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DRAFT WORLD-WIDE STUDY ON THE VEGETABLE OILS AND FATS INDUSTRY: 1975–2000

A SECTORAL STUDY PREPARED BY THE

INTERNATIONAL CENTRE FOR INDUSTRIAL STUDIES

id.77-6880

Explanatory notes

References to dollars ($) are to United States dollars, unless otherwise stated.

Annual rates of growth or change refer to annual compound rates, unless otherwise stated.

A slash between dates (e.g., 1970/71) indicates a crop year, financial year or academic year.

Use of a hyphen between dates (e.g., 1960-1965) indicates the full period involved, including the beginning and end years.

A full stop (.) is used to indicate decimals.

A comma (,) is used to distinguish thousands and millions.

References to "tons" are to metric tons, unless otherwise specified.

The following forms have been used in tables:

Three dots (...) indicate that data are not available or are not separately reported

A dash (-) indicates that the amount is nil or negligible

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RESUME

1. Since a comprehensive summary of the Draft Study has been prepared as a separate document (UNIDO/ICIS.47) the present resume provides only a brief outline of the Study, explaining the chapter development and presenting the major conclusions.

2. The oilseed and oilseed products industry presents a complex subject for analysis. There are many different types of oilseed, each having its own characteristic properties and each appearing in a variety of similar, but not always identical, end uses. The main oilseeds are also grown in a large number of countries, and oilseeds are a crop of major significance in many developing countries. Consequently, the Draft Study confines itself to the major edible oilseeds: soyabean, coconut, cotton-seed, oil palm products, groundnuts, sunflower, rapeseed, sesame seed, and safflower seed.

3. The outline of the Draft Study is as follows. In chapters I and II the main patterns of production, trade and prices of oilseeds and oilseed products are examined. At the time of preparing the Draft Study the most recent complete set of statistical data referred to 1975 and therefore the period 1965-1975 forms the basis of this part of the analysis. The main features to emerge from this section are the overwhelming dominance of soyabean and soyabean products in international markets, and the high degree of geographical concentration that exists in oilseed production generally, despite the widespread cultivation of oilseed crops. Thus, two countries, Brazil and the United States have to an increasing extent dominated world soyabean production, while some sixteen developing countries account for around 70 per cent of all developing country production of oilseeds.

4. The data used in the first two chapters, however, represent the outcome of a series of decisions taken by producers and consumers in the context of particular market conditions and these are consequently explored in greater detail in chapters III and IV. In chapter III a distinction is made between subsistence and commercial utilization of oilseeds, as this has implications for the growth of demand and for utilization of the oilseed products. The remainder of the chapter outlines the different patterns of usage of vegetable oils and oilmeals in the developed and the developing countries, and concludes with a brief discussion of the main determinants of demand for oilseed products, including, in the case of the vegetable oils, the particular significance of substitution between oils in different end-uses.

5. Chapter IV explains what lies behind the supply of oilseeds and oilseed products and begins with an account of the characteristic differences between village-level processing methods and factory-level methods. This section also describes the relative incidence of each type of method in a selection of developing countries, and goes on to discuss the presence of industries which utilize vegetable oils, such as the margarine, vanaspati, and the soap-making industries, in developing countries.

6. One particularly important aspect of the industrial processing of oilseeds is the utilization of capacity, and this is given some attention in this chapter as it serves to highlight a number of problems associated with industrial development in developing countries. The chapter concludes in similar fashion to the previous one with a review of the main influences on the supply of oilseeds and oilseed products. In this case, however, emphasis is on the different incentive schemes that are needed for the expansion of subsistence and commercial sectors of production, and on the patterns of development that are to be expected in those derivative industries which utilize vegetable oils.

7. The first four chapters therefore describe the present situation, and review the recent past, with reference to specific aspects of the oilseed industry. These chapters provide a reference point for any statements about the future of the oilseed and oilseed products industry. However, in order to formalize the procedure to be followed in considering the future prospects for the oilseed and oilseed products industry, in the context of the Lima Declaration, it is useful to identify the most important variables which affect the development of this industry. This is the function of chapter V which is therefore seen as a linking chapter between the first four chapters and those which follow. Chapter V draws on the information provided in the previous chapters and identifies in general terms the main variables which influence the oilseed and oilseed products industry. Any statements about the future of the industry must take account of possible changes in these variables.

8. In reviewing the present situation it becomes evident that a number of decisions have been taken which to a large extent predetermine the supply of certain oilseeds in the medium term. Similarly, a number of trends in consumption and utilization can be assumed to be fairly well predictable in the medium term, and it is evident that as a preliminary exercise in discussing the future of the oilseeds and related industries it is useful to attempt a medium term forecast of the demand and supply balance of oilseed products. The medium term prospects, to 1985, are therefore explored in chapter VI, given certain assumptions about the most important of the main variables outlined in the preceding chapter. The conclusion is reached that a slight excess of supply over demand is possible by 1985, and this provides an additional item of information for the longer-term view which is taken up in chapter VII.

9. The Lima Declaration is principally concerned with the situation of the oilseed and oilseed products industry in the developing countries by 2000, and chapter VII attempts to provide some indicators in this respect. The main variables outlined in chapter V are utilized as an initial starting point but some additional discussion is offered in chapter VII on the likely development of new uses of oilseeds and oilseed products in the years between the present and 2000. In general, however, the adoption and expansion of techniques and products already available in the developed countries is expected to provide the major source of change in the oilseed industry in the developing countries during this period. Tentative calculations in this chapter again indicate that over the long term the supply of oilseeds, and of oilseed products, will be ample to meet the most likely levels of global demand. Since the main growth in demand is expected to take place in the developing countries and since these countries also appear to have substantial potential for increasing their supply of oilseeds, it is evident that potential also exists for expanding the oilseed processing and derivative industries in these countries. Access to the markets of the developed countries provides another potential stimulus to expansion of these industries in developing countries.

10. In the context of the Lima Declaration it is important to guarantee that this potential is realized to the maximum extent possible. The Lima Declaration called for the developing countries' share of world industrial production to be "increased to the maximum possible extent and as far as possible to at least 25 per cent" by 2000, but in the case of the oilseed-based industries the figure of 25 per cent has already been exceded and further expansion must therefore be "to the maximum possible extent."

11. Throughout the earlier part of the Draft Study reference is made to a number of problems and constraints which tend to limit the efficiency and hence expansion prospects of the oilseed and oilseed products industries in the developing countries, and many of these are brought together in the final chapter, chapter VIII, which discusses constraints on the production, processing

and marketing of oilseeds and oilseed products in developing countries. This chapter also contains a short section on the opportunities for further processing. In order to overcome the most important of the constraints and thus enable the developing countries to increase their world share of the oilseed and oilseed products industry, a number of strategies and proposals for action are necessary, and the Draft Study concludes with certain suggestions in this regard.

12. In summary, the Draft Study examines the present situation of the world oilseed economy in some detail, paying particular attention to the developing countries, and goes on to consider the prospects for the oilseed and oilseed products industry in these countries by the year 2000. The conclusion is reached that considerable potential exists for expanding the share of the developing countries in these industries by that time, but that a number of constraints have first to be overcome if the increase is to be maximized, and that policies and strategies to this end have to be developed and effected.

13. Particular features of the industry from the point of view of the developing countries, and which may require special attention, include the extent of geographical concentration of existing oilseed production, within both the developed and developing groups of countries; the dominant role of soyabean; the growth rate of demand in developing countries; the ease of access to markets in the developed countries; and the increasing degree of substitution between vegetable oils in different end uses. Each of these has its own implications for the development of the oilseed and oilseed products industries in particular developing countries, but the solutions to problems raised by these and other features are best sought through international co-operation and agreement whereby benefits are distributed as far as possible to the mutual advantage of all interested nations.

14. Finally, it will be noted that part one of the Draft Study contains very little by way of technical references, and focuses principally on the economic development of the oilseed and oilseed products industry. Technical aspects are naturally taken fully into account in the text but in order to keep the Draft Study to a manageable size, purely technical discussion is presented in part two, which is concerned primarily with the technology of oilseed-processing methods, with substitutability between vegetable oils, and with possible new edible and non-edible uses of vegetable oils. Statistical tables which served as background sources for the Draft Study are also included in part two.

I. WORLD PRODUCTION AND TRADE IN OILSEEDS

Production of oilseeds

15. World production of oilseeds has increased substantially in recent years, showing an increase over the decade 1965-1975 (the latest available 10-year period) of some 43 per cent. The actual increase is from 123.2 million tons in 1965 to 175.9 million tons in 1975.

16. Table 1 illustrates the level of production and the relative share of the major oilseeds over the decade 1965-1975.

17. In terms of volume, the order of dominance has remained remarkably constant between 1965 and 1975. Soyabean remains the largest crop with over 38 per cent of global production; this represents more than twice the proportion of the next most important crop, namely coconuts, which accounted for 16.8 per cent of global production in 1975. Cottonseed and groundnuts are also important crops and jointly accounted for 24 per cent of global oilseed production in 1975. Oil palm, sunflower seed and rapeseed provided a further 18.7 per cent of total production, with sesame seed and safflower seed accounting for the remainder.

18. Despite the comparatively constant ranking in importance of individual oilseeds over the last decade, there have been large production increases in certain oilseeds. In particular, soyabean and oil palm, with increases of 87 per cent and 122 per cent respectively, have far exceeded the average. In the case of soyabean the bulk of the increased production has been from the United States. With respect to oil palm, the bulk of the increased production has been from Malaysia. Of the less significant oilseeds, in terms of volume, there have been important production increases in rapeseed and safflower seed. Output of the former has expanded 53 per cent since 1965, predominantly in Canada and India, whilst that of safflower seed, the least important of these oilseeds in terms of volume, has doubled because of increased production in India and Mexico.

19. All of the remaining oilseeds have also shown increases in production. Coconut production, until very recently, has remained fairly stable with the major increase coming from the Philippines. Cottonseed production has expanded slowly, but the share of the developing countries has declined.

20. Sunflower seed production rose by 21 per cent with the bulk of this increase (over 80 per cent) coming from the centrally planned economies. Sesame seed production increased by 18 per cent, the bulk of production, over 80 per cent, remaining in the developing countries, and groundnut production, which is also a predominantly developing-country oilseed, has also undergone a small increase despite production setbacks in recent years. The following part of the Draft Study considers in detail the production trends for individual seeds, commenting upon geographical distribution and the major producers.

Soyabeans

21. Soyabeans have dominated the world's oilseed economy throughout most of the period under review, usually providing around 30 per cent of total production of the oilseeds mentioned. Total production has increased from 36.5 million tons in 1965 to 68.4 million tons in 1975. This growth of soyabean production has been largely instrumental in the expansion of the world's oilseed economy during this period.

Table 1. Production of major oilseeds
(million tons)

Type of oilseed	1965 Quantity	1965 percentage of total	1965 (1965 base year)	1970 Quantity	1970 percentage of total	1970 (1965 base year)	1975 Quantity	1975 percentage of total	1975 (1965 base year)
Soyabeans	36.5	29.6	100	46.5	32.7	127	68.4	38.9	187
Coconuts	26.4	21.5	100	26.3	18.6	99	29.6	16.8	112
Cottonseed	22.1	17.9	100	22.2	15.6	100	23.0	13.1	104
Groundnuts (in shell)	16.0	13.0	100	18.4	12.9	115	19.1	10.9	119
Sunflower seed	7.9	6.4	100	9.9	6.9	125	9.6	5.5	121
Oil palm (FFB)	6.8	5.5	100	9.2	6.6	135	15.1	8.6	222
Rapeseed	5.3	4.3	100	6.7	4.7	126	8.1	4.6	153
Sesame seed	1.7	1.4	100	2.2	1.5	129	2.0	1.1	118
Safflower seed	0.5	0.4	100	0.7	0.5	140	1.0	0.6	200
TOTAL	123.2	100.0	100	142.1	100.0	115	175.9	100.0	143

Source: FAO.

22. To the extent that it is dominated by the United States, world soyabean production remains a predominantly developed country oilseed. The United States production has been as high as 66 per cent of world production but in 1975 declined to around 60 per cent.

23. Brazil and China account for the vast proportion of the reamining production. There appears to be some divergence of opinion as to the size of China's soyabean crop but the majority view favours a total production of between 11 and 12 million tons. Brazilian production has expanded rapidly: in 1965 Brazil produced little more than 1 per cent of world production but by 1975 this figure had risen to almost 15 per cent and is predicted to increase further.

24. The remaining principal producers are of comparatively little significance in global terms. Countries where soyabean production has expanded to a marked degree, but still remain relatively insignificant, include Colombia and Mexico; both countries are continuing to encourage soyabean growing. Indonesia remains a significant minor producer but production in Japan appears to be falling away from the levels achieved in earlier years.

25. Soyabean production is therefore becoming increasingly dominated by the American continent and this situation seems likely to continue. Developing countries are sharing in the increased production, particularly Brazil, Colombia and Mexico, but it seems probable that for the majority of developing countries soyabean is not a particularly appropriate oilseed upon which to base any major expansion of their oilseed economies, given the range of agronomic and economic constraints involved. However, they could be significant in specific regions at comparatively modest levels of production.

<u>Coconuts</u>

26. In terms of the volume of raw material produced the coconut is second only to soyabean in world oilseed production. It differs from soyabean and all other major sources of vegetable oil, except oil palm, in that it is almost entirely produced in developing countries. Total world production during the last decade has generally remained stable in the range of 25-27 million tons but has recently increased sharply and seems likely to increase further over the next few years following extensive replanting with hybrid varieties.

27. In terms of the volume of production, Asia is predominant, producing approximately 80 per cent of world output. Within the Asian continent, over one third of regional production is produced in the Philippines, which has consolidated its position as the world's principal coconut producer and where production is expected to increase substantially over the next few years.

28. Three other countries, namely India, Indonesia and Sri Lanka, contribute most of the remaining Asian production. Indian production expanded steadily until the early 1970s, but has since remained on a plateau around 4.5 million tons. Indonesian production has until recently grown rather slowly, but the 1975 figure of 6.5 million tons represents a sharp increase.

29. In Sri Lanka, coconut production declined continuously between 1965 and 1974, but appears to have made some recovery in 1975.

30. Outside Asia and the Far East, coconut production is of comparatively minor importance. On the American continent Brazil and Mexico are the main producers but their respective 1975 outputs of 235,000 and 960,000 tons are minor in a global context. Similarly, no African country produces more than half a million tons annually.

