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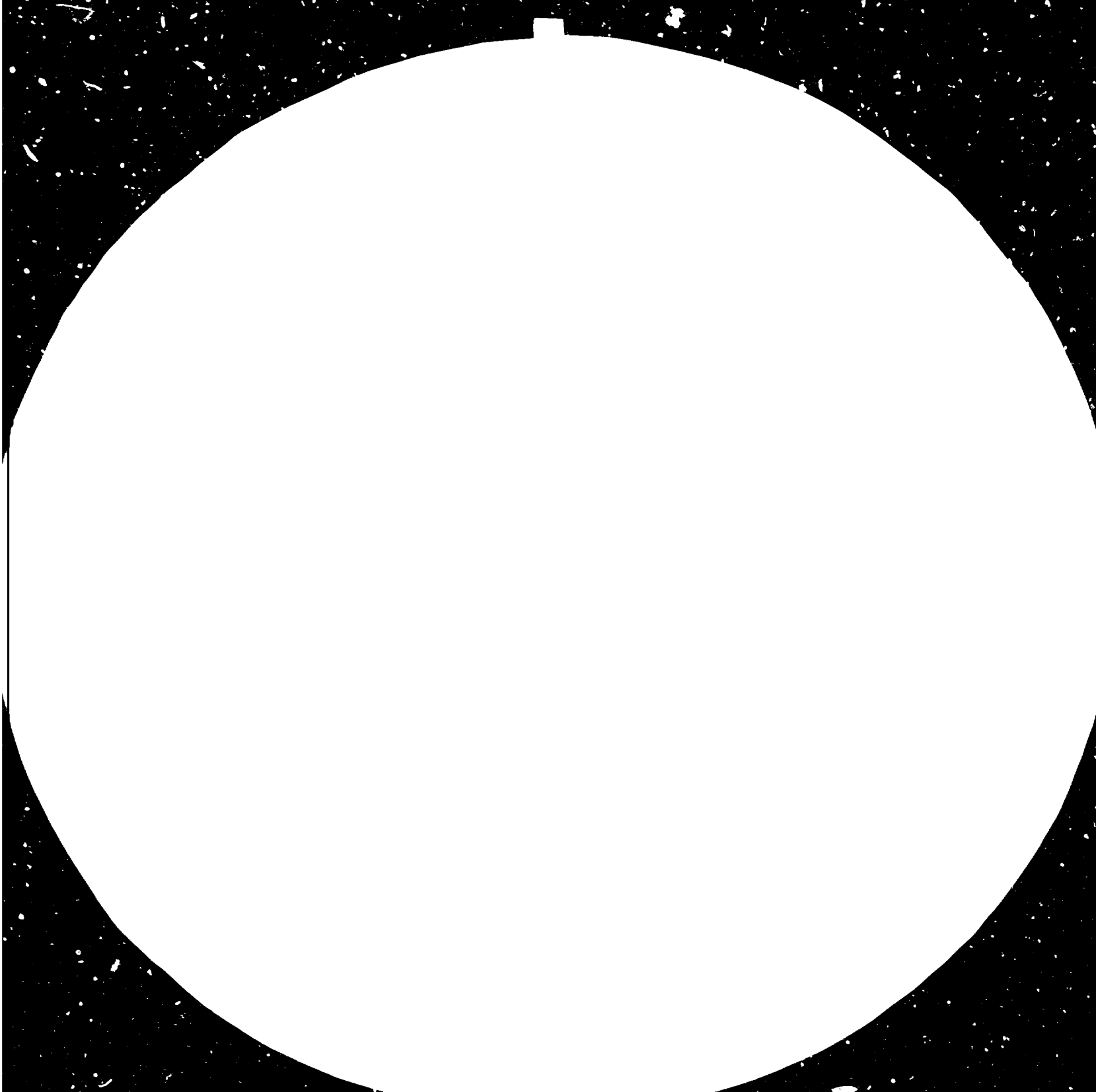

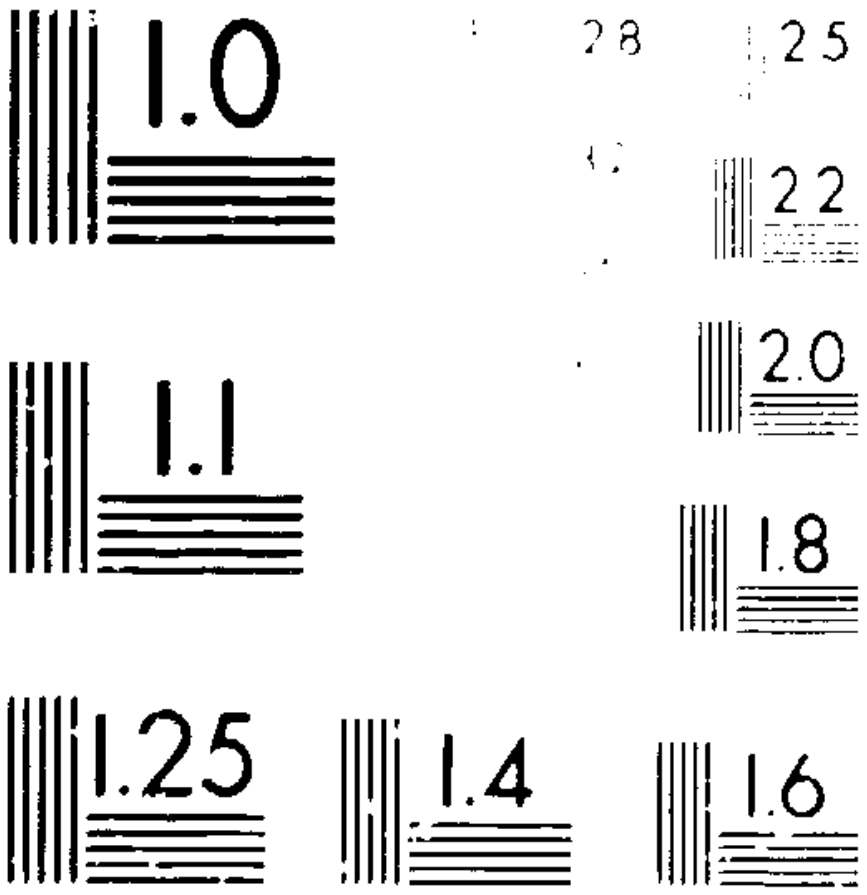

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Expert Group Meeting on downstream processing activities in the vegetable oils and fats industry in developing countries

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Study on Downstream Processing Activities in Vegetable Oils in Developing Countries - Promotional Measures*

by

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Downstream processing activities in vegetable oils in developing countries - promotional measures

1. Explanatory notes

There are a number of reasons why agricultural, industrial and commercial activities centered around edible oil technology in its broadest sense can offer relatively high chances to increase the standard of living and the gross national product of developing countries.

1.1. Edible oils are most promising not only as an important source of nutritional energy but also as replenishable (renewable) raw materials for industrial activities.

1.2. Breeding and growing of oilseeds and palm trees can become highly interesting agricultural activities as - on the supposition of suitable climate - yields per hectare are high: about 350 kg soybean oil; 600 kg sunflower oil; 800 kg groundnut oil; up to 4000 kg palm oil.

1.3. There is an increasing demand for oils and fats in almost all countries. These products, some co-products such as feeding oils for animal nutrition, fatty acids etc. and basic oleochemicals are traded as commodities on the world market. Other semi-finished or final products have their special customers.

1.4. Vegetable oils and fats can help to fight undernutrition and malnutrition in developing countries and play a major role in this context.

1.5. Fat consumption is increasing in developing countries with rising standard of living, as fatty dishes and meals are more satiating and tasty. The co-products of the processing of oilseeds, so-called meals and cakes, are essential in stepping up meat production, especially poultry and pork.

1.6. The availability of edible oils can encourage other industrial food enterprises which use oil as a major ingredient, like confectionery products, canning of fish, ice cream and filled milk products.

1.7. The chemical constitution of oils and fats offers a whole spectrum of opportunities. After hydrolysis further chemical modification of major and minor components is possible.

