we touch enough parts, or have enough *touchstones* we should have a reasonable chance of predicting the future. Well, only if the images we perceive are the correct ones.

What are our touchstones? For that matter, how do we define the future? The year 2000 is less than 20 years from now and our perspective is that 20 years ago was the 1960s. Obviously, anything that we suggest today has to be tempered by the influences of improved technology and the more protracted the prediction period, the more vulnerable it is to changes brought about by new technologies. Technology, the practical application of scientific knowledge can rapidly change a situation; witness the not-too-recent change from rapeseed to canola. So, technology too becomes an important touchstone.

There are a number of touchstones. They are not necessarily independent variables. They are to some extent dependent on each other, and some have more than one facet. Some of these factors are more important than others, have importance at different periods in time, and are not particularly practical to discuss as isolated subjects. Some of the touchstones are mentioned below:

> *Agricultural environment* is an obvious factor; *utility*, as a total crop, oil vs protein, animal or vegetable; *functionality* and interchangeability, or versatility of a fat or oil system, which is also related to its utility; *food needs*, as basic calories and/or to satisfy cultural eating habits or new product aspirations; *demographics* and *production*, the distribution of crops, as a food staple and as a world oil crop, for example, rice vs rice bran oil; *technological forces*, which can have both positive or negative effects; *economics, trade practices* and *agribusiness* decisions, with or without political influences, while having more immediate, short term impacts, do set a tone for the future. As a whole, these *touchstones* are probably more provocative for discussing how we got where we are today rather than where we are going.

The topic for this presentation, the expected futuristic changes in commercial fat and oil products, begs the question: "What fats and oils will be utilized for the production of these products?" For some time now, the world has come to depend largely on comparatively few edible fats and oils sources for food use. Soybeans, sunflowerseed, oil palms and animal fats constitute nearly 75% of the aggregate world's fats and oils production and nearly 80% of its fats and oils' trade (3). Production and trade go hand-in-hand and are touchstones for the future.

Our food fat and oil compositions, be they finished products or ingredients, will continue to be defined in terms of their functional characteristics (4). They provide lubricity, structure, aeration, moisture barriers, heat exchange media, nutrition, and are carriers for vitamins, flavors and colors. This is the way our fat and oil compositions are defined today, and there is no reason to believe that it will be different 20 years from now when we enter into the 21st century. The liquid and solid properties of fat and oil systems, as they contribute to *lubricity* and *structure*, will be the basic descriptors for our fat and oil products of the future. Whether they will be largely liquid, fluid, plastic or solid, packed in round or square boxes, made two or three at a time, or in half the time, are moot questions. What is predictable is that these products of the future will continue to satisfy these basic functional characteristic needs. The real question is: What fat and oil sources will support those needs in the future?

Let us start with a historical perspective. Figure 1 shows the production of vegetable oils vs animal fats vs marine oils over the past 10 years. It is reasonable to assume that the greater vegetable oil growth vs animal fat growth trend experienced over this period, and verified by the previous 50 years, will not be reversed and can be expected to continue. The world's supplies from these sources has come from increased planting of oilseeds and expanding animal numbers rather than from increasing yields of each (3), and this should also continue.

This, then, identifies two significant sources of fats and oils for the future: vegetable oils and animal fats which will continue, albeit disproportionately, to be significant in terms of world trade, relegating marine oils more and more into a group of indigenous oils. For convenience, and since these oils will not disappear from our world, we are defining or classifying as indigenous, those fats and oils that will continue to be produced, based on local economic and/or cultural practices, and may move in and out of world trade on a comparatively limited basis.

The second historical factor is demonstrated by the data in Table I, indicating that the bulk of the vegetable oil expansion in more recent times has been largely with soybean, palm, sunflowerseed, rapeseed and coconut oils (5). This trend too should, on the whole, continue through the next 20 years. However, we can expect some significant growth shifts within this group and these trends are more predictive than they are speculative.

Cottonseed, peanut and olive oils are relegated into the indigenous oil category. A number of complex economic and political forces will combine to influence and sustain the world's production of these indigenous oil crops. The influence on supply will be in the form of planted areas and yields, and on demand in the form of quantities taken at various prices as influenced by population, income and cultural habits (3). Traditional farming practices, that of small farms and hand labor, support these small but locally significant oil crops. Collectively, they are not so small, nor are they insignificant.