Cottonseed

31. Cottonseed production grew from 22 million tons in 1965 to 22.9 million tons in 1975. Four countries, namely China, India, the Soviet Union, and the United States, contribute over 60 per cent of total world output. China and India have maintained their shares of world production but since 1965 the Soviet Union and the United States have virtually exchanged positions in the list of principal producers. In 1965 the United States was the world's leading producer but since then its cottonseed output was declined by over 50 per cent. Conversely, the Soviet Union's output has increased by almost 40 per cent.

32. Taking the developing countries, the region with the largest production of cottonseed is Asia, producing 3.54 million tons in 1975, followed by Latin America with 2.69 million tons and the Middle East and Africa with 2.62 million tons and 0.90 million tons respectively.

33. In Asia, production is dominated by India and Pakistan with output in the former tending to fluctuate around 2 million tons while in the latter it has gradually increased from 830,000 tons in 1965 to 1.3 million tons in 1974, falling to 1 million tons in 1975. The only other developing country to exceed 1 million tons of production in 1975 was Brazil; an increase from 860,000 tons in 1965. Other major Latin American producers are Argentina, Colombia, Mexico and Peru.

34. In the Middle East the traditional producers are Egypt and the Sudan; these countries remain dominant, though production in the former has declined slightly and may have reached a plateau. In the Sudan, production has fluctuated markedly over the last decade but around a predominantly increasing trend. Other major producers in the region are Iran, Syria and Turkey. The overall impression of world cottonseed production is that of a widely dispersed crop with a number of significant producers in virtually every continent.

Groundnuts

35. Groundnuts are grown by a large number of countries including developed, developing and centrally planned economies; over 30 produce significant commercial quantities. World output since 1965 has been relatively stable, ranging from 16 million to 19 million tons. Adverse weather conditions in many African producing countries since 1971 contributed to a decline from which world output has still not fully recovered.

36. In 1965 the developing countries accounted for slightly over 75 per cent of world production while the developed and the centrally planned countries produced approximately 9 per cent and 16 per cent respectively. In 1975, these shares remained virtually unchanged.

37. Among the developing countries India is the largest producer and consistently maintains her position as the world's largest groundnut producer. Indian production increased from 4.3 million tons in 1965 to 6.6 million tons in 1975 and the country's share of world production increased from 26.6 in 1965 to 34.5 per cent in 1975. India, on average, still produces at least double the quantity of groundnuts from any other source. China is generally regarded as the second most important groundnut producer, with about 15 per cent of world output. Chinese production is thought to have increased steadily but slowly over the decade, allowing her to maintain an almost constant proportion of total world output.

38. The most noteworthy change in groundnut producing countries since 1965 has been the decline of the West African countries. Since 1971 Niger, Nigeria and Senegal, the major producers, have suffered from varying degrees of drought conditions. Their aggregrate production has declined from around 3.3 million tons in 1965 to 1.7 million tons in 1975 thereby reducing their share of world production from 21 to 9 per cent. Senegal's production appears to have recovered well in 1975 but Niger and Nigeria continued to suffer a marked fall in output.

39. If groundnuts are to regain the global position they held in 1965, the vacuum left by the West African fall in production, particularly that of Nigeria, needs to be filled. The signs are that the United States may partially fill the need, but the main impression of groundnut production remains one of a widely dispersed crop with a large number of significant producers.

Sunflower seed

40. Sunflower seed is produced in significant commercial quantities in at least twenty countries dispersed among the developed, developing and centrally planned economies. Production has fluctuated in recent years but there has been a general tendency for it to increase. Between 1965 and 1973, the peak year, production increased from around 8 million to about 12 million tons. From 1974, however, production fell and a decline to 9.6 million tons was experienced in 1975.

41. In 1965 the developed, developing and centrally planned economies accounted for 5.1, 12.9 and 82 per cent of world production respectively. However by 1975 the centrally planned countries' share has fallen to 66.3 per cent while the developed and developing countries increased their shares to 18.8 and 14.5 per cent respectively.

42. World sunflower seed production is dominated by the USSR which accounts for over 50 per cent of the total. This share is tending to decline, due partly to a renewed interest in sunflower seed production in other countries but also to a marked fall in production in the USSR. Countries such as Australia, South Africa, Spain, Turkey, and the United States have all made significant strides in extending sunflower seed cultivation in recent years. The developed countries seem likely to increase their interest in the crop still further. For example, the United States target for 1976 is 625,000 tons of seed compared with 20,000 tons in 1965. Canada is also contemplating sunflower seed as an alternative oilseed crop to rapeseed with an expansion programme planned initially for the province of Saskatchewan. Despite the fact that production declined after 1970, Argentina remained the world's second largest producer in 1975 with a production of 732,000 tons.

43. Very few other developing countries produce sunflower seed in significant quantities although India has established a target of one million hectares by 1979. Several other countries have conducted trials, particularly some of the Middle Eastern countries and one or two in East Africa. However, the degree of success has been limited and it seems unlikely that the developing countries will contribute a significant proportion of world sunflower seed production in the foreseeable future.

Palm oil

44. The global distribution of palm oil production has changed markedly in the past decade. In 1965, 73 per cent of world production was produced in Africa, 23 per cent in the Far East and 3 per cent in Latin America, whereas by 1975 almost 57 per cent was produced in the Far East and 38 per cent in Africa, with 4 per cent in Latin America.

45. The prime reason for this change in distribution has been the dramatic increase in Malaysian production since 1965. From a country with 11 per cent of world output, Malaysia has grown to dominate the world palm oil production with at present 43 per cent share of global production. Simultaneously, Indonesian output has also doubled but remains on a more modest scale. Together these two countries account for the growing dominance of the Far East in the world palm oil economy.

46. In contrast, Nigeria, which in 1965 was the world's leading producer, experienced its worst decline during the late 1960s. Production has tended to fluctuate throughout the 1970s but is still considerably lower than the 1965 output level. However in other African countries, notably the Ivory Coast and Zaire, production has tended to rise; the Ivory Coast, in particular, has expanded rapidly and continuously to become an important international producer.

47. World production of palm oil is expected to continue to expand. In part, increased output is predetermined for a number of years because of planting decisions taken in previous years. Considerable areas were planted in West Malaysia in the 1960s and, with palms continuing to fruit for 20-30 years, production is assured for some time. Similar effects are to be expected in those countries, like Indonesia and the Ivory Coast, which entered the field more recently. This explains the results of economic studies in Malaysia which show that the areas under new plantings, rather than actual production, have an influence upon price movements.

Palm kernels

48. World production of palm kernels does not completely mirror palm oil production. Total world production between 1965 and 1975 rose from 1.14 million tons to 1.40 million tons, but this rise was not continuous. Although African production of 721,000 tons in 1975 was larger than that of any other area, this figure represented a decline from 828,000 tons in 1965. Latin America's share of the world production rose gradually between 1965 and 1975 from 20 per cent to 24 per cent, but the most dramatic increase has been in the Far East where an increase from 6 per cent to 24 per cent is recorded.

49. The increase in Far Eastern production of palm kernels is directly linked with the expansion of palm oil production in Indonesia and Malaysia and the production of palm kernels in the region is dominated by these two countries. In both cases production has increased uninterruptedly in recent years. However, although palm oil production in Malaysia has outstripped that of Nigeria, this has not been the case with palm kernels, mainly since the hybrid type of palm planted in Malaysia in recent years has a comparatively insignificant kernel.

Rapeseed

50. Between 1965 and 1975 world production of rapeseed increased from 5.2 million tons to 8.1 million tons. Over 70 per cent of world output is provided by four countries: Canada, China, India and Poland.

51. Of the developing countries, India is the only really major rapeseed producer with 2.2 million tons or 82 per cent of developing countries' production in 1975. This figure is an appreciable increase of the 1.4 million tons of 1965, but there have been considerable fluctuations around this rising trend. The only other developing country producers of any significance are Pakistan, which has maintained an average production of about 250,000 tons over the decade, and Bangladesh, which currently produces about 100,000 tons.

52. The largest producer among the developed countries is Canada, with 1.6 million tons in 1975 compared with only 513,000 in 1965. In the United States very little rapeseed is produced and the country is not important in world production. Other major producers of the developed world are in Western Europe with France the leader, producing 532,000 tons in 1975. Other European producers have also shown an upward trend, though not without fluctuations. In 1975 the next largest producer in Western Europe was Sweden, with 332,000 tons followed by the Federal Republic of Germany with 200,000 tons.

53. Of the 2.42 million tons produced in centrally planned countries almost 53 per cent is grown in China, the remainder being grown in Eastern Europe. Poland produced 700,000 tons in 1975, but output has fluctuated frequently since 1965 when production was 504,000 tons.

Sesame seed

54. Sesame seed is produced in commercial quantities in over 60 countries dispersed among the developed, developing and centrally planned countries. Unlike some other oilseeds, fluctuations in annual production have on the whole not been marked. There has been a slow but relatively steady growth in world supply with production increasing from 1.7 million tons in 1965 to 2 million tons in 1975.

55. China, India and Sudan are the main producers with an aggregate 53.4 per cent of the total 1975 production. India has been the largest sesame seed producer for many years, with around a quarter of world production.

Safflower seed

56. The commercial production of safflower seed is limited to less than ten countries. The production data reveal significant annual fluctuations, although there has been a tendency for production to increase. Between 1965 and 1975 production increased from 469,000 to 982,000 tons.

57. In 1965 the developed countries, mainly the United States produced about 60 per cent of the total world supply of safflower seed. The developing countries, mainly Ethiopia, India and Mexico, produced 39 per cent. By 1975 the pattern had changed with the developing countries accounting for 77.5 per cent of total world production, the developed countries 22.1 per cent and the centrally planned countries only 0.4 per cent.

Conclusions

58. In the last decade there have been production increases for all of the ten major sources of vegetable oils. Soyabean remains the dominant oilseed in volume terms, and seems likely to consolidate its position over the next few years. However, with a limited number of exceptions, the crop does not appear to be particularly suited to developing countries. Coconuts remain important and continue to be produced predominantly in developing countries, particularly in Asia, where there is tremendous scope for yield improvement through disease control, plant breeding and the use of better agronomic methods. A significant upturn in coconut productivity seems likely in the short to medium term.

59. Oil palm has grown in importance and is likely to continue to expand when recent plantings come to maturity; the Far East, in particular Malaysia, is likely to continue to be the principal producing area. Cottonseed production continues to increase steadily in volume terms but in relative terms cottonseed is likely to be outstripped by soyabean, oil palm, sunflower seed and possibly groundnuts. Groundnut production in India, Senegal and the United States is likely to be sustained but it remains to be seen if the West African countries can assume their former importance, if drought problems can be overcome and production technology improved.

60. There is increasing interest in the other, more minor, oilseeds, but lack of experience, and physiological, agronomic and technical requirements are likely to limit their expansion to specific countries and it is unlikely that expansion of sunflower seed, rapeseed or safflower seed will have a major impact on the oilseed economy of the developing countries as a whole.

61. Production of oilseeds is comparatively concentrated geographically. Table 2 lists the main procedure for each oilseed. In aggregate some twenty-four countries, of which sixteen are developing economies, account for over 80 per cent of world oilseed production. Thus, although other developing countries may still have a potential for expanding and upgrading their oilseed processing industries, it must inevitably be to those listed in table 2 that one must first look, if any significant impact is to be made by the developing countries as a group upon the share of the world's oilseed economy held by such countries.

Table 2. Principal producing countries

Type of oilseed	Developed economy	Developing economy	Centrally planned economy
Soyabeans	United States	Brazil	China
Coconuts		India, Indonesia, Philippines, Sri Lanka	
Cottonseed	United States	Argentina, India, Pakistan, Peru, Turkey	China, USSR
Groundnuts	United States	India, Nigeria, Senegal	China
Sunflower seed		Argentina, Turkey	Bulgaria, Romania, USSR
Oil palm		Indonesia, Ivory Coast, Malaysia, Nigeria, Zaire	
Palm kernels		Brazil, Malaysia, Nigeria, Zaire	
Rapeseed	Canada, France	India	China, Poland
Sesame seed		Ethiopia, India, Mexioo, Sudan	China
Safflower seed	United States	India, Mexico	

Trade in oilseeds

62. World trade in oilseeds is relatively small in comparison to total production: in 1975 some 11 per cent of global oilseed production entered international markets in this form. The predominant feature of oilseed trading is its dominance by soyabeans which accounted, as shown in table 3, for 80 per cent of the total volume traded. Although the total volume of oilseeds traded has risen from 12.0 million tons in 1965 to almost 21.0 million tons in 1975, the difference is almost entirely due to the growth of soyabean exports. Otherwise, only rapeseed trade has undergone any marked expansion. The volume of other oilseeds traded has either declined or remained comparatively stable.

Table 3. Exports of selected oilseeds
(Million tons)

Type of oilseed	1965		1970		1975	
	Quantity	ercentage of total	Quantity	ercentage of total	Quantity	ercentage of total
Soyabeans	6.97	57.7	12.62	72.3	16.46	80.0
Groundnuts	1.36	11.3	0.99	5.7	0.89	4.3
Copra	1.36	11.3	0.91	5.3	1.08	5.2
Rapeseed	0.68	5.6	1.23	7.1	0.97	4.7
Palm kernels	0.66	5.4	0.46	2.6	0.34	1.7
Cottonseed	0.46	3.8	0.48	2.7	0.20	1.0
Sunflower seed	0.24	2.0	0.48	2.7	0.35	1.7
Sesame seed	0.18	1.5	0.22	1.2	0.21	1.0
Safflower seed	0.18	1.5	0.08	0.4	0.08	0.4
Total	12.09	100.0	17.47	100.00	20.58	100.0

Source: FAO.

Soyabeans

63. Soyabeans are unique amongst the oilseeds in having such a high proportion of their trade in the form of the seed. The vast proportion of traded soyabeans pass from the United States to Western Europe. The United States normally accounts for around 80 per cent of world exports and the European Economic Community (EEC) about 55 per cent of all imports. The other major importers are Japan and Spain. The major development in the soyabean trade over the past decade which has affected this pattern has been the emergence of Brazil as an exporter. In 1965 Brazil accounted for about 1 per cent of soyabean exports, but by 1975 this figure had risen to 20 per cent. Brazilian exports compete with American soyabeans in the markets of Western Europe, but in 1975 Brazil still had only 20 per cent of that market.

Groundnuts

64. Groundnuts are exported both in the shell and as kernels. Groundnuts in the shell are intended primarily for direct human consumption. There is also a sizeable trade in groundnut kernels for direct consumption. It is estimated that in 1973 the edible trade accounted for 100,000 tons of groundnuts in shell and 380,000 tons of groundnut kernels. No attempt is made in this report to distinguish between edible and milling groundnuts. Historically, trade in groundnuts has been well over one million tons annually, but in recent years the decline in production of certain West African producers has been associated with a tendency for the groundnut trade to decline. There are a number of exporters, each with a significant share of the market.