1.8. Machines and technical equipment can be bought; this technology is well developed.

1.9. Oils and fats, or at least the alkyl esters of their fatty acids, can be used as fuel for diesel engines.

All these arguments which speak in favour of selecting oil and fat technology as an interesting opportunity for a downstream operation in developing countries ask for additional comments and data. There are certainly some general conditions required to pave the way for the realisation of this concept, and a number of factors have to be considered which will be of different weight from region to region and even from country to country. In addition, it might be wise to consider some major limiting conditions, risks and potential weaknesses aiready at this stage of investigation; most of them will be discussed in more detail under 3. and 4.

ad 1.1. There is no other food component as rich in energy as edible oil and fat*):

	energy content in kg-cal/g
fat	9
alcohol	7
protein	4
carbohydrates	4

Moreover, this energy supply is relatively cheap.

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*) There is no basic difference between oils and fats; e.g. it depends on the temperature if consistent coconut fat is a liquid oil in tropical climates; all natural oils become 100 % solid at minus 40° C.

Total world-wide edible fat production amounts to 60 mio tons and is increasing by more than 3 % per year (average of the last decade). This means that production increases almost twice as fast as actual population growth in the world. One third of the production is available on the world market, the greater part is consumed in the countries of origin. Until the early fifties surpluses used to come primarily from developing countries, but due to new activities especially in breeding and growing of seeds like soybean, rapeseed and sunflower seed in industrialised countries, e.g. the USA, this has changed dramatically in connection with a highly efficient agriculture. Only a few rather well developed countries like Malaysia, Brazil and Argentine remain as important net exporters.

Total world fat production (mio tons)

Commodity	1955	1965	1975	Sept. 1982
edible vegetable oils (except palm oils)	9,5	16,3	23,9	34,0
palm oils	3,7	4,0	6,5	10,0
industrial oils	1,2	1,6	1,3	1,3
animal fats	9,3	12,0	13,6	14,6
marine oils	0,9	1,1	1,2	1,2
total	24,6	35,0	46,5	61,1

(source: USDA-FAS)

This investigation has to concentrate on edible fats and oils of vegetable origin, as the production of animal fats is almost constant and closely connected with meat production; the latter could certainly grow in developing countries on the longe run with increasing standard of living.

Marine oils play a role primarily in some South American countries.

ad 1.2. The discussion about replenishable resources had led to an evaluation of different types of bio masses in comparison to mineral oil:

	mineral oil	lignin	cellu-lose	starch	sugars	fats + oils
density of energy	+++	++	+	+	+	+
reactivity	++	+	++	++	++	+++
production of well defined compounds	++	-	++	+	+++	+++
multiple application of structural elements	+++	-	-	-	-	++
vicinity to end producer	++	-	-	-	-	++
possibility of homo-geneous reactions	+++	-	-	+	++	+++

(source: Battelle)

The conclusion could be that fats and oils are the best source of raw material to produce various chemicals if this can be justified from the economic point of view. As regards the well-known special issue of fuel for diesel engines, it should be considered that 50 % of the total production of edible oils and fats could only replace 1 % of the mineral oil demand (3000 mio tons).

The production of animal fat can only grow, as mentioned before, with meat production. However, meals and cakes as co-products of the oil milling could certainly favour this development.

Marine oil production is for the time being totally dependent on the catch of fish in the open sea. Shifting of ocean streams (like Niño and Humboldt streams in front of the Peruvian coast) from time to time changes quite dramatically the potential and often causes severe losses in industrial investments.

Reliable, good prospects are offered by growing vegetable oil plants which may even yield double crops, as with soybeans in the USA and in Brazil. Other interesting examples are the growing of rapeseed in a sequence with other grains, increasing the nitrogen content

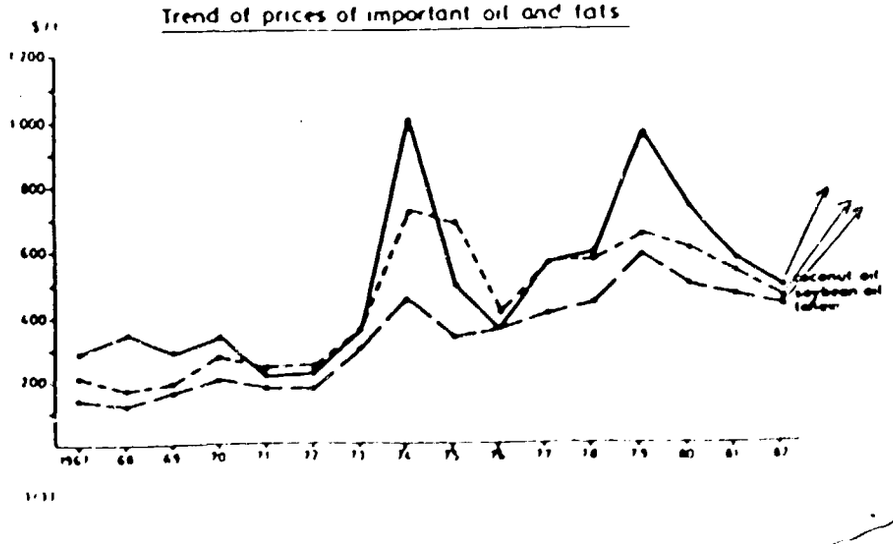
of the soil due to the activity of root bacteria or the growing of palm trees instead of rubber trees; the result would be a much earlier first return of capital employed in the plantations.

Limitations to such an agricultural programme are primarily climatic conditions, but the quality of the soil, the structure of agriculture, the availability of fertilizers, labour and machines have to be considered, too. Such a programme asks in addition for excellent training and communication programmes, persuasiveness and governmental influence.

Seeds and plants to be grown must be carefully selected and must be well adapted to local requirements. They must be multiplied in special stations to avoid a spreading of uncontrolled genetic material. Finally, the need for storage facilities will arise which can become as costly as the processing plants. - The plants have to be grown in rather concentrated areas to save on transport costs and avoid losses in fat quality, e.g. due to enzymatic activities.

ad 1.3. Oils and fats are typical commodities which means their world market price is strongly influenced by political events or climatic changes. A relatively high grade of interchangeability of most raw materials of this kind and the dominating role of crops like soybeans, palm fruits and rapeseed are reflected on the market. There were only a few longer lasting fluctuations in world market prices in the last decades, and on average a moderate price increase.

Trend of prices of important oil and fats



A larger storage capacity world-wide can help to compensate price fluctuations, but this is scarcely under the control of developing countries.

Crude fatty acids are traded world-wide but the price is in general about 50 % that of the crude neutral oil. Special oleochemicals are sold with the help of salesmen, well-trained in their applications, and with a direct link to a range of experienced customers.

ad 1.4. It is well-known that undernutrition is primarily connected with lack of purchasing power. The total food production of the world covers the needs to more than 105 %, but only to 85 % in the developing countries. In all developing countries there might be options to grow one or the other oil plant as long as it is well adapted to climatic and other conditions. The gap between the energy content based on fats and oils in developing and highly industrialised countries reaches from less than 10 to more than 40 energy-% (hidden fat in, e.g., meat and cheese included); the visible fat content of the foodstuffs is often 50 % of the total fat, but there are considerable deviations from this figure in some countries. -
Fat makes food richer in concentrated energy and therefore helps to avoid the negative effects of too bulky food as it is consumed at present in most of the developing countries.

The aspect of malnutrition plays a rather important role, too, especially as far as vitamin A is concerned, and to a lesser degree vitamin D, E, K and linoleic acid (formerly called vitamin F). In large parts of Africa, South America and East Asia children often do not get sufficient quantities of vitamin A or carotene (provitamin A), as meat or fresh green vegetables are not available or too costly. Some hundred thousand children therefore suffer from xerophthalmia and frequently become blind when infected in addition e.g. by measles.

Edible fat is the ideal carrier for all these fat-soluble vitamins.