The 1981 Congress of The International Association of Seed Crushers identified the long-term shift in world trade of their commodities with increased dominance of developed countries as exporters, with contributions by Malaysia, Brazil and Argentina, and with developing countries as importers (6). They further suggested that the world's increased

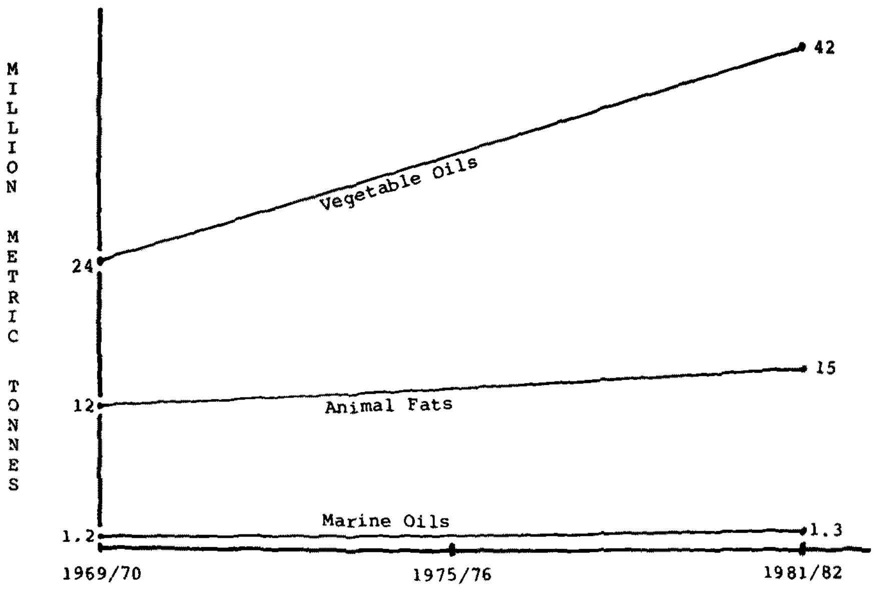

FIG. 1. World fats and oils production (5).

TABLE 1

World Vegetable Fats and Oils Production (million tonnes) (5)

	1969/70	1972/73	1975/76	1978/79	1981/82
Soybean	5.93	7.36	9.98	11.70	13.82
Palm	1.76	2.34	3.23	4.30	5.38
Sunflower	3.80	3.55	3.67	4.71	5.35
Rapeseed	1.75	2.53	2.91	3.67	3.97
Coconut	2.27	2.50	3.43	2.79	3.43
Cottonseed	2.66	3.08	2.69	3.01	3.51
Peanut	3.30	2.93	3.54	3.36	3.25
Olive (pressed)	1.25	1.42	1.79	1.57	1.30
Others	1.62	1.71	2.01	2.21	2.33
Total	24.34	27.42	33.25	37.32	42.34

needs for oil and oilseeds since the late 1960s has been almost entirely from soybeans, rapeseeds and sunflowerseeds plus oil palms, and that all other world exports of other oilseeds and oils, coconut, palm kernel, peanut, cottonseed and marine oils have not changed significantly over the past 40 years. As suggested by the figures in Table II, our five major vegetable oils now account for 54% of aggregate world fats and oils production and 69% of world exports (5). So, trading on the world market is a touchstone for the future.

We can rearrange Table II into vegetable fats and oil sources consisting of (a) oilseeds–soybeans, rapeseeds, and sunflowerseeds; (b) vegetable tallow–palm; and (c) lauric oil–coconut. The major growth will be in the oilseeds group, and the dominant driving force will be increased demands for oil and protein as populations expand and living standards increase. The touchstone is world food demands. Producers will continue to be producers and importers will continue to be importers.

The obvious economic touchstone here is increased vegetable protein demands: primarily for animal and poultry feeds, and secondarily for direct human consumption. The functional touchstone here is that, while the longer-range technological developments for utilizing vegetable proteins in human food forms will come, it is with the already highly developed technologies for animal feeding and the mind-boggling as-yet untapped potential for aquaculture that the importance of oilseed proteins has been established.

This increased utilization of vegetable proteins ultimately leads to the development of internal crushing capacities of developing countries. The additional oil resulting from crushing these oilseeds is easily absorbed in those markets now deficient in fat calories, and, as importantly, by the need for these oils to provide additional blending and formulation opportunities with countries' indigenous oils for products for local use.