65. From 1965 to 1970 Nigeria dominated world exports, although between those years its market share fell from 38 per cent to 29 oer cent. In 1974, however, the United States emerged as the major exporter. This was partly due to a five-fold increase in the quantity exported but was also assisted by the drastic decline in West African exports. In addition to Nigeria, Senegal, traditionally the second major exporter, suffered a major production setback and exports declined to a very low level. In contrast, Sudanese production has been comparatively untouched by the drought problems which have affected West African producers and its exports have continued to grow steadily since 1970. In 1975 Sudan ranked second to the United States in the league of groundnut exporters.

66. Another result of the changes that have taken place in the past ten years is that a number of smaller suppliers now have a significant share of the trade. Today, Brazil, Cameroon, India, and South Africa account for almost a quarter of the world market, whereas in 1965 their exports as a group were insignificant. It may well be that over the next few years this group of countries will consolidate their position in world groundnut markets if the traditional producers continue to experience supply problems.

67. In similar fashion to exports, groundnut imports have declined since 1965. Nevertheless, the broad picture of principal importers has remained remarkably stable. Western Europe is still the major outlet, taking about 70 per cent of the total. Federal Republic of Germany, France, Italy and the United Kingdom are the major importers. The other major importers are Canada and Japan. Canada's imports, contrary to the overall trend, have almost doubled since 1965.

Copra

68. World exports of copra in 1975 were 1.0 million tons compared to 1.36 million tons in 1965. It will be seen later that coconut oil exports have increased in recent years, which suggests a change in the structure of coconut exports rather than an absolute decline.

69. Exports of copra tended to fluctuate up until 1973, showing only a slight and indeterminate downward trend; the main drop in copra exports took place in 1974. The fact that this was not associated with a marked decline in production further supports the view that a greater degree of processing of copra is taking place in the producing countries who then export the oil.

70. Philippine exports, however, have fluctuated considerably during the past decade, falling as low as 268,000 tons in 1974 and rising as high as 982,386 tons in 1972; the 1975 figure is 961,000 tons. Indonesian exports have also fluctuated, again in contrast to their stable production figures. The general trend of copra exports from Indonesia is downward but only in a highly irregular fashion with considerable year-to-year fluctuations. Only amongst the smaller producers do exports constitute a significant proportion of production. India, the third largest producer in the world, exports very little copra. Much the same can be said for Malaysia and Sri Lanka.

71. In Oceania a high proportion of production is exported and the main countries involved, the New Hebrides and Papua New Guinea, have a comparatively stable trade, and have steadily increased their share of world copra exports to 11 per cent in 1975. The only African exporter of any size is Mozambique.

72. The largest importer of copra is the EEC (specifically France, Federal Republic of Germany, the Netherlands, and the United Kingdom) which, in 1975, accounted for 66 per cent of all imports. This particular trade is tending to be an increasing proportion of a smaller total. In contrast, imports of copra into the United States have declined drastically since 1965 when the United States accounted for 20 per cent of total imports. Japan, the other major copra importer, has increased its share of the market but, as in the case of the EEC, the proportion is related to a lower absolute quantity. There are a number of other importers of copra taking small amounts, for example, Australia and Scandinavia, and in aggregate they constitute a significant share of the copra trade. However, the broad impression remains one of many small outlets for a fluctuating but, in the long term, declining total supply.

Rapeseed

73. Between 1965 and 1975 the percentage of total world rapeseed production which entered international trade ranged from 13.0 per cent to 25.4 per cent. Exports increased from 683,000 tons in 1965 to 1.9 million tons in 1971, since which time there has been a tendency for exports to fluctuate broadly within the 1.0 to 1.4 million ton range.

74. Developing countries do not feature significantly in rapeseed trade. In 1965, developing countries were responsible for less than 10per cent of total exports and by 1975 they provided only 0.5 per cent of the total. India, the world's largest producer of rapeseed, does not normally export more than a few hundred tons.

75. Canada is the largest exporter and has considerably increased its exports from 275,000 tons in 1965 to 676,000 in 1975 or about 70 per cent of total exports. This dominant position has been sustained throughout a decade when the total annual trade in rapeseed has virtually doubled. Historically, France and Sweden have contributed together around 30 per cent of rapeseed exports and although there have been fluctuations, this position has been largely maintained. Of recent date, Denmark has also joined the number of minor exporters with 6 per cent of total exports in 1975.

76. The major importers of rapeseed are again predominantly developed countries. Japan occupies the principal position, a position it is tending to consolidate. In 1975 over 60 per cent of world rapeseed imports went to Japan.

77. The other major importer is the Federal Republic of Germany, with almost 11 per cent of the market share in 1975. In absolute terms the amount involved, 117,000 tons, is similar to the level of imports in 1965. Other West European countries with minor shares of rapeseed imports include France, Italy, Netherlands and the United Kingdom. Together they accounted for slightly less than 13 per cent of total imports in 1975. The latter two countries appear to have a small but growing interest in the crop over the past decade. In contrast, Italy, once the leading importer, is now importing very little rapeseed. Nevertheless, Western Europe, along with Japan, appears likely to dominate rapeseed trade in the foreseeable future.

Palm kernels

78. A significant but declining proportion of palm kernel production enters world trade. In 1965 the quantity of palm kernels traded internationally was 665,000 tons or approximately 58 per cent of world production. By 1975 only 339,000 tons or 24 per cent of total production was traded.

79. Since production of palm kernels continues to expand it is evident that a significant move toward a greater degree of processing in producing countries is taking place.

80. Developing countries comprise the main exporters. Some re-exports occur among developed as well as developing countries but there are difficulties in isolating them.

81. In 1965 Nigeria exported 422,000 tons or 63 per cent of all palm kernels traded. This declined to 173,000 tons or 51 per cent of the total in 1975. By comparison, other exporters of palm kernels are of minor importance. Cameroon, Indonesia, Ivory Coast and Sierra Leone together contribute another 30 per cent of total exports. Cameroon and Indonesia are tending to reduce their exports but those of Cameroon have remained fairly stable whilst the Ivory Coast has doubled its output in recent years. This broad pattern of general African domination of palm kernel exports seems likely to be sustained, but some reallocation of trade between African countries is probable.

82. Although Malaysia and Indonesia have expanded their palm production in recent years their interest in palm kernels remains comparatively marginal, largely for the technical reasons mentioned in the section on production.

83. Palm kernel importers are predominantly West European.

Cottonseed

84. A little over 1 per cent of world cottonseed production enters international trade and even this proportion has tended to decline over the past decade. A considerable number of countries export a quantity of cottonseed, but only two countries exported as much as 30,000 tons in 1975; these were the Ivory Coast and USSR. However, trade in cottonseed has tended to fluctuate geographically. In 1970, for example, Nicaragua exported only 17,000 tons compared to 138,000 tons in 1965 and 47,000 tons in 1974. The overall impression remains one of an export trade which is subject to major annual fluctuations in the amounts supplied by as many as a dozen countries.

85. Japan is the principal importer of cottonseed. The only other importers of any note are Lebanon, which has consistently imported from 10-12 per cent of traded cottonseed and Greece, which likewise has been a consistent importer. Mexico built up its cottonseed imports from 1,000 tons in 1965 to over 35,000 tons in 1974, but imported very little in 1975.

86. The pattern of imports appears rather more stable than that of exports. The overall impression remains one of comparative unpredictability with several countries exhibiting marked fluctuations in their requirements. A situation in which a slowly rising level of production is associated with a decline in cottonseed trade suggests that cottonseed is being processed in greater quantities by the main producers, but, if this is so, the beneficiaries are as likely to be developed as developing countries.

Sunflower seed

87. Only a very small proportion of sunflower seed, usually less than 1 per cent, enters international trade. The developed countries have dominated the world market throughout the period accounting for more than 90 per cent of exports. The most notable feature of the market was the increase in exports from the United States from under 1,000 tons in 1965 to 210,000 tons in 1975. It seems probable that, following its intention of expanding sunflower production, the United States will continue to be a significant sunflower seed exporter. However, it must be remembered that in terms of total oilseed exports, sunflower seed exports of about 350,000 tons in 1975 are a relatively minor contribution to world supplies.

88. Imports of sunflower seed into the major importing countries have fluctuated widely since 1965. From 197,019 tons in 1965, world imports rose to 517,907 tons in 1970 but declined to 321,000 tons in 1975.

89. In 1965, the Federal Republic of Germany was the largest importer with 65,000 tons or 33 per cent of the world total, with Italy and the German Democratic Republic taking second and third places with 32 per cent and 16 per cent, respectively. By 1975, the Federal Republic of Germany had emerged as the largest importer with 126,000 tons or 40 per cent of the world total.

Sesame seed

90. Only a very limited proportion of sesame seed production enters international trade. There has been a general tendency for exports to increase slowly, but one or two years have shown a decline.

91. The developing countries comprise the major exporters of sesame seed, normally accounting for well over 90 per cent of all supplies. Ethiopia and Sudan are the largest exporters with 55 per cent of the present market. Mexico and Thailand, both minor exporters, have increased their share of total world exports from less than 3 per cent of the market in 1965 to over 8 per cent in 1975.

92. In 1975, despite a decline in volume compared with 1970, Japan maintained its role as leading importer but was closely followed by Egypt. Italian imports of sesame seed have declined since 1965 but Italy was nevertheless the third major importer in 1975. Greece, Israel, Lebanon and the USSR all continued to import significant quantities and in 1975 accounted for 17 per cent of all imports. However, 18 per cent of all sesame imports in 1975 were still dispersed amongst a large number of small outlets and it seems the nature of the trade that this pattern will continue.

Safflower seed

93. The United States has been the only consistent major exporter of safflower seed. Mexico has been exporting for a number of years, but recently exports have been banned to increase domestic stocks. India, one of the three largest producers, does not export. For many of the minor exporters, the export of safflower seed is not categorized in their trade statistics, but is included under "other oilseeds".

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94. To summarize, it is evident that trade in oilseeds since 1965 has undergone a number of developments. Of outstanding importance is the growth in exports of soyabeans, which has largely accounted for the overall growth of the oilseed trade. Apart for soyabeans, there seems to be a marked tendency for the trade in oilseeds to either decline or at least to stagnate. Trade in groundnuts, copra, cottonseed, palm kernels and safflower seed has actually fallen whilst trade in sunflower seed and sesame seed, never very substantial, has grown very slowly. Only the trade is rapeseed provides an exception. Compared to the trade in soyabeans, the trade in rapeseed is still very small, but it is nevertheless currently the second most important oilseed traded in seed form.

95. The relatively stagnant nature of the export trade in most of the major oilseeds in recent years contrasts with the generally upward trend in production. However, any comprehensive assessment of the trade in oilseed products should also include developments in vegetable oil trading, which are reviewed in chapter II.

Prices of oilseeds

96. The general level of oilseed prices in any one year is determined by supply and demand. Supply is determined partly by past plantings and price expectation, and partly by the weather. Demand depends on price and such factors are population, income growth etc. In addition, there are speculative influences as well as demand for stock-cover. Thus, after a long period of relative price stability, 1974 was an exceptional year in terms of a decline in oilseed supplies, a rapid increase in demand, and a high degree of speculation. The consequent rise in oilseed prices was followed in 1975 by a price decline which can be seen as a reversal of these factors.

97. The price situation for individual oilseeds is shown in table 4.

98. During the first half of the 1960s, two distinct price ranges for oilseeds were discernible. The upper range consisted of copra, palm kernels and groundnuts with average prices varying from $164-225 per ton in the period 1960-1965. The lower ranges, composed of sunflower seed, rapeseed, cottonseed and soyabean, remained within a comparatively narrow price band of $92-128 per ton over the same period.

99. This situation has experienced considerable changes since that period. Between 1965-1975 copra and palm kernel prices rose comparatively little while those of soyabean, groundnut, cottonseed and rapeseed more than doubled, with sunflower seed prices almost quadrupling. However, during the later part of the period, in 1974 and 1975, the situation with regard to demand and supply was somewhat exceptional and since 1975 the situation has to a certain extent reverted to the earlier period. For the period October 1976 - May 1977, for example, soyabean and rapeseed prices averaged $305-306 per ton, sunflower seed $350 and cottonseed $243, while copra and palm kernel prices averaged $424 and $340 respectively

100. Soysabean, therefore, remains highly competitive together with rapeseed and cottonseed. Groundnut prices have also increased at much the same rate, but since they started from a higher base, the actual price of groundnuts remains high compared with competing raw materials. The present situation, however, suggests that a narrowing of the differential between groundnuts and other oilseeds would benefit the developing countries in any effort to gain a greater share of world markets for oilseed products; specific developing countries are already in a position to take increased advantage of the competitiveness of oil palm.

Table 4. Average annual European wholesale prices for major oilseeds ($US a ton, c.i.f. Europe)

Type of oilseed	1960	1965	1970	1972	1973	1974	1975
Copra f/	207	225	223	141	351	670	256
Groundnut a/	198	206	232	326	543	604	462
Palm kernel g/	164	179	179	124	260	463	204
Rapeseed e/	128	124	148	132	254	374	293
Sunflower d/	104	124	208	164	235	481	473
Cottonseed b/	97	104	105	106	153	230	219
Soyabean c/	92	117	128	140	290	274	222
Sesame h/	...	...	288	323	387	617	647

Source: FAO

a/ Nigerian, shelled.

b/ Sudanese, bulk.

c/ United States No. 2 yellow.

d/ East African, pure.

e/ Canadian, 40% bulk.

f/ Straits.

g/ Nigerian.

h/ Sudanese.

II. WORLD PRODUCTION AND TRADE IN OILSEED PRODUCTS

Production of vegetable oils and fats

101. Precise figures on the quantity of world oilseed production that is converted into vegetable oil in any one year are difficult to obtain. Only a few countries keep records of crushing activities, including the use of seed from stock, and of these most are developed economies. The estimates must, therefore, be regarded as approximations. Estimates made by FAO, the United States Department of Agriculture, and commercial sources are in general agreement that the amount of vegetable oil produced in 1975 from the seeds at present under study was about 28-29 million tons. Taking a figure of 28.5 million tons as reasonable and comparing it with total world production of these oilseeds of 175.9 million tons in 1975, a ratio of oil to seed of 1:6.2 is obtained. After allowing for meal, the remaining difference is taken up by seeds retained for replanting, direct human consumption, stockpiling, wastage and processing losses.