Lack of vitamin D (rachitism in the young and osteoporosis in the old-age group) has been assessed in countries of the Near East where people do not expose themselves to the sunlight. - All those vitamins are not expensive and can easily be added to edible fat products; on the other hand, red palm oil is e.g. a natural source of carotene, and vitamin E and F are contained in relatively high amounts in most of the vegetable fats and oils.

ad 1.5. Fat consumption per capita grows everywhere with increasing standard of living, as fat makes food more tasty. A great many more flavour components are carried via the fat phase towards the taste papillas.

Fat consumption per capita (kg/year)

	Industrialised Countries		Developing Countries	
	1965	1974	1965	1974
visible fat				
- vegetable	8,8	10,9	3,3	3,9
- animal	7,8	8,1	1,0	1,0
hidden fat				
- vegetable	3,4	3,5	3,9	3,8
- animal	18,6	21,7	3,7	3,8
total	38,6	44,2	11,9	12,3

ad 1.6. It will primarily depend on eating habits (which are very difficult to change) and on raw material supply, which type of industries for the production of fat-containing food products could be developed in addition to the processing and modification of vegetable fats and oils as such. Two examples may illustrate the importance:

Confectionery products are very interesting as they are in general well accepted and rather stable. Baked goods contain 10 to 50% edible fat, but the desired performance is only achieved with consistent fats like coconut fat, hydrogenated oils or interesterified mixtures of high melting fat fractions as in palm oil or tallow blended with liquid oil. This calls for capital investment (medium), energy supply (medium) and know-how (medium to high).

Fish canning will locally be of high interest, especially on both coasts of South America. Machinery can be produced or purchased, and know-how transfer can certainly be organised, if necessary. The average fat content of those canned fish products is between 20 and 30 %.
Filled milk products and ice cream based on vegetable fat might be of interest.
Other options are listed under chapter 2 below.

ad 1.7. Generally speaking, edible fats and oils consist of glycerin and a whole range of fatty acids which differ in chain length and grade of saturation/unsaturation.
Technology and application of saturated fatty acids of different chain length is well developed, in contrast to many options which are still not tackled in the area of modification of unsaturated fatty acids.
Free fatty acids as by-products of oil processing can only cover a small percentage of requirements but the splitting of neutral fat to obtain free fatty acids is commercially only attractive in the case of either cheap (tallow) or very rare raw materials (medium chain fatty acids, e.g. in coconut oil); it is otherwise much more lucrative to export neutral oil and import crude or even distilled fatty acids. - Fractionation plants for fatty acids as for producing derivates are certainly expensive and there are over-capacities world-wide.

Major products like the whole range of soaps ask for a blend of more than one fatty acid to get good quality products. This has to be considered as far as possible in the production of oilseeds and fruits, or it might be necessary to buy one or the other raw material on the world market of oils or fatty acids.

Products called oleochemicals are to a large extent competing with products of the petrochemical industry world-wide. Only a high grade of specialisation in oleochemistry can justify the risk of investment which is inevitable. Activities to develop industries in the area of oleochemicals, starting from fat and fatty acids, need

careful investigation, and the result will be strongly influenced by requirements of other well developed industries such as textiles, paper, leather, chemicals, cosmetics etc. in the region, as it would be a special task to find clients and cooperation abroad.

Overall picture of oils and fats

(use)	(mio tons)
edible and animal feeding	52
soap	4
oleochemicals	3
other industrial uses, e.g. paints, linoleum	2

ad 1.8. Most of the equipment to start a downstream processing activity which is centered around edible fats can be purchased from more or less specialised producers all over the world. The selection of the sequence of operations is nevertheless already crucial in the first phase of oil milling and fat processing, and the choice of technologies to follow must be in correspondence. This problem becomes even more complex and difficult to solve in the case of the production of more sophisticated products like oleochemical derivates.
It might be desirable to seek advice or even cooperation with experienced companies which have already demonstrated their ability to successfully start such activities in developing countries.

Vegetable raw materials are natural and never quite constant in quality, processing plants must be flexible to a great extent, safety requirements are high - just to mention a few points stressing the importance of management experience and know-how.

ad 1.9. The issue of using vegetable oil as fuel for diesel engines may be of interest to farmers here and there, or even to local governments with an interest in saving foreign currency. This approach can nevertheless scarcely be justified. Malnutrition could spread in the world if a relatively high quantity of edible oil would be burnt in combustion engines (remember 3000 mio tons of mineral oil consumption versus 60 mio tons of edible oil production world-wide).

Economically, orientated on the world market prices, there is still a considerable gap which will not be bridged by reduced transport costs etc. in the near future.

The neutral fat produced is not suitable to be burnt in a diesel engine but there is a good chance for the relevant fatty acid ester (cf. 2.8.1.3. page 20). In producing these esters a high percentage of the energy of the oil gets already lost and additional energy has to be provided.

2. Possible types of downstream processing activities based on vegetable oil crops, and fields of application of products obtained in the processing phase

Downstream processing activities comprise all fields of application from the relevant agricultural production of a country to the whole spectrum of semi-finished or end products which can be obtained either as products of the main stream, as by-products or derivatives. The downstream processing operation asks for a complete sequence of interrelated technological steps within a country. It offers different options to choose one or the other final product.
In general, the product with the higher value on the world market should be the target, but alternatives must be investigated in case of other priorities due to local circumstances in one or the other country. It may be necessary to import special raw materials, semi-finished products or processing aids, if they play a key role in a broad concept.

Major potential options to start or develop downstream processing activities based on vegetable oil crops shall be listed in this chapter before a critical evaluation is made (cf. 3).

2.1. Agricultural activities

2.1.1. Breeding of oilseeds and trees with fruits of high fat content.
Alternative: the first seeds or plants are imported to start the agricultural activity.

Depending on climate etc. the following seeds are of interest: soybean, rapeseed, sunflower, cottonseed, sesame seed, linseed, safflower seed, groundnuts, coconuts, palm kernels.
Others which are of minor importance but of relatively high market value per ton deserve special investigation, like sal (India), babassu (Brazil), jojoba (desert plant).
Finally, oil from the germs of corn, oil of grapes and ricebran oil deserve interest.

The two before-mentioned fruits of importance are: olive and palm fruit.

2.1.2. Growing of the seed plants and trees in farms and plantations will be the method of choice, but there are exceptions when e.g. seed of coconut trees, sal trees, babassu nuts is collected in areas with a dense population of those trees.
In many cases double cropping will be possible and even of benefit to the soil.

2.1.3. Harvesting: all before-mentioned seeds produced by plants can be harvested with machines which should not only be effective but help to avoid damage to the seeds, or admixture of foreign materials.
There is certainly the alternative of hand-picking the trees; especially palms are now grown with lower trunks which makes harvesting easier.

2.2. Storage, transport and processing of fats

Both areas can become crucial for the whole operation.

2.2.1. Olives and palm fruits have to be processed as quickly as possible (within hours or at least a few days), as the neutral fats(the triglycerides) are split due to enzymatic action.
Capacity of the processing plant and harvest area of the fruits have to be well adapted. Decentralised processing in a number of plants will be the result.

2.2.2. Seeds can overcome a relatively long storage period (some months) before considerable losses in fat quantity and quality will occur, provided they have been harvested mature and dry or have been

dried in suitable equipment (or in the sun). Splitting or other damage to the seeds will increase enzymatic activity which again leads to losses.

2.2.3. Storage must be possible at different processing stages, e.g. limited quantities at the farm, at collecting points in the region, and finally at the processing plant. Great care must be taken during storage, e.g. to avoid mould infection. Investments can be high. The storage capacity must be well adapted to the throughput of the processing plants. This optimisation will be a special task as financial, transport, energy, labour, hygienic and environmental aspects have to be elements of the calculation.

Processing of seeds and fruits

The processing of seeds or fruits is entirely different, the latter is much easier to achieve.

2.2.4. To obtain oil from the seed there is the choice between pressing and extraction.

Pressing needs less sophisticated equipment with the exception of the high-pressure continuous press itself: the method is rather flexible. Energy supply is needed primarily or exclusively in form of electricity. Nevertheless, pressing of oilseeds is applied in industrialised countries only for oilseeds with more than 20 % fat content, and those are mostly only prepressed and later on extracted, too.