Palm oil and coconut oil need to be discussed separately; they both suffer from the same lack of a broader utility, a functional touchstone difference when compared to the other three oils.

It is quite common for people not to understand and appreciate what business they are really in. Individually, we are crushers or refiners, equipment manufacturers, consultants or what-have-you, and some of us are actually in the food business. Collectively, we are in the food business and only secondarily do we produce this or that oil. An important touchstone for predicting the future, therefore, is to understand that the fat systems of the future will be largely determined by world food needs, or perhaps world food *demands* is a more accurate term.

As already suggested, competition between our five vegetable oil sources is as the total plant product and, as such, palm and coconut oils both carry a bigger burden for long-range growth. On that basis, one would predict that coconut oil will remain where it is. It will continue to be important to local economies where it performs well in household cooking operations, and it should continue to do so. However, it is not sufficiently functional to pick up the growth slack of a soft oil which will be present as the result of protein demand.

An imposed variable for our list of functional characteristics for food fat systems is flavor and flavor stability. Coconut oil's good oxidative stability and relatively poorer hydrolytic stability is a net negative functional touchstone for future commercial fat and oil product use.

Palm oil, which is really a vegetable tallow, has enjoyed a tremendous growth during the past decade. The touchstones were and still are both economical and political, and it represents a substantial part of various countries economies. It provides the world market with excellent fat solids and provides fat calories to developing countries at attractive prices.

TABLE II

Percentage of 1981/1982 World Production and Exports

	Production	Exports
Soybean oil	23	33
Palm oil	9	16
Sunflowerseed oil	9	6
Rapeseed oil	7	7
Coconut oil	6	7
	54	69
Other vegetable oils	18	14
Animal/marine fats and oils	28	17
World	100	100

Palm oil will continue to grow, but at a considerably slower rate. Touchstones are both economic and functional. Crude palm oil quality cannot satisfactorily survive overseas shipment without first being processed; therefore, any additional significant growth will require refining capacity and a financial commitment in that direction.

Secondly, and perhaps more importantly, is that the high solids content of palm oil restricts its utility. Fractionation is really not very specific, it is expensive and produces a product of limited utility even in tropical climes. Palm oil production will continue to be an important established source of fat worldwide; however, in the long term, its growth will fall considerably behind the other three oils, or oilseeds.

A longer-range difficulty for plantation crops is that they tend to amortize people (7), and by the year 2001 this could have a profoundly negative effect on oil and coconut palm crops. A mitigating factor against that would be less labor-intensive production (increased productivity) or harvest mechanization, a technological touchstone. Agribusiness has already surfaced concerns for tree crops and their protracted return-on-investments, and the absence of more serious and more aggressive political commitments to the commercial survival of coconut plantation programs places that crop in long-term jeopardy.

This now narrows our discussion of primary future fats and oils sources to soybean oil, rapeseed oil, sunflowerseed oil and oil palms. A fat is a fat, or, oil is a triglyceride, whatever its source. Therefore, the only real difference appears to be its source, as a source of proteins for food use.

Table III shows the world production of major high-protein meals over the past 10 years (5). Again, our three oilseeds, soybean, rapeseed and sunflowerseed are prominent. Cottonseed meal production is significant in volume but its economic touchstone is negative, with cottonseeds being a byproduct and not moving significantly in world trade. About 10% of cottonseed meal production is exported and this amounts to only 1% of all trade with these high-protein meals (8). Fishmeal quantities have started to decline and that can be expected to continue as fish, as a harvested crop, continues to fall off because of higher fuel costs required to obtain their catch and their lower yields. Fish, as a part of the broader potential aquaculture needs, will become more prominent as a direct edible protein product competing for and increasing the demands for oilseed proteins. Peanut meal and copra meal are of lesser value and will continue to be used for indigenous feeding.