102. The distribution of vegetable oil production between the developed and developing countries is more difficult to obtain. The developed countries produced 67.2 million tons of oilseed in 1975, but this was augmented by net imports to provide a domestic availability of 76.2 million tons. If the ratio of 1:6.2 is applied to this figure, then a total vegetable oil production of 12.3 million tons is implied. This ratio refers to global use of oilseeds, however, and covers a variety of different practices. In the case of the developed countries, a high proportion of oilseed availability is taken up by soyabeans, and, since most of the soyabean harvest in these countries is crushed, the ratio of 1:6.2 will tend to underestimate the quantity of oil produced.

103. Actual crushing statistics are available for most of the developed countries, and in 1975 these indicated an oil production of 13.9 million tons from the oilseeds in question. Since oilseed stocks did not decrease over 1975, this figure must relate to oilseeds which become available in the course of the year. However, since Australasia and certain Eastern European countries are not included, this figure must also be regarded as an underestimate. Accepting that actual crushing statistics provide a more accurate estimate than do other methods, and if some allowance is made for omissions, a final figure of approximately 14.3 million tons for developed countries' vegetable oil production in 1975 is arrived at. It follows that the balance of 14.2 million tons was produced in the developing countries. These figures are summarized in table 5.

Table 5. World oilseed and oil production and availability, 1975 (million tons)

	Oilseeds a/		Oil
	Production	Availability b/	Production
World	175.9	175.9	28.5
Developed countries	67.2	76.2	14.3
Developing countries	109.1	100.3	14.2

Sources: FAO, USDA, Oil World Weekly.

a/ Includes only the ten major oilseeds at present under study.

b/ Availability = Production - Exports + Imports, excluding stocks.

104. The table illustrates the effects of international trade in altering the positions of the developed and developing countries with regard to production and availability of oilseeds. Thus, the developing countries produced 62 per cent more oilseeds than the developed countries in 1975, but only 32 per cent more was available for domestic use. The amount of vegetable oil produced was also slightly higher in the developed countries. However, the slightly higher proportion of oil in the developed countries had to be shared amongst a total population less than half that of the developing ones.

105. Using the same sources, an estimate of world production of vegetable oil by type of oil in 1975 can be made, and this is shown in table 6 together with the situation as it was in 1965. A comparison of these two years shows that the most significant increases have ocurred in the case of soyabean oil, palm oil, and, to a less extent, rapeseed oil, all of which have increased their share of the total. Oils from coconut, cottonseed, palm kernel, and sesame all increased in absolute terms but declined in percentage terms in the face of the substantial increases in soyabean and palm oil. Of the two remaining major oilseeds, groundnut and safflower, groundnut oil declined both absolutely and relatively between 1965 and 1975, and safflower declined in relative terms while remaining constant in absolute terms.

Table 6. Vegetable oils and fats - production 1965 and 1975

	1965		1975	
Type of oil	**Million Tons**	**Percentage of total**	**Million tons**	**Percentage of total**
Soyabean	3.9	20.4	8.5	29.8
Groundnut	3.4	17.8	3.2	11.0
Coconut	2.1	11.0	2.7	9.6
Cottonseed	2.7	14.1	3.2	11.3
Palm	1.3	6.8	2.9	10.3
Palm kernel	0.4	2.1	0.5	1.8
Sunflower	3.1	16.2	4.0	14.2
Rapeseed	1.4	7.3	2.6	8.9
Sesame seed	0.6	3.1	0.7	2.5
Safflower seed	0.2	1.0	0.2	0.7
Total:	19.1	100.0	28.5	100.0

Sources: FAO, USDA.

106. The increasing share of soyabean oil and palm oil in the world total of vegetable oil production is yet another facet of the importance of these two products in the overall picture of the world oilseed economy. This is also reflected in the patterns of trade in vegetable oils, examined below.

Trade in vegetable oils and fats

107. As far as trade in vegetable oils is concerned, the information base is more substantial than for production of oils, and FAO data can be used to describe the situation in some detail. This also provides added insight into production and utilization patterns.

108. As table 7 shows, the volume of vegetable oils traded has expanded steadily, with only minor interruptions, since 1965, at an average annual rate of about 9 per cent, which implies a doubling of supplies in approximately ten years. World trade in vegetable oils is thus of great significance, with as much as one fifth of world vegetable oil production being traded annually.

109. In 1965 it was possible to distinguish six principal traded oils, each of which had at least 10 per cent of the market, but equally none had more than a quarter of the market. Soyabean oil and palm oil had the largest shares, with 22 per cent and 20 per cent, respectively; groundnut, coconut, cottonseed, and sunflower seed oils were all traded in broadly similar amounts. Thus the vegetable oil trade had a comparatively broad product base. In addition, smaller amounts of palm-kernel oil, rapeseed oil and sesame-seed oil were also available.

Table 7. Exports of selected vegetable oils

Type of Oil	1965 Quantity (1000 tons)	1965 Percentage of total	1970 Quantity (1000 tons)	1970 Percentage of total	1975 Quantity (1000 tons)	1975 Percentage of total
Soyabean	691.4	22.5	1125.9	25.6	1364.0	21.1
Palm oil	618.0	20.1	906.2	20.6	2046.0	31.6
Coconut	474.8	15.4	615.6	14.0	1031.0	16.0
Groundnut	415.4	13.5	429.7	9.7	405.0	6.3
Cottonseed	352.8	11.5	245.1	5.6	375.0	5.8
Sunflower Seed	315.7	10.3	731.2	16.6	624.0	9.6
Palm Kernel	108.8	3.5	170.1	3.9	259.0	4.0
Rapeseed	94.7	3.1	178.9	4.1	353.0	5.4
Sesame seed	-	-	2.0	-	3.0	-
Safflower seed	-	-	-	-	-	-
Total	3071.6	100.0	4406.7	100.0	6468.0	100.0

Source: FAO.

110. The doubling of efforts since 1965 has been accompanied by a marked concentration of the trade in vegetable oils. In 1965, soyabean and palm oils, two leading products, had an aggregate 42 per cent of the market, but this has now grown to 53 per cent. Faced with a major expansion of supplies in these two oils, producers of the other vegetable oils have had difficulty in retaining their market shares, even though quite often their own supplies have been increased. For example, the amount of cottonseed oil traded has increased in absolute terms, but not enough to prevent a marked decrease in its market share. However, the worst performance has been that of groundnut oil. Even less groundnut oil is traded now than in 1965, which inevitably means a quite signigicant loss of markets.

111. The remaining oils, notably sunflower seed and rapeseed, have both managed to at least maintain their market shares since 1965, but at a rather more modest level of supply than that achieved by the leading oils. Nevertheless, they remain significant factors and help to counter the tendency to greater concentration of the vegetable oils trade.

112. The export of palm and coconut oil obviously benefits the developing economies, but it is evident from the data that the overwhelming share of the benefit goes to two principal producers, Malaysia and the Philippines. On the other hand, a number of developing economies, in particular Iran and Iraq, are becoming increasingly dependent upon imported oils. Again, therefore, whilst

the developing countries as a group have managed to improve their share of the world's trade in vegetable oils over the past decade, a closer look reveals a very marked geographical concentration of the benefits derived therefrom, and in certain countries a worsening of the balance of trade in vegetable oils. The very broad spectrum of individual country situations within the group of developing economies makes it very difficult to generalize and therefore unwise to draw conclusions that are not truly representative of the majority of developing economies.

Soyabean oil

113. Exports of soyabean oil increased from 0.7 million tons in 1965 to 1.3 million tons in 1975. To a major extent the level of exports is dictated by the United States as the world's major producer. In 1965 the United States exported 7[illegible] per cent of world supplies, but by 1975 this figure had fallen to 26 per cent. However, other notable soyabean oil exporters are not, for the most part, soyabean producers. The tendency has been for other developed countries, especially West European countries, to import Brazilian and United States soyabeans, process them and export the oil surplus to their own needs. In particular, the Federal Republic of Germany and the Netherlands have built up a considerable trade in this manner and in 1975 accounted for 33 per cent of soyabean exports.

114. Significant absentees from the list of soyabean oil exporters are the developing countries growing soyabeans, notably Brazil, Indonesia and Mexico. Most, if not all, of their trade is still in the form of soyabeans and clearly represents a potential source of raw material for further processing.

115. Soyabean oil is imported and utilized by more countries than any other vegetable oil. No country dominates the import trade; on the contrary a large number of countries import relatively small amounts. The distribution of countries importing soyabean oil range through Latin America to Africa, Western Europe and Asia.

Groundnut oil

116. In line with the setbacks in groundnut production in recent years, trade in groundnut oil has also suffered reversals. Somewhat less groundnut oil, 405,000 tons, was exported in 1975 than in 1965 when 415,000 tons were exported. Bearing in mind the overall expansion of the oilseed economy and trade in oilseed products, this represents a significant decline by groundnuts relative to other oilseeds.

117. In 1976 exports of groundnut oil were dominated by West Africa; Senegal, Nigeria, and the Gambia having 34 per cent 22 per cent and 4 per cent of the market respectively. Apart from these countries only Argentina, with 19 per cent of the market, and the United States, with 7 per cent were significant exporters.

118. Much the same picture was true in 1970, except that Argentinian trade suffered a setback and Brazil became an important exporter. Since 1970, the significant change has been the decline of Nigeria, whose groundnut oil exports are now negligible. The other West African countries, the Gambia and Senegal were much more successful in sustaining their exports despite production problems. Exports from the Gambia have remained at much the same level as in 1965, but Senegalese exports in 1975 were over 200,000 tons, representing over half of total groundnut oil supplies.

Coconut oil

119. The expansion in coconut oil exports over the past ten years has been significant but modest in comparison with some other oils, increasing from 475,000 tons in 1965 to 1,031,000 tons in 1975. However, there was a substantial increase in exports of almost 400,000 tons in 1975 which may well be repeated in the next few years wit the maturing of extensive plantings in the Philippines and elsewhere.

120. In 1965 the Philippines exported 241,000 tons or 51 per cent of total supplies, but by 1975 this had grown to 614,000 tons or 60 per cent of supplies. It is also significant that a major proportion of the increased production of coconuts in the Philippines has been in the form of oil rather than copra. Minor exporters who have maintained small shares of the market include Fiji, Mozambique and Papua New Guinea; in aggregate they retain about 5 per cent of the market, but their trade in copra suggests the possibility of an expansion of processing, though the small amounts involved could be a limiting factor.

121. One further feature of coconut oil trade over the past decade has been the decline of Sri Lanka whose declining production was referred to earlier. In 1965 Sri Lanka held 18 per cent of the market with exports of 88,000 tons, by 1975 the amount involved had fallen to 50,000 tons and the market share to 5 per cent. Without a substantial improvement at the production level a reversal of this trend seems unlikely.

122. Over 40 per cent of coconut supplies oil go to the United States mainly from the Philippines. The United States share of world imports has remained much the same since 1965, but in that time the amount involved has increased from 175,000 tons to over 400,000 tons.

Cottonseed oil

123. Trade in cottonseed oil over the past decade has shown comparatively litlte change in terms of the amounts involved, but the pattern of trade has undergone a number of changes.

124. The United States remains the dominant influence, having retained in the range of 60 to 80 per cent of the export market over the past ten years. If anything the United States is tending to consolidate its position as the principal source of cottonseed oil exports. All other producers appear relatively insignificant by comparison. The second major exporter, the USSR, exports only about one tenth as much as the United States. Other very minor exporters are Argentina, Guatemala, Israel, Nicaragua and the Sudan. Over the decade quite substantial changes have taken place in the destination of cottonseed oil exports. Egypt has emerged as the major importer. Egypt took over 60 per cent of traded supplies in 1975, compared with less than 10 per cent in 1965; a quite important increase.

125. Of the other importers, Europe takes about 13 per cent of world supplies. The only other major importers are Japan and Venezuala. The past few years have seen a reorientation of cottonseed oil trade away form the historical United States-Europe route.

Palm oil

126. World exports of palm oil have expanded rapidly since 1965, having more than trebled to reach 2.0 million tons in 1975. Almost the entire increase has come from the Far East, notably Malaysia, but also Indonesia. The region increased its share of world exports from 51 per cent in 1965 to 76 per cent in 1975.

The only other region producing and exporting significant quantities of palm oil is Africa, whose exports have fluctuated considerably, and which has experienced a reduction in its share of total world trade. In 1975 African exports of palm oil were only about 230,000 tons. It should be noted, however, that palm oil is also re-exported from the developed countries, especially the Netherlands.

127. By far the major exporter is Malaysia with exports of over 1 million tons in 1975. This figure compares with 143,000 tons in 1965 and follows a period of almost continuous growth which is expected to continue for some years. The other major exporter is Indonesia, which exported 336,000 tons in 1975. This is a less spectacular rate of increase than Malaysia, but is expected to increase further. It should be noted that a proportion of the Far East trade passes through Singapore, which recorded exports of palm oil of 140,000 tons in 1975, mostly of Malaysian origin.

128. In the rest of the world, only two countries are exporters of significant amounts, namely the Ivory Coast and Zaire. The former has experienced an increase since 1968, and in 1975 exported 114,000 tons, whereas Zaire exports have tended to decline from a 1968 peak. Other African exporters are Angola, Benin, and Cameroon, all of which export under 20,000 tons annually. One very notable change is evident in the case of Nigeria, which in 1965 was the leading palm oil exporter with 152,414 tons: by 1975 this figure had fallen to 31,000 tons. The reason for this is not only a fall in production, since Nigeria is still Africa's largest producer at 450,000 tons, but also increased domestic consumption.

129. Regionally, Western Europe is the largest importing area, though as a proportion of world imports its share has fallen from 65 per cent in 1965 to 38 per cent in 1975. Within Europe, the Federal Republic of Germany, the Netherlands and the United Kingdom have the largest market share. The pattern of usage differs, however, since the Netherlands re-exports a large part of its imports, in contrast to the Federal Republic of Germany and the United Kingdom, which utilize practically all imports in domestic manufacturing. The Netherlands is the largest single supplier of palm oil to Belgium. Of interest is the wide diversity of main sources of supply for the different countries. Thus, although Malaysia is the world's largest exporter, it is the major source of supply for only three of the EEC countries, namely Denmark, the Netherlands and the United Kingdom. For the Federal Republic of Germany, the main supplier is Indonesia, for Italy it is Zaire, and for France it is the Ivory Coast.

130. In North America, the main importer is the United States, with 442,000 tons in 1975. Although this makes the United States the world's largest importer of palm oil, the amount is insignificant in relation to the total United States market for edible fats and oils, amounting to only 3 per cent of this market. Nevertheless, more palm oil is imported into the United States than any other oil.

131. In the rest of the world, Iraq with about 120,000 tons, Japan with around 100,000 tons and India with 53,000 tons are remaining major importers. Iraq is almost entirely dependent on imports for its vegetable oil requirements and mostly imports palm oil, for use as ghee. Palm oil constitutes some 30 per cent of India's current imports of edible oils and fats.