Pressing - with or without conditioning (to obtain more fat and to destroy enzymes;
output: crude oil and cake (the latter as animal feed).

Extraction - without or with dehulling (to obtain meal with a higher protein content, e.g. 50 versus 45 % in case of soybeans;
output: crude oil and meal (the latter as animal feed).

Full meal - could in special cases be of interest to produce; such meal with full fat content, e.g. from soybeans, can be used as animal feed or as an additives to food as long as a somewhat beany or bitter taste is accepted by the consumer.

Special processing plants are needed to obtain oil from oil fruits:

output: olive oil and palm oil,
residues of olives (as animal feed),
residues of palm fruits (to be burnt in boilers of the processing plant)

odification of fat

There is more liquid oil in the world than consistent fat; the latter is also needed for food, and in any way for technical applications (an exception is palm oil as the high melting solid fraction, i.e. the palm stearin, is less valuable than the oil).

2.2.5. Hydrogenation of fats (and fatty acids) with hydrogen produced either with the help of an electrolyser or in a catalytic process:

output: a practically endless range of more or less consistent fats, tailored to the needs of the edible fat and other food industries.

2.2.6. Fractionation of fats either "dry" or in solvents (complicated, high investments, etc.):

output: fat fractions of which one or both are more valuable than the starting materials for edible fat products and other industries;
cocoa butter substitutes of different qualities.

2.2.7. Interesterification (and re-esterification):

The re-esterification of oils and fats (like olive oil) with a high content of free fatty acids is possible but forbidden in Mediterranean and other countries.

Interesterification is as important as hydrogenation to modify oils and fats as such or as blends: only the distribution of fatty acids at the glyceride molecules is changed but not the fatty acid. The result are fats with a higher value.

output: fats tailored to the special needs of the edible fat and food industries.

Interesterification can be regarded as a desirable but not always necessary supplement to hydrogenation and fractionation.

2.2.8. Refining of oils and fats

The result is a neutral tasting fat; environmental chemicals like pesticides are also removed. The refining process comprises a number of steps: desliming, neutralisation, bleaching and deodorisation.

output: refined oils and fats for the food industry,

by-products at different stages are:
crude phosphatides for industries like margarine, chocolate, instant products, pharmaceuticals, cosmetics, and soapstock as raw material for fatty acid production,

bleaching earth (spent earth ultimately for animal feeding with up to 50 % fat content),

condensates (eventually as potential source of tocopherols = vitamin E, or perfume components).

Modern physical refining can simplify the process depending on the raw material used (cf. 3 below).

2.3. Edible fat products

2.3.1. Fats for industrial use (refined !) as bulk products (transported in lorries, tanks etc.):

oils and fats (100 %),
blends of oils and fats,
fractions of fats,
hydrogenated fats and fat blends of different dilatation/melting points,
interesterified fat blends of specific characteristics,
pumpable shortenings (semi-liquid);

as packed products (in tins, boxes, etc.):

same as under "bulk" above, plus
plasticised, softened fats,
plasticised, softened fats whipped with gas,
mayonnaise for fast-food and other restaurants.

2.3.2. Products for in-home use:

salad and cooking oil (in tins and bottles),
white cooking fat ,
yellow fat (carotene or red palm oil concentrate added, often flavoured, e.g. vanaspati, ghee),
margarine (in general about 80 % fat content, yellow, flavoured, adapted to the functional and nutritional requirements by selecting special fat blends and additives),
special margarines for artisan bakers,
mayonnaise with 10 to 80 % fat content, as a rule with 5 to 10 % egg yolk or lecithin-based replacers.

These consistent and semi-liquid products are in general packed in wrappers, tubs, tins and tubes (mayonnaise).

Food products with less than 50 % fat content

It depends on local eating habits, legislation and standard of living to what extent edible fat will be used in a broad range of food products.

2.3.3. Industrially fabricated products:

baked goods: eventually 1 to 2 % fat in bread to improve quality
10 to 30 % fat in the majority of baked goods
up to 50 % in puff-pastry

ice cream: up to 30 % fat

filled cheese: vegetable fat replacing milk fat
up to 50 % fat (calculated on dry matter)

all-vegetable cheese made of vegetable protein and fat (up to 50 %)

canned fish: up to 30 % fat

ready-made meals and quick-frozen meals

soups - canned and dried
baby food - including reformed milk
reformed meat products and sausages
snacks and potato chips
dressings and sauces

2.4. Edible fat in animal feedstuff

Vegetable or animal fat can be used to enrich compound animal feed and calf-milk replacer as well as pet-food. This is an industry in itself but special know-how is needed.

The total consumption of oils, fats and fatty acids for this purpose is in general much higher than that for technical use.

2.5. Meal and cake as raw materials for other industries

Depending on the seed processed, meal and cake are often the larger but the less valuable co-product of the oil milling operation. The essential component of meal and cake obtained is protein. The amino acid pattern of the protein is decisive for the nutritional value of these co-products which are in general blended and applied with other components in the food- or feedstuff-industries, e.g. additives like vitamins and trace metals can be added to increase the feeding value. On the other hand, there are sometimes minor components in the meal or cake which can limit the use in compound animal feed (e.g. glycosinolates in rapeseed meal). This is one of the reasons why vegetable protein for human consumption has been concentrated and isolated from soybean meal only. Other proteins like rapeseed protein have equal or even better nutritional value, but difficulties in the processing due to the removal of undesirable substances and off-flavours have at least postponed their application.

Meals and cakes are in general essential as components of animal feed to start large-scale livestock production.

2.5.1. Toasting

of meal as part of the oil milling operation must destroy substances which can hamper enzymatic activity in the body of the animal.

2.5.2. Products for animal feeding

Cakes - (pressed with up to 1000 mbar) are cracked to smaller pieces and transported in sacks or in bulk and used for feeding or blended with other components.

Meals - after careful removal of residues of hexane are transported in sacks or in bulk; the meal is sometimes pelleted to facilitate storage and transport to the farmers or the factories as compound feed.

2.5.3. Vegetable protein for human consumption
(real experience only with products made from soybean meal)

The protein yield per hectare is about 5 times higher when growing soybeans than when raising cattle or other livestock. The "Protein Efficiency Ratio" (PER) of soya protein is 90 % of the PER of casein. - Urease and trypsin inhibitor as well as other unwanted flavour components can be removed by suitable processing. - Soya protein products have interesting functional properties such as good solubility, emulsifying properties and water-binding capacity, and they can therefore be used as ingredients in many food products. But the greatest interest deserve special soya protein products for human consumption:

De-fatted soybean meal: limited percentages e.g. in bread (50 % protein).

Texturised soybean meal: extruded like spaghetti has the "cooked soybean off-flavour" but is superior to the de-fatted meal.

Protein concentrates: produced by extraction of meal with water/alcohol mixtures; protein content 60 to 70 %; added in rather high percentages to meat products (20 to 30 %) and fish products, sauces and baked goods.