The importance or significance of soybean meal is further illustrated in Figure 2. Soybean meal is the world's most important high-protein meal, comprising about two-thirds of the total world's meal production. The economic

TABLE III

World Production Major High-Protein Meals (million tonnes)

	1969/70	1972/73	1975/76	1978/79	1981/82
Soybean	27.506	34.275	46.229	53.604	63.229
Cottonseed	7.617	8.826	7.735	8.646	10.058
Rapeseed	2.778	3.958	4.524	5.621	6.227
Sunflowerseed	3.479	3.279	3.397	4.423	5.109
Fish	5.426	3.942	4.773	4.896	4.516
Peanut	3.962	3.516	4.250	4.028	3.896
Copra	1.240	1.366	1.878	1.528	1.875
Total	55.46	62.00	76.00	86.11	98.20

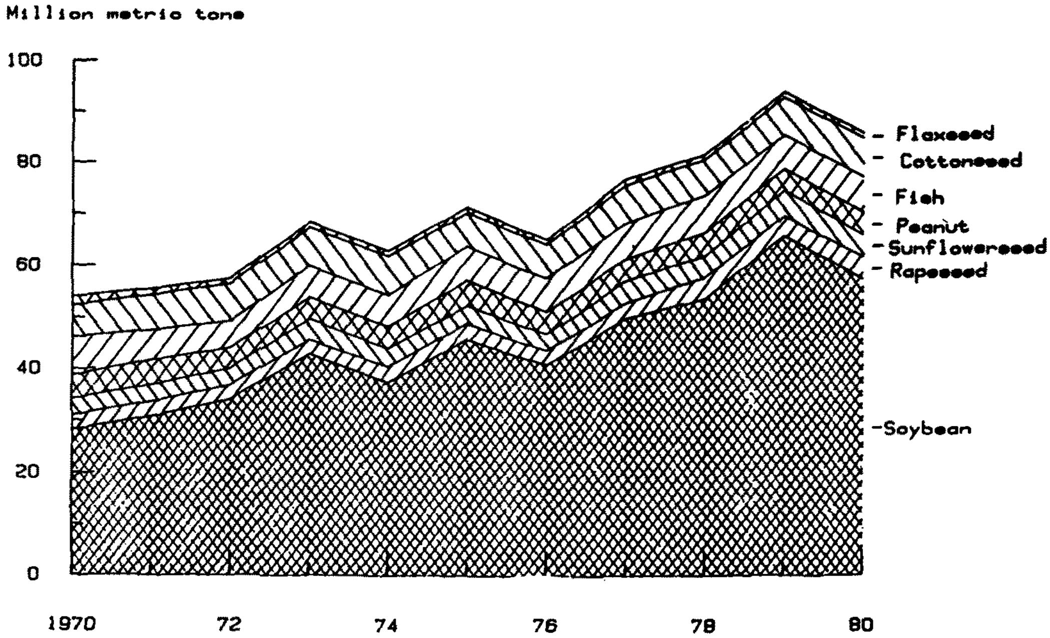

FIG. 2. World production of high-protein meal (8).

and functional touchstones are that the average protein content of soybean meal is 44%. For sunflowerseed and rapeseed meals it is, respectively, 42 and 31%, and while sunflowerseeds and rapeseeds yield 50% meal, soybean meal yield is about 80%. Shifting within these oilseeds does provide some leverage opportunities for balancing oil and meal demands at any point in time, if the existing technology is in place.

For soybeans, this protein use is predominantly for animal and poultry feed as opposed to direct human consumption, which is now limited to about 10% of its total production. While we can expect some absolute increases in the use of vegetable proteins, especially soybean proteins, in human foods, the relative percentage increases, probably in disparity with what we see here, will be with meal growth in meal demands for animal, poultry and aquaculture feeds. As go soybeans, so goes soybean oil. The touchstone that could negatively affect this prediction or expectation is the development of full-fat meal feeding technology.

Technology and the economics of capital investment for processing oilseeds and crude oils are also important touchstones, once they are in place, and for their long-term flexibility for switching capabilities, one oilseed or oil crop for another. Here the oil mill situation is more acute (6). More countries in the world will, therefore, have more oil refining flexibility than oil crushing or milling flexibility. As a result, when the crushing capacity is in place, there will be a greater long-range commitment to that particular oilseed or oil crop.

Table IV suggests a new growth pattern for the future, that soybean oil will outstrip animal fats and that palm oil will lag behind both sunflowerseed and rapeseed oils. Indigenous oils will continue to be a significant source of fat calories for the world's food supply.

If there is to be a new oil to alter this scheme, it has to come from either one of two categories. One is that it is already around and just has not had the opportunity or found

TABLE IV

Oils/Fats of the Future

	1981/82 (million tonnes)	Growth
Animal fats	14.804	+
Soybean oil	13.823	++++
Palm oil	5.376	+
Sunflowerseed	5.348	++
Rapeseed oil	3.974	++
Indigenous oils[a]	16.456	+

[a]Not all for direct consumption as oil (5).

its time to surface; which means that it is in our indigenous oil group. And two, that it is yet to be a product of new technology.