Sunflower seed oil

132. Sunflower seed oil exports have virtually doubled over the past decade, but most of this expansion took place during the first five years, 1965-1970. Since 1970, exports have tended to fluctuate annually.

133. Throughout the decade the USSR has been the dominant exporter with as much as 70 per cent of the market, but currently its share is about 62 per cent. Other Eastern European countries, specifically Bulgaria, Hungary, and Romania, account for a further 25 per cent of the market, but Romania is by far the leading exporter from that region. Apart from the countries mentioned above, only Belgium, the Federal Republic of Germany and the Netherlands contribute significantly to sunflower seed oil trade at present. Argentina, a major exporter in 1965, traded very little sunflower seed oil in 1975. The marginal interest of developing countries in sunflower production and trade seems likely to preclude any major change in this broad picture in the near future. Total dominance of the market for sunflower seed oil by the USSR and Eastern Europe seems likely to continue.

134. Trade in sunflower seed oil is characterized by a large number of importers who, individually, handle comparatively small quantities. Almost a quarter of all imports go to countries which in themselves handle no more than 4 per cent of total imports, and often much less. Broadly, however, trade in sunflower seed oil is dominated by Europe. Within Europe, the Federal Republic of Germany and France are the leading importers, with 15 and 13 per cent respectively of total imports in 1975. Outside Europe, only Algeria, Cuba and Iran are major importers, accounting collectively for about 20 per cent of total imports in 1975.

135. It seems very unlikely that the European dominance of the sunflower seed oil trade will change in the near future, but the emergence of new producers, especially the United States, could bring a measure of diversification.

Palm kernel oil

136. World exports of palm kernel oil have increased quite substantially from 108,000 tons in 1965 to 170,000 tons in 1970, and 259,000 tons in 1975. This represents an increase of over 56 per cent between 1965 and 1970 and of 52 per cent between 1970 and 1975.

137. In 1965 the largest exporter was Zaire, with 33,000 tons or 30 per cent of the world market, with the Netherlands, Benin and Brazil taking second, third and fourth places with 17.1, and 15.6 and 11 per cent of the market respectively. The Federal Republic of Germany, Paraguay, and the United Kingdom accounted for most of the remainder. It is readily apparent that in the case of the West European countries, palm kernel oil was being re-exported.

138. By 1970 both the Netherlands and Zaire had increased their exports and maintained their positions among the world's leading exporters with a collective 48 per cent of the market. However, Nigerian exports had increased to claim almost 20 per cent of the world market. Benin, despite an increase in its exports, was forced into fourth position with 10.9 per cent of the world total. Brazil and Paraguay also marginally increased their exports, and Malaysia emerged for the first time as an exporter.

139. By 1975 Malaysia had become the world's largest exporter, selling over 100,000 tons or 42 per cent of the total exports. The traditional exporters, namely the Netherlands, Nigeria and Zaire, accounted for almost another 30 per cent. Exports from Benin have been stable around 17,000 tons, but those of Brazil have declined to insignificant levels.

140. In 1965 the United States was the largest importer of palm kernel oil with nearly 38,000 tons or 40 per cent of the world total. The Federal Republic of Germany, Italy, and France took a further 15, 10, and 6 per cent respectively. Significant quantities were also imported by Argentina, Belgium, Canada, the Netherlands, South Africa and the United Kingdom.

Rapeseed oil

141. For the past decade France has been the world's leading exporter of rapeseed oil, and at the present time accounts for one third of the market. Throughout the period 1965-1975, the Federal Republic of Germany has been France's main

rival. In spite of the fact that rapeseed oil exports over the decade have increased from 94,000 tons to 350,000 tons in 1975, the two countries have managed to retain over half of the market. However, the emergence of Canada and the Netherlands over the past few years as significant exporters could affect the dominant position of these two principal exporters in the near future. Sweden also continues to expand its exports, but has not been able to keep up with the rapid overall expansion of the market and has not retained its 1965 market share. The only other major exporter is Poland, whose record exports have been variable; the underlying trend has been for Polish exports to increase, and in 1975 it accounted for 14 per cent of the market. The leading rapeseed producers amongst the developing countries, namely Bangladesh and India, have little if any trade in rapeseed products.

142. Rapeseed oil exports are dispersed amongst a large number of importers. Over 30 per cent of the market is shared by countries who individually account for no more than 3 per cent of total imports.

143. The general tendency appears to be for a number of importers not historically associated with the rapeseed oil trade to consolidate their positions. Chile, Hong Kong, India, Italy and Morocco are among present importers who, while still importing on a comparatively modest scale, showed in 1965 only a marginal, if any, interest in rapeseed oil.

Sesame seed and safflower seed oils

144. There are no recorded statistics of the trade in those two oils. Sesame seed oil is used overwhelmingly in the producing countries, largely at the rural level. To a degree the same comment applies to safflower seed oil, but in addition it also has industrial uses which are mainly confined to the United States. In the case of both oils, the amounts involved are very small.

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145. To summarize, it is evident that there has been a tendency, which still exists, for a higher proportion of the vegetable oil trade to be dominated by a small number of oils as the total amount traded has expanded. With the exception of palm oil, most of the expansion has been in those oilseeds which are not widely grown in developing countries, for example, sunflower, rapeseed and soyabean. Even in the case of palm oil, the degree of expansion has been largely due to one country. It is to be hoped that trade in coconut oil will continue to grow and that groundnut oil will recover some of its lost ground. In addition, there are signs that some of the traditionally temperate oilseeds are becoming more widely established and diversifying their overseas markets.

146. The net effect of trade in vegetable oils is also to reduce the amount that is available for use in developing countries. In 1975 net exports from the developing to the developed countries were about 1.5 million tons, thus augmenting the developed countries' estimated production of 14.3 million tons, as shown in table 5, to 15.8 million tons and reducing the production of 14.2 million tons in the developing countries to a domestic availability of 12.7 million tons. These figures imply that per capita consumption of the oils under review was therefore over three times greater in the developed than in the developing countries.

The production of oilmeals

147. The other principal oilseed product besides the oils and fats is the oilmeal obtained as the residue of oil extraction. The product remaining after oil extraction is called vegetable cake or vegetable meal, depending on the manufacturing process used. Throughout this section, the term "meal" is applied to all products.

Table 8. Oilcakes and meals: production
(Thousand metric tons protein equivalent)

	1964-1966 Average				1969-1971 Average				1973-1975 Average			
	World	Developed	Developing	Centrally planned economy	World	Developed	Developing	Centrally planned economy	World	Developed	Developing	Centrally planned economy
Vegetable oilcakes	17 460	8 670	4 430	4 360	28 130	18 040	5 330	4 760	27 130	14 340	7 560	5 230
Soyabean	8 930	6 900	130	1 900	12 910	10 310	620	1 980	17 270	12 380	2 800	2 090
Cottonseed	3 070	1 080	1 190	800	3 090	770	1 390	930	3 660	900	1 590	1 170
Groundnut	2 100	90	1 800	210	2 170	130	1 810	230	1 990	140	1 600	250
Sunflower seed	1 190	70	160	960	1 470	110	230	1 130	1 630	230	260	1 140
Rapeseed	820	200	290	330	1 070	380	380	310	1 340	490	430	420
Linseed	660	290	270	100	690	320	250	180	470	170	900	100
Copra	260	-	260	-	270	-	270	-	280	-	280	-
Others	430	40	330	60	460	20	380	60	490	30	400	60
Percentage	100.0	49.6	25.4	25.0	100.0	64.0	19.0	17.0	100.0	53.0	28.0	19.0

Source: FAO statistics.

148. As was the case with the production of vegetable oils, data on the production of oilmeals is difficult to obtain for all but the main developed countries and it is consequently difficult to provide a comprehensive review of oilmeal production. However, table 8 shows the aggregate situation by major oilseed for the developed and developing countries between 1964-1966 and 1973-1975, from which it is seen that soyameal has increased its share from 51.1 per cent in the period 1964-1966 to 63.7 per cent in the period 1973-1975. The main reasons for this overwhelming dominance of soyameal are as follows.

149. Effective demand for vegetable protein, in the form of oilmeals, has grown at a faster rate than the demand for fats and oils. Consequently, the oilmeal sector of the market has tended to lead the global oilseed economy, and this has led to the changed pattern of production for oilseeds themselves as noted in chapter I, and accounts for a growing market preference for oilseeds with a high meal and low oil content. Soyabean is the oilseed which has benefitted most from this trend, since it yields 78-80 per cent meal and 18 per cent oil, in contrast to a product such as copra which yields only 35 per cent meal and 64 per cent oil. Yield differences of this magnitude are reflected in the relative values of the different oilseed products, as is illustrated in table 9. As a result of the trend in favour of soyabean, the developed countries, especially the United States, have experienced their share of production and trade in oilmeals.

Table 9. Estimated theoretical value of oil and meal component of oilseeds

Parent material	1969/73 average			1974			1975		
	Cake/ meal	Oil	Total	Cake/ meal	Oil	Total	Cake/ meal	Oil	Total
Soybean USA c.i.f. Rotterdam	97	22	119	219	50	269	174	40	214
Groundnuts Nigeria shelled c.i.f. United Kingdom	133	104	237	-	000	-	-	000	-
Rapeseed Canada 40% bulk c.i.f. N W Europe	75	51	126	215	147	362	167	114	281
Copra Philippine/ Indonesia c.i.f. N W Europe	66	121	187	235	429	664	90	164	254
Palm kernel Nigeria N W Europe	75	67	143	245	222	467	108	127	235
Linseed Canada No. 1 c.i.f. N W Europe	83	45	128	311	170	481	216	118	334

Source: Based on oilseed prices quoted in *Oil World Weekly*, Hamburg.

150. In addition to its high meal to oil ratio, the overwhelming dominance of soymeal in the world production of oilmeal is also due to the fact that, together with fishmeal, which in recent years has experienced uncertain supplies, soy meal is rich in lysine and so is virtually essential to feeds of monogastric animals, particularly in feed-deficient countries such as Japan and in Western Europe. Moreover, the structure of the oilseed processing industry in the above areas is geared to soybean extraction; soybeans are available in large quantities, permitting bulk handling and processing. There are several plants in Western Europe that have an annual capacity of 1 million tons of soybeans. Again, as far as United States soybeans are concerned, they are easily traded on the Chicago Board of Trade. This is an element of stability not found in oilseeds imported from developing countries.

151. In contrast to the rapid expansion, amounting to a virtual doubling of production of soyameal between 1964-1975, world production of other oilmeals increased only slowly or not at all. Cotton seed, sunflower seed, and rapeseed meals increased to a greater degree than copra meal, while groundnut meal production actually declined. With regard to cottonseed meal, the increase was due entirely to production in the developing countries since developed country production of cotton seed meal declined over the period. On the other hand, while rapeseed meal production increased in both developed and developing countries, the rate of increase was much higher in the developed countries.

152. Taking all oilmeals together, table 9 shows that in spite of the United States dominance in soyabean production, the developing countries as a whole increased their oilmeal production at a faster rate than did the developed countries, though not by a greater absolute amount. Both groups of countries increased their share of world oilmeal production between 1964-1975, in the case of the developed countries from 49.6 per cent to 53.0 per cent, and in the case of the developing from 25.4 per cent to 28.0 per cent. In each instance, this was at the expense of the centrally planned economies which experienced a decline in their share of world production. The implications of these changes for international trade in oilmeals are described in the next section.

<u>Trade in oilmeal</u>

153. Data on trade in oilmeals is, as with vegetable oils, more accessible than for production and is again consequently covered in somewhat greater detail. Table 10 summarizes world exports of the major vegetable oilmeals. In 1965 the summary shows exports of 6.6 million tons, of which soyabean, groundnut and cottonseed meal accounted for 5.5 million tons, or 83 per cent of the total. By 1975 exports of oilmeal were 12.7 million tons or almost double the 1965 level. The three major oilmeals, soyabeans, groundnut and cottonseed, have consistently accounted for about 83 per cent of total supplies. However, this does not reflect an even performance by the three oilmeals. Soyabean has increased its market share strongly over the decade and now accounts for almost 70 per cent of supplies. In contrast, trade in groundnut and cottonseed meals underwent an absolute decline and consequently their combined market share has halved between 1965 and 1975.

154. The consolidation of soyabean's position as the premier vegetable oilmeal has been largely at the cost of groundnut and cottonseed meal. Exports of other oilmeal have on balance performed reasonably well. Although the volume of minor oilmeals traded is much smaller, none reaching 1 million tons in the period, some of them have steadily improved their volume of exports between 1965 and 1975. Copra meal and palm kernel meal were notable in this regard. Exports

Table 10. Exports of selected vegetable oilmeals

Type of oilseed	1965		1970		1975	
	Quantity ('000 tons)	Percentage of total	Quantity ('000 tons)	Percentage of total	Quantity ('000 tons)	Percentage of total
Soyabean	2 801.4	42.4	5 370.9	55.1	8 745.0	68.8
Groundnut	1 497.6	22.7	1 492.3	15.3	1 158.0	9.1
Cottonseed	1 167.6	17.7	1 275.2	13.1	1 115.0	8.8
Coconut	465.2	7.0	569.7	5.8	697.0	5.5
Sunflower seed	353.0	5.3	558.9	5.7	358.0	2.8
Rapeseed	174.6	2.6	230.4	2.4	272.0	2.1
Palm kernel	149.6	2.3	245.0	2.5	374.0	2.9
Sesame seed	...	...	...	...	...	...
Safflower seed	...	...	...	...	...	...
Total	6 609.0	100.0	9 742.4	100.0	12 719.0	100.0

Source: FAO.

of copra meal increased by 50 per cent and those of palm kernel meal by 150 per cent. Exports of sunflower and rapeseed meal fluctuated quite widely in the period, and, although the volume of trade in the latter progressed rapidly to 1974, increasing by 124 per cent to 392,000 tons, exports in 1975 decreased by 120,000 tons. Despite an overall impovement in exports of the minor oil-meals, in terms of the market shares, only one - palm kernel meal - improved its position to account for 2.9 per cent of the market in 1975. However, this was not sufficient to retard the overall decline in the minor oilmeal share of world exports, which fell from 17 per cent to 13 per cent between 1965 and 1975. The oilmeal trade, therefore, seems to be increasingly reliant on soyabean, leaving other oilmeals, often those produced in developing countries, faced with declining markets.