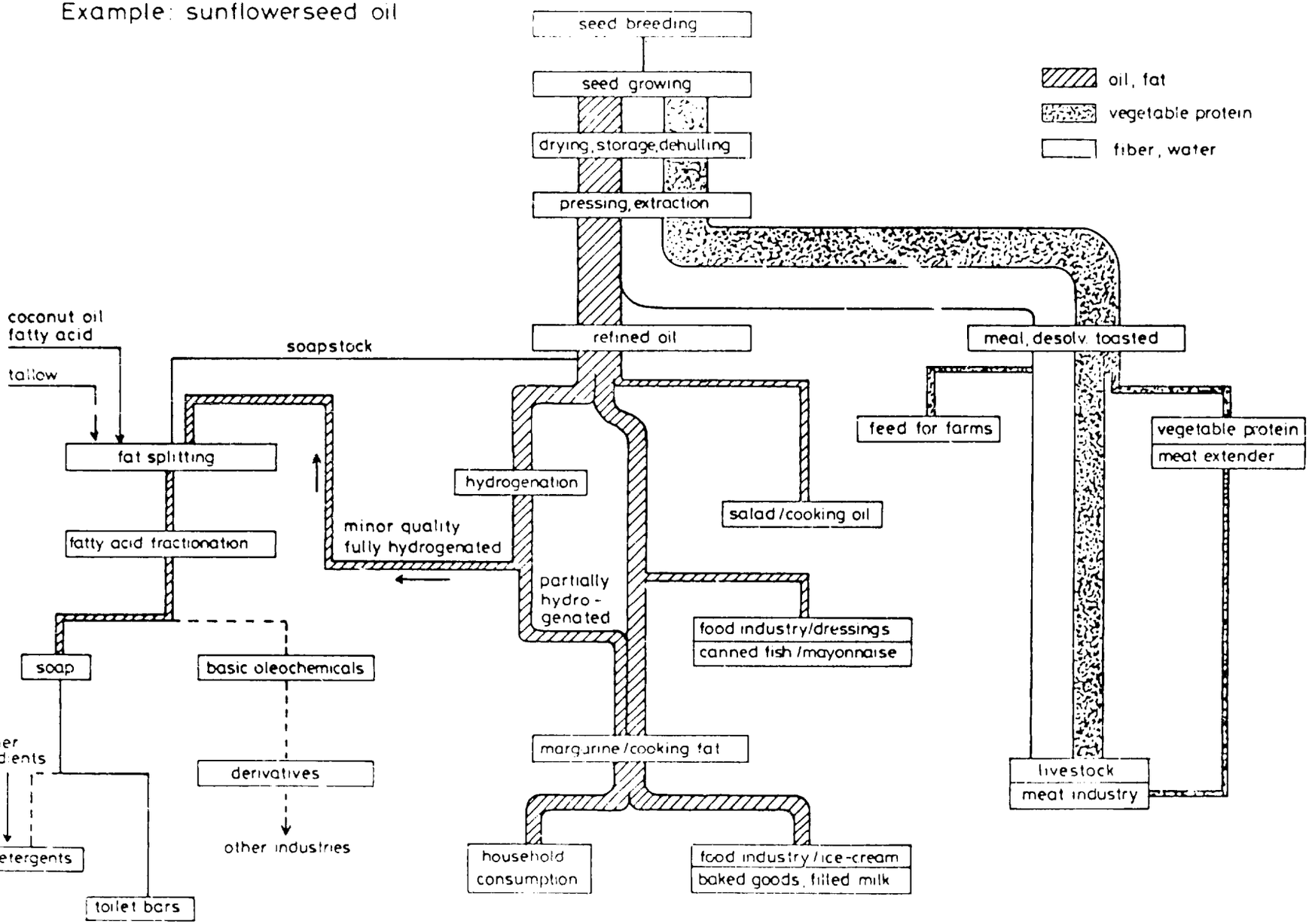
Texturised concentrates: even broader application, e.g. in quick-frozen products, soups ragouts etc.

Protein isolates: produced by extracting the meal with water and precipitation of the protein at pH 4.8 (isoelectric point); protein content: 90 %, PER-value: 70 % of casein; primarily used as additives in many food products.

Texturised isolates: protein is dissolved in alcaline medium and later on precipitated in sour medium; it may be spun to simulate meat fibre.

Simplified example of a possible downstream processing activity

Example: sunflowerseed oil



2.6. Soaps

The oldest industrial product made from fat or fatty acids and still the most important one - certainly for developing countries - is soap. Not only laundry and toilet soap bars or soft soap but soap as an active component (tensid) in detergents might be of interest for developing countries.

Soaps have to be manufactured from saturated or almost saturated fatty acids to avoid oxidative deterioration, cracking and destruction of perfume. Starting materials are in general "laurics" like coconut and palm kernel fatty acids and tallow. The latter can be substituted by hydrogenated vegetabe oils or hydrogenated unsaturated fatty acids. Depending on habits ("washing profiles") and purchasing power, a number of different types of soap could be produced:

soap products as semi-finished products;
toilet soap bars, floating soap, marbelized soap transparent soap, antibacterial soap, etc.;
soap detergent bars (e.g. with fatty acid derivatives to avoid calcium-(lime) soap formation);
soap as active component in heavy duty and other detergents;
soap as additive in cosmetics;
metal soaps used in many industries as catalysts, anti-statics, stabilizers, etc.

2.7. Technical uses of (neutral) oils and fats

There are technical uses for oils and fats (triglycerides) after some modification. Especially important are drying oils, namely, different kinds of linseed oil, perilla- and hempseed oil.
Such products are:
paints and varnishes made of drying oil after thermal and/or oxidative polymerisation;
lubricating oils and greases;
linoleum as floorcovering made of highly oxidised and polymerised linseed oil;
further: drying oils as components for oil cloth and rubber-like materials (factices);
other oils and fats are used for the finishing of leather, as

additives in cosmetics and pharmaceutical products, as spreading agents for insecticides and fungicides, and for dust control.
Finally, oils and fats have always been used for burning and illumination.

2.8. Oleochemicals

The attraction of natural fatty acids over synthetic products is often the specific location of double bonds and functional groups, but the majority of oleochemicals is made of saturated fatty acids. -
It is impossible to list all opportunities in this area, as there are too many products and applications. The industry is "mature", but derivatives of basic oleochemicals might again and again find more customers. In contrast to petrochemistry, oleochemicals start already from molecules which have been synthesised by nature. Nevertheless, competition with petrochemical products will remain fierce. - Starting materials for oleochemicals are in general saturated fatty oils from sources which enable a low price, like tallow of low quality or soapstock.

2.8.1. Basic oleochemicals

2.8.1.1. Fatty acids:
crude fatty acids made by splitting of neutral fats or soapstock (by-product of refining). - Unsaturated fats or fatty acids have to be hydrogenated for most uses in soap and oleochemistry. - Crude acids can be purified and fractionated by distillation or alternatively by wet fractionation (Lanza/Henkel process).

2.8.1.2. Fatty alcohols made of fatty acids or fatty acid methyl esters, and primarily used as intermediates.

2.8.1.3. Fatty acid methyl esters
made by alcoholysis of fats and primarily used as intermediate or hydrogenated to fatty alcohols. They have a viscosity which is only twice as high as Diesel fuel and they are therefore much more suitable to replace the latter than neutral refined oils. The viscosity of vegetable oils is ten to twenty times higher than that of Diesel oil which, earlier or later, is one of the reasons for mechanical trouble in the engine.

2.8.1.4. Fatty amines
made from fatty alcohols; direct use in road building, anti-caking, printing inks, etc., but the greater part is used for derivatives like quarternary ammonium components.

2.8.1.5. Glycerin

as by-product from fat splitting and soap manufacture, applied e.g. in cosmetics and pharmaceutical products and in form of monoglycerides (emulsifiers) in food and other industries.

2.9. Derivatives of basic oleochemicals

There is only room to mention some important derivatives of the before-mentioned basic products.

Fatty acids: soap, fatty alcohol alkanolamides, fatty acid chlorides, metal soaps, candles.

Fatty alcohols: fatty alcohol sulphates, fatty alcohol ethoxylates and other surfactants, polyglycol ethers, polyacrylmethacrylates.

Fatty acid methyl esters: alkanolamides, alpha-sulphofatty acid-methylesters.

Fatty amines: quarternary ammonium compounds (desinfectants and surfactants), aminethoxylates.

Glycerin: alkyd resins.

Components of this product range find application as surfactants, plasticiser, stabiliser, emulsifier etc. It will certainly require intensive market research to find out which industries take interest in one or the other product in the region concerned.

3. Basic and general technological differences in various kinds of downstream processing activities in the vegetable oil field

There are a number of options to discuss first some basic differences in such downstream activities:

3.1. The whole operation has to start from scratch, and

3.1.1. (almost) exclusively with locally produced raw materials, or

3.1.2. with considerable quantities of imported raw materials.