Let us look at our indigenous oil group, keeping in mind our touchstones, and the fact that the demand, the driving force, is primarily for food and only secondarily for oil (Table V).

On paper at least, rice bran oil has potential. Rice is second to wheat as a world food commodity. At least one and a half billion people depend on it as their daily major source of energy. The world rice production in 1981/82 was 409 million tonnes (9) with a potential of producing at least 7 million tonnes of rice bran oil; that is, over 15 billion pounds of oil. That is at least ten times the start that palm oil had, and it only remains to organize its technology. They have, or had, a number of things in common: fast deterioration of oil after harvest and small plantation or paddy operations. The one thing that they do not have in common, and it is the biggest deterrent to success, is potential centralization.

Rice is grown over a wide area in the world (Table VI)—too wide, in fact, for the development of an effective marketing program. Even in the larger producing countries, about 50% of the crop is grown outside the rice bowls. The potential for rice bran oil to be a more significant indigenous oil awaits the development of technology to control postharvest deterioration.

This adds credence to our earlier position: that our future oil supplies will probably be basically more of the same at some changing level; it also suggests why indigenous oils will remain indigenous and recognizes the importance of the indigenous oils group as a long-term source of dietary fat.

New technology's best opportunity to influence the future fats and oils' supply is probably to modify, in some positive way, what we already have, rather than to create something entirely new. It will happen, if not in the next 20 years, then soon thereafter. We will, of course, know before that time what we can have, and it will just be a question of how long it takes to organize production and translate the lessons of the laboratory to the market place, which in this instance will be agriculture and agribusiness. At the same time, we should not be timid in thinking that it might not happen sooner. The speed of new technological discoveries is in itself unpredictable.

Biotechnology, genetic engineering, is new technology with a futuristic bent. Its potential impact on existing oilseeds and for new lipid systems is almost whatever we want it to be. The uncontrollable element for that future is its humanity—"profoundly quirky and ultimately unpredictable" (2).

Recombinant DNA, gene-splicing technology, is what, in the long term, will really change our oilseed products to produce optimally the food products we want. Soybeans will still be soybeans, and sunflowerseeds will still be sunflowerseeds; their root causes will remain unchanged even if we call them "sunbeans" (11), but we may not recognize them compositionally or even their traditional growing latitudes.

Apart from genetic manipulation, industrial biotechnology, that is, enzyme and cell technology, is not new and has been used for a long time in the production of a variety of food products and pharmaceuticals (12). Although this approach may be significant in what it can do, its numbers cannot be expected to be significant. It would take a lot of petri-dishes, end-to-end, to produce a 5 or 7 million tonne crop. Its real opportunities, therefore, rest with the development of small-volume, high technical-content lipid systems for very special applications, e.g., the production of an emulsion stable, metabolizable lipid for parenteral nutrition.

TABLE V

Indigenous Oil Group

		1981/82 (million tonnes)
Cottonseed		3.5
Coconut		3.4
Groundnut/peanut		3.3
Olive		1.3
Marine		1.3
Palm kernel		0.7
Corn		0.5
Mustard		< 0.3
Sesame		< 0.3
Rice bran	potential[a]	7.0

[a]Calculated basis world rice production (9).

TABLE VI

World Rice Production, 409 million tonnes, 1981/82 (10)

	Production	Oil equiv
China	138.0	2.30
India	81.0	1.40
Indonesia	29.0	0.50
Thailand	18.0	0.30
So. America	14.0 (Bolivia, 10.0)	0.25
Japan	12.0	0.20
Africa	8.6 (3 countries)	0.15
No. America	8.5 (US 6.6)	0.15
So. Korea	5.0	0.09
No. Korea	4.5	0.08
Soviet Union	2.4	0.04
Europe	2.0	0.03
		5.5 (80%)

Someone once suggested that, just because an argument is logically valid, it does not necessarily follow that its conclusions are, or will become, true. Nevertheless, the strength of existing technology and potential technological developments, is that, in the long range, those technologies will allow us to make the future's commercial fats and oils products from the then-available fats and oils, even if we do not know today what they will be.

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