Soyabean meal

155. World exports of soyabean meal increased from 2.8 million tons in 1965 to 8.7 million tons in 1975. Two countries dominate world exports, Brazil and the United States. The United States is regarded as the established premier producer/exporter of soyabean meal and its volume of exports increased from 2 million tons in 1965 to 3.8 million tons in 1975. This represents a 90 per cent increase in trade, but when compared with Brazil's performance this appears a modest achievement. Brazil's exports were a mere 105,000 tons in 1965, but by 1975 they had risen 3.1 million tons, a staggering rate of increase. The United States and Brazil in 1975 therefore accounted for 43 per cent and 36 per cent of world exports respectively. The United States share of the market had been 70 per cent in 1965, and the figures show that Brazil has been the major competitive force contributing to the erosion of the United States market position. Other exporting countries are mainly European and their trade reflects meal crushed from imported beans or transhipments of imported meal. This is particularly the case in the EEC market. The main reasons for the expansion in soyabean meal exports have been its versatility and availability as a protein feed. It is not only versatile in that it can be fed to different classes of livestock; it is also widely used for poultry feeding, and it is the broiler and egg industries which have exhibited the most rapid growth in the developed countries which provide the major market for soyabean meal.

156. The most important market for soyabean meal is the EEC. In 1965 EEC countries imported 1.3 million tons and accounted for 55 per cent of world imports of the meal. By 1975, two major markets, Denmark and the United Kingdom, had joined the EEC and imports reached 4.6 million tons, but still only represented 55 per cent of world imports, illustrating a notable shift in the direction of trade away from the EEC, as this 55 per cent includes additional EEC members to those of 1965. The markets which have gained in relative importance are those of the Eastern European countries in particular Czechoslovakia, Hungary and Poland. The volume of imports into these countries increased substantially between 1965 and 1975, impmoving their market share from 2 per cent to about 15 per cent. The proliferation of minor markets is a further indicator of the competitiveness of soyabean meal, and by 1975 these markets accounted for almost one-third of world imports.

Groundnut meal

157. World exports of groundnut meal faced a steady decline between 1965 and 1975, their volume falling from 1.5 million tons to 1.1 million tons. Groundnut meal is almost exclusively a product of the developing countries, amongst

which India and Senegal maintained their dominant positions between 1965 and 1975. In 1975 these countries accounted for 7? per cent of world supplies. In some cases the oilmeal trade has tended to become geographically diversified, but exports of groundnut meal have tended to become more concentrated. Supplies decreased significantly form Argentina, Brazil, Burma and Nigeria in particular. In the cases of Argentina and Brazil this was due to decreased acreages of groundnuts in favour of sunflower and soyabean. At the same time some of the smaller suppliers have expanded their exports.

158. The EEC dominates the market for imports of groundnut meal, although within its membership individual requirements have followed differing trends. The EEC (original members) accounted for 356,000 tons of world imports in 1965, rising to 588,000 tons, with its expanded membership, by 1975; the respective market shares being 27 and 50 percent. Individually France has sustained the greatest growth in imports, whilst the other members' imports have shown greater fluctuations. In 1965, whilst outside the EEC, the United Kingdom imported about 500,000 tons of groundnut meal; by 1975, as an EEC member, these imports had fallen by over a half, reflecting possibly the changing trade pattern that emerged from EEC membership. Requirements of their markets have also fluctuated.

Cottonseed meal

159. Cottonseed meal is supplied to world markets by more developing countries than any of the other oilmeals surveyed. By 1975 developing countries accounted for 66 per cent of world exports. Although this was an improvement on their market share since 1965, they traded in a decling market. In 1965 India, Sudan, Syria, and Turkey all exported over 100,000 tons of meals. In 1975 only India and Turkey, which were both trading at much higher levels (192,000 and 219,000 tons respectively), exported over 100,000 tons. Sudanese exports were very low in 1974 owing to an exceptionally bad harvest but approached 100,000 tons again in 1975. Syria's exports were less than 10,000 tons in 1975 and from holding 11 per cent of the market in 1965 her share declined to less than 1 per cent. The smaller suppliers, for example Colombia, Uganda and Tanzania, have also seen their market shares eroded to the advantage of India and Turkey.

160. Imports of cottonseed meal are primarily a Western European preserve. With imports of 499,000 tons, Denmark accounted for the largest proportion of world imports in 1975 and maintained its place as the premier importer. With the exception of the Federal Republic of Germany, all other importers each accounted for less than 10 per cent of the market in 1975. In particular the United Kingdom has experienced a consistent fall in imports, and this market has contracted by over 200,000 tons in 10 years.

Copra meal

161. Copra meal is almost exclusively a product exported by developing countries. World exports are very low when compared with the leading vegetable oilmeals, but their volume increased between 1965 and 1975 from 465,000 tons to 697,000 tons. The two leading exporters, Indonesia and the Philippines, strenghened their market position during the period and in 1975 accounted for 86 per cent of world exports. The other suppliers account individually for only small quantities of exports, under 10,000 tons in most cases, and none showed sustained growth over the period. The Netherlands is the only non-producing country supplying copra meal to world markets, but its imports have declined considerably with the decline in the crushing of imported oilseeds.

162. Copra meal is particularly suitable for feeding to cattle, particularly dairy cattle, and the two markets which account for the bulk of demand, the Federal Republic of Germany and the Netherlands, have large dairy sectors. In these markets there has also been some substitution of high priced cereals (the traditional energy source in feeds) by low-protein oilmeals, such as copra, which provide relatively high amounts of energy.

163. Imports by the Federal Republic of Germany peaked in 1974 at 339,000 tons but the Netherlands market generated a rapid upturn in demand and imports rose from 23,000 tons in 1965 to 181,000 tons in 1975. Copra meal is also marketed to small extent within South-East Asia, probably resulting from the proximity of Indonesia and the Philippines as suppliers. In 1965, Malaysia and Singapore accounted for 4 per cent of imports. However, by 1975, despite the addition of two other countries, this portion of the market represented only 3.2 per cent of world imports.

Sunflower seed meal

164. Sunflower seed meal is a valuable feed for livestock but its use in poultry and swine feeds is limited because of its low lysine content and its high fibre content. Exports of the meal were over 550,000 tons in 1970 but by 1975 had fallen back to 353,000 tons, which was not much higher than the 1965 figure. Decreased exports from Argentina were the main reason for this decline. Following a reduced acreage of sunflower in Argentina, export availability of the by-products has been adversely affected. Turkish exports peaked in 1974 at 93,000 tons, when they accounted for 23 per cent of the total entering world trade, but by 1975 exports had contracted sharply to only 26,000 tons.

165. Some sunflower is grown in the EEC and the Community's meal exports accounted for 7 per cent of the world total in 1975. The USSR is also an important producer of sunflower but her exports of oilmeal fluctuate considerably and in the 1970s have tended to decline, presumably in response to smaller sunflower seed crops, which recovered only in 1973, and larger domestic meal requirements.

166. The market for sunflower seed meal is again largely confined to the EEC, in particular those members whose climates prevent widespread cultivation of the crop. The Federal Republic of Germany has remained a primary importer in the EEC and indeed world-wide; imports were 157,000 tons in 1975, representing 44 per cent of world imports.

167. Eastern Europe forms the second major grouping of importers. Their share of world imports was 8 per cent in 1965 and 22 per cent in 1975.

Rapeseed meal

168. World exports of rapeseed meal expanded from 175,000 tons in 1965 to 392,000 tons in 1974, but the 1974 level of exports was not maintained in 1975 and fell to 272,000 tons. It is notable that the two leading producers of rapeseed, Canada and India, are not significant exporters of the meal. This is thought to be due to a lack of appropriate processing and storage facilities in the countries and also to the import tariff which the EEC, itself a major producer of rapeseed, imposed on non-Community exports of the by-products. The EEC's exports of rapeseed meal account for the greater part of world exports, 64 per cent in 1975, but some developing countries also export quantities of the meal.

169. Pakistan and the three African exporters, Algeria, Ethiopia and Morocco, accounted for 28 per cent of world exports of meal in 1975. Pakistan's market share represented an improvement in its position but for the other suppliers it was less than the share held in some of the previous years.

170. As a trade grouping, the EEC is one of the world's leading rapeseed producers and traders. However, trade in the EEC is often between members. In 1965 the EEC accounted for 58 per cent of world imports of 173,000 tons. By 1975, the United Kingdom and Denmark had joined the Community and the EEC's imports accounted for 88 per cent of world imports of 314,000 tons. The impact of EEC membership has been greatest in Denmark, where imports of rapeseed meal have increased from 10,000 tons in 1965 to 44,000 tons in 1975. The United Kingdom's imports have followed an opposite trend and decreased with membership of the EEC, but domestic production of rapeseed is known to have expanded considerably. Japan is the only non-European importer of rapeseed meal of any importance, but imports are sporadic. Rapeseed meal in Japan is generally derived from crushed imported rapeseed.

Palm kernel palm

171. The expansion of oil palm production in South-East Asia has led to the increased availability of palm kernel meal, although because of breeding programmes which have lowered the palm kernel content of the seed, availability of palm kernel products has had a lower rate of increase. World exports of palm kernel meal were 150,000 tons in 1965 and 374,000 tons in 1975.

172. Malaysia was not a supplier of meal in 1965 but by 1975 was the leading exporter, accounting for 39 per cent of the market. Several other suppliers have entered world trade since 1965, namely Brazil, China and Zaire, and in 1975, together with Malaysia, their exports of 240,000 tons accounted for 64 per cent of world supplies.

173. The traditional suppliers of palm kernel meal in west Africa have not matched the performance of the new suppliers but the volume of their exports has improved overall. The Netherlands, where meal is obtained from crushing imported kernels, supplied 12 per cent of exports in 1975 compared with 44 per cent in 1965.

174. The EEC is the major outlet for palm kernel meal exports, accounting for about 99 per cent of world imports. The Federal Republic of Germany is the market of greatest single importance. Imports rose from 218,000 tons in 1965 to 299,000 tons in 1975. The reasons for the success of palm kernel meal in the Federal Republic of Germany are similar to those applying to copra meal.

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175. To summarize, since soyabean meal now accounts for almost 70 per cent of total oilmeal exports, the role of any other oilseed must remain a comparatively minor one. Furthermore, since between them Brazil and the United States account for almost 80 per cent of soyabean meal exports, it is readily apparent that the international trade in oilmeal, in volume terms, is highly concentrated. Outside the trade in soyabean meal only groundnut meal exports from India exceed half a million tons from a single source. However, in spite of this high degree of concentration, the developing countries, in the form of Brazil, can claim a major share of the market.

Prices of oilseed products

176. The prices of oils and fats are very sensitive to a number of factors, the major ones being climatic changes and weather conditions, supply and demand patterns, inflation, standard of living, crop yields, economic and political situation in producing and consuming countries, wage and income levels, and speculative tendencies.

177. In general, these are factors which also determine the prices of oilseeds. The trend in relative oilseed prices, noted in chapter I, is mirrored in the price relationships of the oils themselves. This is evident from table 11 where, if soyabean oil and palm kernel oil prices are taken as an example, the price of soyabean oil was, with one exception, less than the price of palm kernel oil throughout the 1960s. In much of the period 1972-1976, the situation has been the reverse. By October 1976-May 1977, however, soyabean oil prices, at an average of $582, were again less than those of palm kernel oil which averaged $626. This pattern is virtually identical to that observed for the basic raw materials in chapter I.

Table 11. Prices of selected fats and oils a/ c.i.f. Europe, 1960-1976
($US per ton)

Year	Soybean	Sunflower	Cotton-seed	Groundnut	Rape-seed	Olive	Palm	Coconut	Palm Kernel
1960	225	243	235	326	219	585	228	312	317
1961	287	311	305	331	280	561	232	254	263
1962	227	246	266	275	221	631	216	251	255
1963	223	236	243	263	215	871	222	286	287
1964	205	255	250	315	252	586	240	297	299
1965	270	294	278	324	263	663	273	348	353
1966	261	263	333	296	244	661	236	324	271
1967	216	212	378	283	206	690	224	328	249
1968	178	172	305	271	161	681	169	399	367
1969	228	213	291	332	200	666	181	361	306
1970	307	331	354	379	293	699	260	397	429
1971	323	375	392	441	295	727	261	371	335
1972	270	326	324	426	232	916	217	234	244
1973	465	480	500	546	395	1,399	378	513	491
1974	795	983	939	1,077	745	2,174	669	998	1,010
1975	619	739	726	857	551	2,436	433	393	439
1976	376	600	645	675	390	2,350	370	340	360

a/ Descriptions:

Soybean oil: Crude, United States, c.i.f. Rotterdam.
Sunflower oil: Any origin, ex-tank Rotterdam.
Cottonseed oil: United States, PBSY,, c.i.f. Rotterdam.
Groundnut oil: Nigerian/Gambian/Any origin, c.i.f. Europe.
Rapeseed oil: Dutch, f.o.b. ex-mill.
Olive oil: Spanish, edible, 1% drums.
Palm oil: Malaysian, 5%, c.i.f. United Kingdom.

Coconut oil: Philippines/Indonesian, bulk, c.i.f. Rotterdam. For 1973, Dutch, 5%, ex-mill; prior to 1973, White Ceylon, 1%, bulk, ex-tank Rotterdam.
Palm kernel oil: West African, c.i.f. United Kingdom.

178. In a similar way, the long period of relative price stability throughout the 1960s and early 1970s ended in 1974, which, as was pointed out in chapter I, was an exceptional year in terms of a decline in supplies, a rapid increase in demand and a high degree of speculation.

179. The price of a particular oil depends very much on the degree of substitutability between it and other fats and oils. If an oil such as olive has few substitutes, its price may be independent of the price of all other fats and oils. If it has many substitutes, then it is likely to follow the overall price level closely. The increasing degree of substitutability between oils is reflected in a tendency toward unity of their price correlations, particularly in periods of rising prices, and is illustrated in table 10.

180. The price mechanism in the oilmeal trade is a complex one, affected by the fact that vegetable oils have also to be taken into account by the producers of oilmeals. Prices of oilmeals as a whole have not been subject to fluctuation, but strong upward and downward trends may be established in any one season, depending on the level of overall supplies in the markets.

181. On the demand side, short-term demand is relatively price inelastic, as at the beginning of every year there is a given livestock population to rear and feed, and if farmers are faced with high protein prices, their response in reducing livestock populations takes place over a relatively long period.

182. The trend in oilmeal prices is illustrated by table 12. Over the period 1966-1973, prices of oilmeals moved steadily upwards, but in 1972/73 a sudden escalation in price occurred. The factors generally regarded as causing this were on the supply side, namely the small increase in production in the 1972/73 season caused primarily by a shortfall in fishmeal supplies and groundnut meal, but also by a reduction in supplies of sunflowerseed, rapeseed and linseed meals and the very low level of stocks. Coupled with this, demand was particularly strong that year with much higher livestock populations in the major meal-utilizing countries and the entry of the USSR into the market as a major meal importer. After 1972/73 the oilmeal prices were reduced but have stayed at a higher level than that existing up to 1972/73.