3.2. Major operations in the area of vegetable oil technology exist already.

3.2.1. Gaps would be closed. By-products have to find better use. Some modernisation is to be planned to save energy and other costs.

3.2.2. Existing technology should be extended to produce more sophisticated products.

Starting from one of the before-mentioned situations, a step-wise build-up of these processing activities could take place.
There are a number of very important and sometimes entirely different solutions which have to be investigated, depending on the situation in the country.

ad 3.1.1. To start such an activity from scratch one has to decide on the raw materials which should become the basis of the whole operation. Agricultural, especially climatic conditions are crucial. In case of perennial plants like olive or palm trees, a time span of some years is needed before the first crop can be expected. On the other hand, for almost all seeds the planning of the investment in factories, including silos, has to be the first stage.
Transport conditions and storage capacity deserve greatest attention as only an excellent cheap transport system of raw materials can permit the centralisation of processing plants. This offers better opportunities e.g. to cooperate with neighbouring industries from the point of energy supply, effluent systems and even training of personnel. There are better chances to extend the downstream operation to special derivatives of intermediate products. It will pay or is even necessary to use modern sophisticated equipment and machines.

Many developing countries do not have such a well functioning transport system, and if there is no quick change foreseeable, a decentralised location of the processing plants must be the solution at least for the first processing steps, as transport of raw materials has to be reliable and cheap to keep the plants running. In case of oil fruits like olives and palm fruits there is in any case no alternative as the raw material has to be processed as quickly as possible to stop enzymatic damage of the fat.

Traditional agricultural activities have to be changed round the factories if necessary to get a highly efficient raw material supply. Only part of the desired downstream operation will be sensible in those decentralised places, but the capacity can be well adapted and - as only one raw material has to be handled - the plants can be simpler in their construction and equipment. Less bulky keepable intermediates can afterwards be transported much more easily to a central point where the final steps of the downstream activity will take place.

In addition to the sharing of energy supply systems and training stations, some cross-fertilisation of this activity with other industries, clients and suppliers will be desirable or even essential for the success, as chemicals, catalyst, engineering services etc. are needed.

ad 3.1.2. The range of intermediate and final products can possibly be broader if imported raw materials supplement the locally produced vegetable oil. Centrally located processing plants or those which process the intermediates collected from the country should be located in a harbour area with a deep channel and suitable unloading facilities; only in exceptional cases a railway connection would be acceptable.

The proper choice of the location must be of great importance anyway, as machinery, spare parts etc. must come in and possibly fuel or coal to produce steam and electricity.

It can be imagined, nevertheless, that only the first steps of the whole activity would be located in a harbour area and the final part in another industrial centre of the country to have the full benefit of cross-fertilisation.

ad 3.2.1. In case there are already some industrial activities in the field of vegetable oil technology in the country, it has first to be investigated if they should become part of a new downstream activity at all. The answer will primarily depend on their location and flexibility to process possibly a different raw material. Furthermore, it should be ensured that those factories fit in the total plan for a new downstream activity to avoid bottlenecks in production steps.

The enlargement of existing plants e.g. by combining modern continuous with older batch operations can be another point of discussion.

Special investigations are needed to make best use of by-products e.g. cake and meal or soapstock.

ad 3.2.2. On the assumption that basic steps of a downstream activity are already well developed , an intensive market research seems advisable before investments in a range of other new products are made. This task might be rather easy as far as food products, soap and animal feed are concerned, but it will be much more difficult in the case of oleochemicals. The majority of those products is anyway competing with petrochemicals on the world market, and there is already some overcapacity under the present conditions. It will depend on the stage of development of other industries in the country or the region if oleochemicals can be regularly sold at reasonable prices. Export opportunities ask for the service of salesmen experienced in the broad range of application of oleochemicals, and for reliable clients as well, as otherwise rather sophisticated processing plants could stay idle. Joint ventures could be an optimum solution.

3.3. There are general technological differences in various kinds of downstream activities which will be elaborated in two respects:

3.3.1. Activities primarily orientated on the composition of the raw materials, and

3.3.2. Confrontation of rather simple with modern, elegant technologies.

ad 3.3.1. The kind of material(s) will determine at first what method of extraction will be applied:
Mechanical extraction of oil (in open or closed batch process, or in continuously operating expellers), a process which has been used primarily for oil seed with a high fat content like copra (more than 60%), palm kernel (45 to 50%), sunflower seed kernels (45 to 60%), safflower seed (25 to 35%), groundnuts (25 to 35%), rapeseed (40 %), linseed and others. But in modern extraction plants most of these seeds are only prepressed to reduce the fat content to about 20 %, afterwards the rest fat is extracted with solvents (hexane).

If sufficiently high pressure (about 1000 bars) is applied, the fat content can be reduced directly to 4 to 5 % by pressing only, but it is more economic (in industrialised countries) to extract with solvents as only 1 % is then left in the meal. Higher fat contents in the oilmeal are often not well paid for by the animal feed industry.

Solvent extraction is certainly especially attractive when soybeans or cotton seed can be directly extracted with hexane after cleaning, dehulling and flaking but without any pre-pressing. High safety requirements, continuous operation, a well defined solvent etc. are needed. Solvent residues in the meal have to be carefully removed (primarily for safety reasons). - Losses of up to 0,2 % solvent calculated on seed throughput are unavoidable in practice.

Recovery of oil from pulps of olives or palm fruits with about 35 % fat is in principle much easier. Originally, batch processes were used, but to-day continuous processes and centrifuges solve the problem. Modern plants for palm oil extraction will have the necessary heavy machinery to crack and press the palm kernels (from the same fruit) as wel

Not only the extraction but the following steps of downstream activity as well will depend to a high extent on the type of raw material:

Refined oils from coconuts or palm kernels can be used for almost all food products as mentioned under 2. above. In addition, these fats (if they are of minor quality) can be used without any modification other than bleaching for the production of soaps or fatty acids because they consist primarily of saturated fatty acids of medium chain length. These fatty acids are stable and have a broad spectrum of potential applications.

The other refined seed oils are used as cooking/salad oils and as components in cooking fats and margarines, but the bigger part must be partly hydrogenated to fulfill the role of a hardstock in the latter products. Refined oils can be used as such in many other food products (canned fish, dressings), but only hydrogenated fatty acids of these oils could be used in soap and oleochemicals, industries which would anyway prefer animal fats for price and chemical reasons (narrower spectrum of fatty acids). The effort for fractionated distillation

of fatty acids of those oils will often be considerably higher.

Palm oil is an interesting exception as it can be fractionated in stearin and olein. The latter can be used (after a special refining procedure) like a refined seed oil but the stearin has a fatty acid somewhat similar to tallow. Stearin is used as edible fat, e.g. after interesterification with oil or low melting fats. The stearin fatty acids are suitable for soap making and oleochemicals.

It should be mentioned once again that cake and meal of practically all seeds can be used as animal feed, but there are great differences in quality. The essential component is the protein, and the nutritional value depends on the spectrum of amino acids. - Real experience with vegetable protein for human consumption is only available with soybean protein. As far as other cakes and meals are concerned, the protein concentration is either too low or the isolation and purification is still too difficult and costly (e.g. in the case of rapeseed).

Some other special seeds have to be mentioned here, as they offer chances for activities which are clearly directed to one or just a few products or are collected and processed in only small quantities:

cocoa beans	- for cocoa butter, chocolate, etc.
linseed oil	- for different industrial uses (see under 2)
babussu seed	- fat similar to coconut oil (Brazil)
shea butter	- for use in special food products (Borneo)
oil from grapeseeds	- for food use
sesam oil	- for food use (Burma, Turkey, China)
corn oil	- for salad oil (by-product from corn)
teaseed oil	- (China)
ricebran oil	- difficult to process, high in free fatty acids, primarily for technical or animal feed use
sal fat	- used as substitute for cocoa butter (India, Nepal)
jojoba fat	- used as substitute for sperm oil (Mexico)

ad 3.3.2. It might be realistic to differentiate between the option to use either simple and cheap installations or a more sophisticated technology, especially if limitations in financing, qualified personnel or energy supply have to be considered. Some examples as follows:

Extraction of fat

Pressing is much easier to control than solvent extraction. The investment, safety and energy requirements in solvent extraction are high and the technology of such plants with solvent recovery etc. is much more complex than for high-pressure pressing. In addition, extraction plants are often less flexible.