183. Table 13 brings together the price indices for fats and oils, and for oilmeals and meals for the period 1960-1976, and deflates them by a common index. From this table it can be seen that although prices for both oils and meals have remained at historically high levels since the peak years of 1974 and 1973, respectively, if they are expressed in terms of real purchasing power (for manufactured goods), they are by 1976 practically at their lowest level since 1960. High levels of international inflation of recent years can thus easily distort the impression given by undeflated prices.

184. The exceptional nature of the years 1973 and 1974 is also demonstrated by this table. Thus, not only were the price fluctuations experienced over these years greater than at any previous period, but so also were the extreme changes in the relative values of oil and meal that occurred. During the period 1960-1971, real prices of oils and meals remained comparatively close to each other, as did actual prices, but in 1972-1973 oil and meal prices diverged widely as a result of higher meal prices, only to be followed in 1974 by an almost equal divergence in the opposite direction as a result of high oil prices and the collapse of meal prices. However, by 1976, although real values for both oil and meal had declined, the relative stability of the earlier years appeared to have been recaptured.

Table 12. Selected oilcake/meal prices
($US per ton)

Type of cake/meal	Average 1966-1968	Average 1969-1972	1973	1974	1975
Soyabean meal, USA, 44% c.i.f. Rotterdam	89	107	302	184	155
Cottonseed expeller, 45/46% c.i.f. Hamburg	-	93	225	179	153
Groundnut meal, 50%, any origin, c.i.f. Hamburg	95	107	266	174	140
Groundnut expeller, Nigeria, 56% c.i.f. United Kingdom	-	121	305	223	136
Sun pellets, 33%, Argentina/Uruguay c.i.f. Rotterdam	73	87	217	150	135
Rape meal, 34%, f.o.b. ex-mill Hamburg	70	73	178	143	128
Coconut pellets, 23/24% Philippines c.i.f. Hamburg	-	83	153	118	145
Fish meal, Peru, 65% c.i.f. Hamburg	-	194	542	372	245

<u>Source</u>: Oil World Semi-Annual.

Table 13. Price indices
(1964-1966 = 100)

	Total Fats and oils		Total Oilcakes and meals		Deflator index[a] (1964-1966=100)
	Current	Deflated	Current	Deflated	
1960	93	99	77	82	94
1961	97	100	85	88	97
1962	86	88	90	92	97
1963	89	91	94	96	98
1964	95	96	94	95	99
1965	107	106	103	103	100
1966	98	96	104	102	102
1967	89	86	94	91	103
1968	87	85	92	90	102
1969	92	87	97	92	106
1970	115	101	108	95	113
1971	117	97	103	86	120
1972	101	76	129	97	132
1973	181	116	279	179	156
1974	324	171	193	102	189
1975	213	98	153	70	218
1976 (prelim.)	188	81	200	86	232

Source: FAO statistics.

a/ Deflator index provided by the World Bank; it is an index of c.i.f. prices of developed countries' manufactured exports to all destinations.

III. UTILIZATION AND DEMAND FOR OILSEEDS AND OILSEED PRODUCTS

184. The pattern of world production and trade in oilseeds and oilseed products, as described in chapters I and II, represents the outcome of a series of decisions taken by producers and consumers of these products. In order to better understand how production and trade patterns are determined, and therefore to facilitate discussion of future trends and possibilities, it is necessary to take a closer look at the basic structures of demand and supply which underlie the data shown in the first two chapters.

185. In chapter III, therefore, the factors which influence the demand for oilseeds and oilseed products are studied, beginning with a review of utilization patterns, and concluding with a short discussion of demand. The following sections therefore deal with the utilization of oilseeds, the utilization of oilseed products, and aspects of demand. Chapter IV deals with various aspects of supply.

Utilization of oilseeds

186. Throughout the world, oilseeds are either utilized whole or are processed in order to derive their principal components. Although the following discussion refers to utilization in both developed and developing countries, it is convenient from the point of view of the latter group of countries to distinguish between subsistence and commercial usage. This division is justified on the grounds that the two sectors are subject both to different constraints and a different emphasis upon similar constraints in terms of providing a framework for the expansion of the oilseed economy in developing countries.

187. Before proceeding in detail, the terms "subsistence" and "commercial" sectors should be defined. Subsistence production in agriculture is usually taken to mean that there is little or no surplus available for the market after the needs of the farmer and his family have been met. Where the products of subsistence agriculture require processing prior to consumption this is typically carried out domestically or by cottage-type industry. In the case of oilseeds, when the product required by the producer is the oil contained in the seed he may make use of the village mill. It is this type of environment which is regarded as subsistence although it cannot be associated with a given technology, oilseed or country. Basically, the definition implies that the value added to the oilseed after harvest is minimal. The commercial sector is largely associated with that proportion of the oilseed crop which is sold off the farm and subsequently processed to produce end products, or raw materials for end products, for sale in the retail sector.

188. In the subsistence sector the greater proportion of the oilseeds produced is therefore retained by the farmer. The crop retained has two principal uses: as the seed for next year's crop and to meet the consumption requirements of the farmer and his family. The former use generally accounts for 5-10 per cent of total crop utilization depending upon the individual crop, the overall yield obtained and the state of economic development. Most smallholders in developing countries retain their seed requirements from the preceding crop, although various schemes to improve seed quality often make it possible for farmers to obtain improved seed on concessionary terms. Farmers in developed countries make wide use of certified seed, which implies buying-in for each new crop seed which is guaranteed disease-free and of known characteristics.

189. The proportion of oilseed production retained by the producer for his own food requirements varies both geographically and according to the particular oilseed concerned. Broadly speaking, most subsistence utilization is found within the developing countries, but even within this group there is wide variation according to the traditional uses of each oilseed. Precise information on the proportion of each oilseed that is utilized commercially in different regions of the developing world is difficult to come by, but a number of estimates have been brought together in table 14, which provides a backcloth to the discussion of individual oilseeds which follows.

Coconuts

190. In a similar manner to groundnuts, coconuts are virtually a staple food in their traditional growing regions. The only coconut producing countries of any significance in world terms are Asian, namely India, Indonesia, the Philippines, and Sri Lanka. India and Sri Lanka have basically domestically-oriented industry although exporting small quantities of coconut products. On average, India and Sri Lanka process only about 40 per cent of their coconut production. In other words, by far the greatest share is utilized at the subsistance level by smallholders and their families.

191. Although Indonesia has an export industry, it still utilizes almost half its coconut production at the subsistence level, but it is estimated that at least 80 per cent of Philippine coconut production has a commercial outlet, being exported as copra, crushed or coconut oil, or used in the desiccated coconut industry. It is estimated that, taking together the main coconut producers, and making an allowance for small producers in Africa and Latin America, about 40 per cent of world coconut production is used at the subsistence level.

Soyabeans

192. World production of soyabeans is dominated by Brazil, China and the United States. Brazil and the United States present a sharp contrast to China in terms of soyabean utilization. In the United States virtually all soyabeans are used in the commercial oil-milling industry. Brazilian production of soyabeans has expanded with the same end in mind. However, soyabeans are a traditional Chinese food and a very high proportion of soyabeans are used domestically, after various forms of preparation, as a staple food. The bean shoots are also a popular item of diet. Similarly soyabeans in Indonesia are used essentially as an ingredient of traditional dishes. Consequently, in Asia generally, it is estimated that as much as 40 per cent of soyabean production remains in the subsistence sector. However, globally the amount which reaches the commercial sector is probably about 80 per cent.

Groundnuts

193. The proportion of groundnut production which does not enter commercial marketing channels is high compared with that of most other oilseeds, since in its principal growing areas the groundnut is in effect a staple food. In many countries a high proportion of the groundnuts consumed at the subsistence level are eaten as nuts and are not crushed. However, the latter form of utilization is common where groundnuts are the predominant source of vegetable oil. As a worldwide average it is estimated that about 40 per cent of groundnuts are not marketed, of which perhaps 8 per cent would be retained for seed and the remainder used as food.

Table 14. Estimates of availability of oilseeds and extent of commercial utilization in developing countries - 1975

Type of oilseed	Total oilseed production in developing countries ('000 tons)	Asia		Africa and Near East		Latin America		All developing countries	
		Domestic availability ('000 tons)	Commercial utilization %	Domestic availability ('000 tons)	Commercial utilization %	Domestic availability ('000 tons)	Commercial utilization %	Domestic availability ('000 tons)	Commercial utilization %
Coconuts	29 630	21 129	59	1 386	75	2 068	...	24 583	60
Soyabeans	25 328	14 089	45	183	...	8 319	80	22 591	58
Groundnuts	16 936	10 886	63	4 523	52	1 053	80	16 462	61
Oil palm	15 141	8 747	90	5 440	60	629	...	14 816	78
Cottonseed	14 107	7 872	56	3 440	80	2 681	61	13 993	63
Rapeseed	3 946	3 912	40	61	...	68	...	4 041	40
Sesame seed	1 984	1 023	32	592	36	230	60	1 845	37
Sunflower seed	1 505	69	71	637	84	801	100	1 507	92
Safflower seed	761	196	31	26	...	533	75	755	63
Total	109 338	67 923	59	16288	62	16382	77	100573	62

Notes: Domestic availability = production - exports + imports, excluding stocks.

Commercial utilization of oilseeds has been calculated from various documentary sources, but because of certain gaps in information the figures shown should be regarded as no more than estimates.

194. Regionally, the proportions retained by the producers vary quite significantly. North America, mainly the United States, has the lowest retention percentage. However, only about 25 per cent of groundnuts are crushed for their oil. Most groundnuts in North America are used in the food industry, for example, to make peanut butter. Latin America, mainly Argentina and Brazil, retains about 20 per cent of groundnut production at the village level. Compared with the other continents, this is a low figure. However, there are marked regional differences in both Africa and Asia. As a whole, Asia is close to the world average, India being the main representative with 36 per cent retained. At the other end of the scale, however, minor groundnut producers, such as Bangladesh and Pakistan, are estimated to retain over 80 per cent of their production on the farm. In the latter two countries groundnuts are neither the principal oilseed nor the main source of vegetable oil. Africa is the major groundnut-producing continent and the continent most dependent upon groundnuts as a staple food. Nevertheless, variations are again apparent in a number of countries, for example in Senegal and Sudan where groundnuts are a major source of foreign exchange, the amount retained is of the order of 25-30 per cent despite the large local consumption. In contrast, the decline of production and trade in groundnuts in Nigeria has considerably raised the proportion retained for local consumption. It is estimated that at present 75 per cent of Nigerian groundnut production is retained by producers. Other small West-African producers show similar figures. On average it is estimated that about 48 per cent of African groundnut production is utilized at the subsistence level.

Cottonseed

195. Broadly speaking, the proportion of cottonseed utilized at subsistence level is much the same as for groundnuts, around 40 per cent of total seed production. However, the reasons are very different. Cottonseed is not a staple food, and cottonseed oil is very unlikely to be used in its crude state at the village level. Consequently, very little cottonseed is crushed at village level. The main use of cottonseed at the rural level is as animal feed. Essentially, the use of cottonseed depends very much upon the degree of organization and centralization of cotton-ginning facilities. In contrast to the situation with regard to groundnuts, Africa retains comparatively little cottonseed at the farm level, usually some 20 per cent. This is primarily because the two major cotton producers, Egypt and Sudan, have well organized and modern cotton industries which allow large quantities of cottonseed to be processed. Sudan, for example, retains very little cottonseed at the farm level, even a proportion of the seed requirement being replaced each year. In comparison, other African cottonseed producers are of little significance.

196. On the whole, cottonseed production in Asia is not as export-oriented as that of Africa, consequently cotton-ginning facilities are not always located in such a way as to promote the extraction of the cottonseed. India is possibly the prime example in Asia: only some 40 per cent of cottonseed is actually crushed. In Afghanistan and Pakistan, on the other hand, cottonseed is a major source of vegetable oil. Consequently a high proportion of cottonseed in these two countries is crushed. In Latin America, Brazil is the main producer and the cotton industry is similar to those of the Asian countries in being essentially domestically oriented. Consequently, a relatively high proportion of cottonseed, some 40 per cent, is not utilized commercially.

Oil palm

197. The oil palm fruit has to be processed quickly once picked. Most of this processing is carried out on a factory scale but village processing methods are common in West Africa. However, on a global scale the amount involved is small, probably not more than about 20 per cent of total oil palm production. This first stage processing of oil palm fruit usually yields palm oil and palm kernels. The latter may also be processed at the village level but again the amount involved is very small. Consequently, looked at in terms of the possible transferance of processing from village to factory level, the potential in the case of oil palm is rather limited.

Rapeseed

198. Although India is the leading producer, the developing countries as a group account for only about 30 per cent of global rapeseed production. Rapeseed is invariably crushed for its oil but in the developing countries a high proportion of seed is crushed at the village level. Bangladesh, India and Pakistan account for almost all developing country oilseed production, and in these countries crude rapeseed oil is highly regarded for the flavour it imparts in cooking. Consequently, it is estimated that more than half of developing country rapeseed production is used at the subsistence level.

Sesame seed

199. Sesame seed is a minor oilseed but it has certain unique features in terms of its utilization. For example, the majority of exported sesame seed is not crushed but is used in the confectionery and baking industries. The principal producers of sesame are Ethiopia, India and Sudan. Indian sesame production is primarily for home consumption, and it is estimated that about 65 per cent of sesame seed production is retained at the village level. In Ethiopia and Sudan considerable quantities of sesame seed are exported. Sudan's exports plus its own commercial utilization account for little more than 30 per cent of the country's sesame production, but in Ethiopia about 80 per cent of the sesame production is accounted for by commercial uses, mainly exports of seed. In the marginally cultivated areas of the Sudan sesame is the major oilseed. The principal oilseed in Ethiopia is niger seed, which accounts for most domestic usage. In global terms as much as 65 per cent of world sesame production is consumed in the subsistence sector.

Sunflower seed

200. Sunflower seed production is dominated by the USSR and Eastern Europe, where the vast proportion of seed is crushed for oil, although small quantities are sold for direct human consumption. Consequently, amongst the group of developed countries there is little use of sunflower seed other than for its oil. In a number of developing countries sunflower seed is primarily used as a foodstuff without crushing. In India it is estimated that about 30 per cent of sunflower seed production is crushed at the village level. However, as a group the developing countries account for such a small proportion of world sunflower production that they have little influence upon the structure of its utilization. Argentina is the only significant producer and nearly all sunflower seed there is commercially crushed.