Refining of oil

Many raw materials require all steps of classical refining, but the alternative of physical refining - especially for palm oil - will pay, if the necessary stainless steel apparatuses and high temperature steam are available to combine distillative neutralization and deodorization in one operation (at about 240 ^{o}C).

Soap making

The simplest and oldest process would be the so-called semi-boiled and cold method to produce soap in kettles or crutchers. There are, on the other hand, a number of continuous and more or less automatically controlled processes available. Other alternatives exist for drying of the "neat" soap in frames or spray-drying and finally many different machines for finishing the soap are available.

Fat splitting

This can either be done batchwise at normal pressure (Twitchell) with rather long residence time, or semi-continuously. The equipment is cheap in the first case, but some discoloration of the fatty acids will occur. Alternatives are medium pressure splitting in autoclaves with metal catalysts, or the high-pressure splitting in especially constructed towers with complicated and expensive equipment for heat recovery etc.

Hydrogenation

It will depend on the throughput of the hydrogenation plant, environmental factors and electricity supply, to mention only the most important factors, in what way hydrogen should be produced; i.e. either by electrolysis or in a rather complex plant for a catalytic process with a number of steps to purify the gas.

There are certainly a number of other examples of that kind in fat and oleochemical technology, and there will often be some trade-off between quality requirements and processing costs, but generally speaking

investment must not always be made in most modern techniques if local conditions speak in favour of a simpler solution which is sometimes even more flexible.

4. Assessment of the present downstream processing activities in developing countries.

It has been pointed out that the kind of raw material(s) will to a high extent determine the chances for any downstream activity. Agricultural experts should therefore carefully investigate all options.

4.1. Major raw materials for moderate zones are rapeseed and under good climatic conditions (competing with other crops) soybeans, sunflower and flax (linseed).

4.1.1. Rapeseed can be grown in two basic varieties, namely, with either 50 % erucic or oleic acid as major component of the oil. Erucic oil finds special application in oleochemistry (anti-foaming components, lubricants and nylon 1313) but limits the consumption in food (only 5 % erucic acid is permitted in the oil of food products in many countries).
There are varieties of rapeseed available which are low in erucic acid and in addition low in glycosinolates which otherwise limit the percentage of rapeseed meal in animal feed ("double-zero" rapeseed).

4.1.2. Soybean oil (20 %) and soybean meal (80 %) which are an excellent choice if feedstock is of major interest to make direct use of the meal. The production of soya protein concentrate and isolate is stagnating in the countries of Western Europe due to protective legislation and as yet non-compatible consumer habits.
A downstream activity of this kind deserves nevertheless interest for developing countries in this climatic zone, as the protein is almost as good as meat or egg protein from the nutritional point ov view, especially in connection with locally grown cereals.

4.1.3. Sunflower seed is a source of special high quality (high in linoleic acid and scarcely any linolenic acid), and the meal is well accepted as animal feed.

4.1.4. Olives contain an oil of high image and good keepability. Most of the oil is refined to get rid of special flavour components not to everybody's liking. - Relatively high quantities of free fatty acids are often the result of retarded harvesting or processing. Those fatty acids are e.g. raw material for special mild soaps (containing at least 20 % of olive fatty acids).

4.1.5. Linseed oil is a typical technical oil but in quick consumption or after hydrogenation it can be used for edible purposes. Paints and varnishes based on linseed oil are more and more substituted by synthetic binders (polymers). Linoleum has already been replaced by other floor coverings in most cases.

4.2. The semi-tropical zone can offer options to grow soybeans, olives, sunflower and in addition groundnuts, safflower, sesame and cotton.

4.2.1. Safflower grows not only in Southern California but also in North Africa and India. - There are varieties which are either especially rich in oleic acid (similar to olive oil), or the well-known species higher in linoleic acid than any other seed or oil respecitvely (70 %). The resulting high market value of the latter variety is backed by the application of the oil in dietetic products (lowering blood serum cholesterol).

4.2.2. Groundnuts contain up to 50 % oil and around 30 % protein. They are source of an oil which is especially stable and therefore used for deep-frying of food and baked goods of long keepability. The price of groundnut oil was often twice as high as that of soybean oil. The meal has good properties for animal feeding but should be used locally because mould producing toxins can easily develop on this substrate during storage of the meal.
Groundnut oil contains about 5 % long chain fatty acids (with more than 20 C atoms) which can possibly find special application in oleochemical products.

4.2.3. Sesame seed is somewhat difficult to harvest, but the oil content of 45 to 55 % is high.

4.2.4. Cotton seed is an important co-product with 30 to 40 % fat (after dehulling). The oil, after special refining, is a very stable fat for all kinds of food products.

4.2.5. Castor oil produced in Brazil, India and USSR, contains more than 80 % ricinoleic acid. The first pressing is used for pharmaceutical products, further pressing or solvent extraction produces a relatively dark oil which can play a special role in oleochemical industries. After dehydration of the oil modified alkyd resins can be produced, after cleavage a precursor to produce nylon 11.

4.3. Tropical countries are traditionally producers and exporters of crude vegetable oil and copra. The basis are the extremely high yields in agriculture. Two major sources of vegetable oil deserving special interest are coconuts and palm fruits.

4.3.1. Coconuts contain fat which has a fatty acid spectrum different from all other fats with the exception of palm kernel and babassu fat. The C_8- to C_{14}-fatty acids amount up to 85 %. The keepability of the oil is excellent and it has a short melting range which is of special interest to many branches of food industry where quick melting is wanted. - Moreover, these medium chain fatty acids are the most important and rather scarce raw material for the soap and oleochemical industry. Soap usually contains 10 to 20 % of those fatty acids improving the activity for washing especially in cold water. Many oleochemicals and their derivatives are made of these fatty acids depending on requirements. - The presscake (30 % of the copra) is used for animal feed.

4.3.2. Palm kernels which are separated during processing of palm fruits from the pulp, contain fat with similar characteristics as coconut fat (but with less C_8- and C_{10}-fatty acids). The varieties of oil palms differ somewhat in the amount of kernels in the fruits.
The fat and the cake from palm kernels are used in the same way as the corresponding coconut products.

4.3.3. Palm oil production became the success story of Malaysia due to specially favourable conditions which finally led to an important downstream activity.
Palm oil was regarded and traded mostly as a technical oil 30 years ago when Africa was major exporter. Due to special efforts made in Malaysia with new plantations and modern technology palm oil is now almost exclusively used for edible purposes like almost all other vegetable oils. The oil quality is much better (crude oil is low in free fatty acids) and the world production of 5 mio tons is as high as that for butterfat, in spite of the fact that Africa lost its leading position for a number of reasons.
The yield of 4 to 5 tons of oil per hectare is especially high and trees already carry fruit after 4 years.

Palm oil has a special glyceride structure which offers the option of relatively easy fractionation into palm stearin and olein.
The refined olein is mostly used as any other seed oil for cooking oil and with or without hydrogenation for other food products. Stearin is suitable for consumption in food only after interesterification.
The latter modification is even very useful to improve the glyceride structure of palm oil without any fractionation and much bigger quantities could then become components of margarine blends, vanaspati etc. Special "mid fractions" of palm oil are used as substitute for cocoa butter. Partly hydrogenated palm oil has a fatty acid spectrum similar to lard and tallow. This indicates already that saturated fatty acids from hydrogenated palm oil or palm stearin can serve as starting material for soaps and oleochemicals.

4.4. Prevailing constraints in different groups of developing countries

The technology of oils and fats is rather capital- and engery-intensive, labour costs playing a minor role. This shows clearly that the stage of development of the country and the creditability will be crucial for a start or the extension of a downstream activity in this field. Moreover, it might be a question of priority where available financial resources are invested. -

Countries in the Far East have already made much more progress in comparison with many states in Africa or South America as far as vegetable oil technology is concerned.

Examples in Malaysia, the Philippines and parts of India demonstrate the importance of entrepreneurial thinking and a "concerted" action comprising agriculture and industry. A very diversified structure of the farmland e.g. can complicate the issue. - Experience in Southern parts of Brazil has shown how important a good structure of the transport and storage system will be. - Energy supply can be another limiting factor as the requirements for producing e.g. 1 ton of refined oil from seed is often in the order of 2 tons of steam and 200 kWh.

There is in principle enough expertise to build up such a downstream activity in the world but partners well trained in science and technology are needed or at least highly desirable in the developing country itself. Factories can be planned and installed by a number of big engineering companies with world-wide experience. Maintenance, repairs and further development adapted to local conditions will nevertheless require well trained personnel which is not available everywhere. Technical managers may even need special education and training in institutions outside the country.

A downstream activity ending in rather sophisticated products like refined vegetable protein or oleochemicals and their derivates should be backed by scientific service institutions and will certainly benefit from other well developed industries. The palm oil research centre in Kuala Lumpur and fat institutes in India are examples greatly contributing to the success of the total activity in those states.

The downstream activity will not only need such know-how in vegetable oil technology in the broadest sense; a marketing strategy and well trained salesmen might play an important role as well.

To compound animal feed or to apply oleochemical derivates requires special experience and close contact with the clients.

Investigations in different countries will probably show that those needing help urgently struggle with more of the before mentioned constraints than others. This can only be compensated by an effective support from outside and from international enterprises and institutions.

4.5. Economic and technical conditions indispensable for broader development of downstream processing activities

Only a few aspects can be mentioned here, local conditions will in any way differ very much.

The developing country should be in a position to grow oil seed or palm trees at prices which are more or less competitive on the world market. This aspect, to be competitive without direct or indirect subsidies, is at least as important for further technological steps like oil extraction, production of compound feedstuff, oil refining etc. as the relatively high investment in technical installations should at least earn so much money that full costs (including depreciation or replacement value) are covered. Otherwise the export of raw materials like seed or crude oil could very well be the more sensible solution at least for an intermediate phase. -

The broadening of the vegetable fat activity requires a certain purchasing power and demand in the country. This could mean that food- and compound feed industries should be developed in parallel with other enterprises within the country and the region, as it would be risky to rely primarily on export activities which may possibly never be realized.

In other words: a market for products of this downstream activity should be developed within the country or the region.

Profit margins for products of this downstream activity for vegetable oil and fat will not be exceptionally high. Crude fats and fatty acids as well as cake and meal are commodities produced in increasing quantities world-wide, and this trend will on a longer run stabilize prices, but there is always a demand somewhere and prices are fixed traditionally in one or the other hard currency. The broad range of processed food containing more or less oil and fat will meet a regular, probably increasing demand, but the products are often regarded as basic food which should be available at relatively low prices.

More sophisticated products like fat fractions, vegetable proteins, pet-foods or oleochemicals can only be produced with great experience in manufacture and application. Moreover, a careful study of the potential market is anyway necessary.

Scientific centres specialised in agriculture, chemical, nutritional and technical aspects of this downstream activity - as they already exist in most industrialised countries - are at least highly desirable. Unforeseen events in agriculture and industry can happen and the help of experts is then certainly needed. The factories need a reliable supply of engergy and spare parts. Skilled craftsmen are needed in the workshops of the factories, others must be available nearby in case of major maintenance or repair tasks which must be executed quickly to avoid e.g. high cost in an idle plant.
The processing plants must be controlled regularly by an independent engineering service to reduce safety risks with this relatively complicated technology to a minimum.

Chemical and hygienic quality control can be crucial. Many products of this downstream activity - especially food - can offer health risks, other goods are bought by critical clients. The contracts will in general contain clauses concerning the quality standard.

Other conditions concerning transport, storage, training etc. have already been mentioned earlier.

5. Possible measures and actions recommended for increasing downstream processing activities in developing countries

There are a number of possible measures which should be taken before deciding on activities and there are other actions which should start only after a careful assessment of the present situation

5.1. Internal measures (at national, sectoral and plant level)

A number of questions should first be answered in a study:

Are the kinds of raw material grown at the moment the optimum solution from the agricultural point of view ?

Are better varieties of plants and trees available, or are there even chances to breed them in the country ?

Are the products produced from this raw material suitable to serve as starting material for sensible industrial activities in the fields of fat products, other food, animal feed, raising of livestock, soap and detergents and oleochemicals ?

Are the areas for growing seed and trees sufficiently concentrated logistically ?

Are necessary storage capacities available at the farm, in the region and at the processing plant ?

Can the transport system fulfill actual and future requirements ?

Have existing factories the right location primarily from the point of view of reliable raw material and energy supply ?

Is the quality of the present products well accepted locally and outside the country ?

What is the population growth and what are the prospects for the demand of more and better food products rich in oils and fats, adapted to the local eating habits ?

Is there an interest in raising more livestock ?

Is the demand for soap qualitywise and quantitywise well covered ?

What detergents are needed ?

Is there a local petrochemical industry which could compete and limit the chances for any oleochemicals ?

What is the level of present production costs at different stages ?

Are there severe environmental problems connected with production steps ?

Are there options to make better use of co- and by-products after necessary investments have been made ?

Would it be wise to modernise one or the other processing plant, or is a newly built factory the more economic solution on the longer run, especially if alternative processing methods are taken into consideration ?

What are the actual imports which could practically be avoided by a downstream activity in this field ?

What are the chances of exporting either raw materials or intermediates and final products, taking under consideration an eventually already existing overcapacity in the world ?

When these and other questions have been answered, the scenario for a sensible downstream activity can be drafted. - The question will arise whether the country can start this activity with its own scientific, technical and financial resources, or whether international cooperation, e.g. joint ventures, would be the solution.

5.2. International cooperation

could take place in different forms, e.g. sponsorships in which other countries and institutes engage themselves; foreign experts and advisors (e.g. from "Senior Executive Service" of an industrialised country);
foreign companies with great experience in this area could be asked to invest in this downstream activity or cooperate with local enterprises in joint ventures;
know-how could eventually be bought from companies which could be compensated either by money or raw materials and intermediates;
internationally operating consulting firms could help in the layout of factories.

5.3. Supporting action by international organisations (UNIDO)

If there is a chance being supported by international organisations it might be wise to be already more or less involved in necessary local investigations as outlined unter 5.1. In addition, international institutions could help in this area of market research outside the country as their experts should be in the best position to give an unbiased comment about the chance of success and the needs for technological and financial help. Otherwise it will scarcely be possible to assess a proposal and analyse risks and benefits.
In case support is justified, this help could certainly mean a real break-through for the planned activity.

It might be wise to first check if private enterprises are in a position to start such an activity on safe economic grounds; advice and subsidies from an international institution can in any way be crucial for the realisation.

International institutions should not only send experts at a certain time. They should assist in training technical and other managers outside the country at international centres of expertise. - Moreover, responsible people and experts from the country should receive the opportunity to discuss their plans and get impulses and suggestions from visiting colleagues and institutions abroad.

6. Conclusions

A downstream processing activity in vegetable oils in developing countries is in principle especially attractive as a very broad potential to increase industrial activity, nutritional status, standard of living and purchasing power is part of this scenario.

Great hopes to export rather sophisticated products could be an illusion if they are not backed by market research data.

The activity should be based on relatively low production costs, a sufficiently high demand and a good marketing system.

There is, however, scarcely a chance to manufacture products which are unique. - Cheap labour costs play a minor role in such technologies with the exception of those in agricultural activities.

A systematic investigation concerning all conditions and environmental factors within a special country seems absolutely necessary in view of the fact that no generalisation is possible.

The study will have to start with the crucial selection of raw materials and end with marketing data and investment plans.

Cooperation with international private enterprises and international institutions might be highly welcome, as great experience and know-how is available in industrialised and a number of rather well developed countries.