Safflower seed

201. Safflower seed makes the smallest contribution to the oilseed economy of all the seeds under review. Its utilization at the subsistence level is largely a reflection of its function in India and Mexico. In the former country, safflower production has a long history but has remained a comparatively minor oilseed, popular for its oil. By far the greater proportion of production is processed at the village level. In Mexico, safflower growing is of more recent origin and has largely developed over the past decade. Consequently the crop is primarily associated with commercial processing facilities.

* * * * *

202. To summarize, the subsistence sector is a major user of oilseeds in the developing economies. Taking all the oilseeds under review and the developing economies as a group, about one-third of available oilseeds never enter the "market", in the sense that they are primarily grown, processed and consumed within an economic and social framework that allows little if any opportunity for adding value to them. Consequently, over one-third of developing country oilseed production is contributing little more than its farm gate value to the oilseed economy as a whole. The implications of this for the demand for oilseeds are explored in the final section of this chapter.

Utilization of oilseed products

Vegetable oils

203. The extensive occurrence of subsistence utilization of oilseeds in developing countries carries implications for the utilization of products derived from oilseeds. Thus considerable differences are found not only between the developed and the developing countries, but also amongst the developing countries themselves. Such differences are also reflected in different per capita consumption levels of oilseed products. For example, in the case of oils and fats, per capita availability net of trade of the ten major oilseeds was, in 1975, three times as great in the developed countries as it was in the developing countries. Even in those developing countries which are major producers of vegetable oils per capita consumption is generally under half that of developed countries, although in some of these countries, such as Argentina, Brazil, Malaysia, the Philippines, Sudan and Zaire, where the oil-crushing industries are well developed, consumption has risen quite considerably. It is also notable that vegetable oils provide a much higher proportion of oils and fats consumption in certain developing countries. Asian and African countries in particular show a reliance on vegetable oils as the main source of fat in the diet.

204. Different levels of per capita consumption of vegetable oils reflect different patterns of usage and hence of demand between the developed and the developing countries. The figure summarizes the end uses of oilseeds and oilseed products and it is evident that a wide variety of consumption patterns is possible. In the developed countries the principal end uses are as margarine or shortenings, which account for about 45 per cent of total vegetable oil utilization. Substantial amounts are also utilized as cooking or salad oils, especially in the United States, where about 43 per cent is used in this way, in Japan, and, in the special case of olive oil, the Mediterranean countries. In developing countries, on the other hand, a much higher proportion is used as cooking oil, while margarine and shortening industries are less well developed.

For example, in India something like 60 per cent of total edible oil consumption is utilized as cooking oil, with only 20 per cent used in vanaspati. Since animal fats comprise only a small proportion of this, mainly in the form of ghee, the distribution closely reflects the pattern of utilization of the major vegetable oils.

Figure . The end uses of oilseeds

- Vegetable oils
  - Cooking/salad oils
  - Shortening
  - Margarine
  - Soap
  - Paints
  - Confectionery
  - Cosmetics
  - Lubrication
  - Industrial chemicals
- Oilmeal
  - Animal feeds
  - Protein flour
  - Beverages with high protein content
  - Meat extenders and substitutes
  - Texturized protein foods
- Hulls, shells, fibre etc.
  - Handicrafts
  - Fuel
  - Building materials
  - Matting
  - Pulp and paper
- Whole seed or nut
  - Confectionery
  - Subsistence food
  - Beverages

205. The other major oil users in Asia, namely Indonesia and the Philippines, are largely dependent upon coconut oil. In Indonesia it is estimated that over 80 per cent of oil production is currently used for cooking purposes. In the Philippines, on the other hand, multinational companies utilize a major share of the available coconut oil; so the amount actually used for cooking is somewhat lower than is found in other parts of Asia. Another country at the lower end of the spectrum is Sri Lanka, where it is estimated that only about 45 per cent of available coconut oil is used for cooking purposes. In Asia as a whole some 70-75 per cent of vegetable oil production is used as cooking oil. The major exception to this figure is Pakistan where only a relatively small proportion of refined cottonseed oil is actually used for cooking. By far the major proportion of vegetable oil in Pakistan is hydrogenated to form vanaspati.

206. In Africa the use of vegetable oils for cooking purposes is even more pronounced. A number of countries, for example Ethiopia, have little other form of utilization. Here the vegetable oil marketed is often a blend of two or three oils, most of which are marketed in the crude form. Only a very small proportion of vegetable oil is partially or fully refined for sale as cooking

oil. The proportion of oil used for cooking also varies somewhat between the major groundnut producing countries of West Africa. The majority of countries, such as Mali, Niger and even Nigeria use 80 per cent of their groundnut oil for cooking purposes. However, at the lower end of the scale is Senegal where the proportion is only 65 per cent. Again much of the oil produced is utilized in its crude rather than refined form. This situation is in contrast to the major cottonseed oil users, such as Egypt and Sudan. In these countries refined cottonseed oil is used widely for cooking, mainly by the urban population. The crude groundnut and sesame oils are predominantly used by the rural populations. Taking the developing countries in Africa as a whole, approximately 70 per cent of their vegetable oil availability is used as cooking oil.

207. Latin and Central American countries generally have a broader-based industrial sector than most African and Asian countries. Consequently, although the amount of vegetable oil used for cooking remains high in absolute terms, it can be considerably smaller when expressed as a proportion of the total amount of vegetable oils utilized. The major users of vegetable oils such as Brazil, Mexico and Venezuela produce substantial quantities of refined oil as well as having quite significant rural oil producing sectors. On average some 55 per cent of vegetable oil is probably used in these countries for cooking purposes, but some countries, such as Bolivia, Colombia, Ecuador and Peru, all make far greater use of vegetable oils for cooking purposes.

208. The proportion of vegetable oil not used as cooking oil has two major uses, namely soap and associated products and margarine/shortening production. The most important industry based upon vegetable oils in the majority of developing countries is the soap industry. However, the amount of oil used for soap making is relatively small even though the industry as such is often a major one. As a group the developing countries utilize about 16 per cent of their vegetable oil production in the soap industry. Further details are provided in chapter IV.

209. The other major end use of vegetable oils, especially in the developed countries, is in the manufacture of margarine and shortening. These products are not highly acceptable in many tropical countries but are nevertheless tending to become established in certain countries, for example Brazil. The production of refined soyabean oil in Brazil provides an ideal raw material and it is estimated that nearly all the 120,000 tons of margarine produced in Brazil each year is based on soyabean oil. In contrast, Mexico produces very little margarine but has a major market for prepared fats such as shortenings.

210. India is undoubtedly the major developing country market for hydrogenated fat, in the form of <u>vanaspati</u>. In 1974 <u>vanaspati</u> production accounted for about 20 per cent of total vegetable oil consumption in India. <u>Vanaspati</u> is used in all parts of India for the preparation of confectionery and all types of sweetmeats. Besides this general usage, most <u>vanaspati</u> consumers are from the urban areas and amongst those who have a preference for animal <u>ghee</u> as a cooking oil.

211. As noted above, <u>vanaspati</u> production is also by far the major end use of vegetable oil (nearly all cottonseed oil) in Pakistan.

Oilmeals

212. Oilmeals are a major source of protein, most of which is presently consumed by the livestock industries of the developed countries. The growing utilization of oilmeals in these countries (noted in chapter II) has been generated by the growth of livestock industries, generally in response to increased demand for meat and the development of more intensive feeding methods for most types of

livestock. Provision of protein is essential in livestock feeding and although grains are commonly the main source of protein in feeds produced in developed countries, oilseed meals are used to supplement them. Developed and, to a lesser extent, centrally planned economies are therefore at the centre of the demand for oilmeals.

213. In the developing countries, on the other hand, grains are primarily used directly for human consumption and oilcakes, and meals tend often to be the principal source of protein for animal feeds. At subsistence level oilcakes are also a source of energy due to their high residual oil content, while in many cases the whole seed is used as feed.

214. The international pattern of oilcake utilization is illustrated through an examination of imports. In this respect the EEC accounts for almost 50 per cent of world imports. Other major developed markets are Spain and Japan. Imports into Eastern Europe and the USSR have considerably increased in recent years, while import markets in developing countries have also grown rapidly, among them Iran, Mexico, the Republic of Korea and Venezuela.

215. Although all oilmeal importing countries import soyameal, the import patterns for other products differ significantly. For example, the incidence of aflatoxin contamination has seriously reduced the consumption of groundnut cake, and only the United Kingdom and France are major consumers in the EEC, partly because of their former connection with producing countries. Denmark's consumption is nil. Moreover the harmonization of EEC regulations will become an increasing constraint on its consumption. Imports into Eastern Europe (notably Czechoslovakia, Hungary and Poland) are significant, being due mainly to barter agreements, mainly with India.

216. In general, in the developed countries, oilcake/meal other than soya form a residual or marginal market. They are either in short supply, e.g. linseed, because of the falling demand for linseed oil, or sesame, because the seed cannot be mechanically harvested; or they possess certain toxic/anti-nutritional elements that reduce demand, e.g. rapeseed (erucic acid), cottonseed (gossypol) and groundnut (aflatoxin). Copra and palm kernel cake have a high fibre content and so are generally used only in cattle feeds.

217. A further use of vegetable protein is directly for human consumption. It has long been recognized that consumption of vegetable protein from oilmeal need not be limited to animal feeding but could be extended to direct human consumption. Recently, following the escalation of meat prices throughout the world mainly caused by the increased cost of the compound feed on which animals are reared, the use of vegetable protein for direct human consumption has become an economic proposition in developed countries. Soya protein leads the market and at present is sold in a number of forms but particularly as texturized vegetable protein. This is used mainly as a meat extender. Nevertheless, the inherent nutritional value of soya protein should eventually encourage its use as an alternative food source in its own right.

218. Some soya protein products have been marketed for up to forty years, for example soya flour, grits, concentrates and isolates, but only recently were extrusion and spinning processes applied to the defatted flakes to form textured vegetable protein. The United States is the largest market for soya protein for human consumption and it is estimated that 900 million pounds (408,000 tons) are used annually for all applications, including export to overseas markets.

219. Protein made from oilseeds is not yet important quantitatively in developing countries, although it has already been used successfully to enrich protein-deficient foods in a number of cases (see also chapter VII).

220. Despite the recent use of soya protein for human foods, the market for vegetable oilcakes as animal feed will continue to be the dominant one for some time to come.

The demand for oilseeds and oilseed products

221. The main patterns of usage of oilseeds and oilseed products outlined in this chapter provide a frame of reference for discussing the demand for these products.

222. In the case of oilseeds, the situation in developing countries is complicated by the presence of subsistence activity, which has been shown to be widespread. In the subsistence sector the demand for oilseeds is, by definition, met by the consumer's own sources of supply and has little importance outside the sector. Demand is a function in this case of customary tastes, agriculture practices, and low levels of income. As farmers move out of subsistence production their income levels generally tend to increase and become important determinants of demand. This is already the case in commercialized sectors throughout the world. However, the demand for oilseeds is to a large degree a derived demand, depending upon the demand for vegetable oils and oilcake.

223. The extent to which the supply of oilseeds is able to meet an increased demand for vegetable oils and oilcakes depends not only on the rate of growth of total oilseed supply but also on the type of seed grown, since different seeds contain different amounts of oil and cake. Thus the rate of growth of demand for oilseeds may be greater or less than the rate of growth of demand for oils, depending on whatever changes occur in the composition of oilseed production. Such changes, however, would have to be extremely substantial before they would be capable of affecting the rate of growth of total demand for oilseeds by as much as even a half per cent, and any effects of changing the composition of production will be of marginal significance. For practical purposes the rate of growth of demand for oilseeds is therefore assumed to be similar to that for vegetable oils.

224. The main uses of vegetable oils are as liquid cooking oils or as inputs into consumer goods such as margarine, vanaspati, confectionery and soaps and the widely differing patterns of usage throughout the world have been described above. In the case of liquid cooking oil, demand is direct, but for oil-based products the demand is again a derived one. The different patterns of consumption throughout the world to a large extent reflect differing income levels, and incomes are therefore a primary factor influencing the level of demand. The growth of incomes, in developing countries in particular, can be expected to have profound effects on the demand for vegetable oils at present being consumed at much lower per capita levels than in the developed countries.

225. In the developed countries, on the other hand, where per capita consumption levels of oils and fats are already extremely high, averaging between 20-25 kg per capita a year, it is not thought that future increases in per capita incomes will lead to any substantial further increases in consumption of vegetable oils. In this sense the markets of the developed countries are thought to be saturated. The main influence on future demand for vegetable oils in these countries is expected to be population growth. From the point of view of individual vegetable oils however, the demand in developed countries has been experiencing a continuous change towards a preferance for soft oil, i.e. oils liquid at room temperature. This is partly due to their growing availability, particularly of soya oil, but also to the qualitative changes in consumer patterns occurring in many developed countries, where consumers either believe or are being led to believe in dangerous links between saturated fats and certain health problems.

226. In the developing countries, changing per capita levels and population growth are both powerful determinants of overall demand for vegetable oils. In fact, the level of effective demand for fats and oils in many developing countries is rising at a faster rate than domestic supplies. This is due to rising incomes, e.g. in the mineral oil exporting countries such as Iran and Iraq, or to the fact that the Governments of certain countries, e.g. India and Pakistan, have become committed to national food policies in which fats and oils have been classified as essential commodities. Such countries are therefore committed to importing fats and oils in order to make up shortfalls in domestic production.

227. While the factors which influence the demand for vegetable oils as a group are comparatively easy to specify, the situation with regard to individual vegetable oils is considerably more complex. This is because of the high degree of substitution between different oils which has become possible in recent years for most uses. With the aid of modern technology nearly all vegetable oils are substitutable to varying degrees, both for each other and for other animal oils, marine oils, and synthetic products. The manufacturer of food and non-food materials based on vegetable oils has a wide choice when deciding on a suitable oil for his particular end-product. Generally, he will select the cheapest and most readily available oil, depending on the nature of his end-product.

228. Thus an oil or fat which becomes in excess supply in its traditional markets is likely to be used as a raw material by manufacturers in both the food and non-food processing industries. An example would be the widespread use of soyabean oil by manufacturers because it has tended to be readily available and supplies have been generally predictable on a short-term basis. Palm oil is being increasingly used as end-users are able to assess that future supplies are fairly assured due to the already substantial planting of oil palms in Malaysia and with the prospect of an increase in supplies from new plantings in Indonesia. The result of intensive competition between soyabean and palm oil will probably be that each oil will find uses in an increasing number of new end-products.

229. The degree of substitution between vegetable oils is a function of both economic and technical considerations. The important relationship between price and supply is demonstrated by the fact that the most competitive oils, namely palm oil and soyabean oil, have increased their share of total world vegetable oil production from 35 per cent in 1965 to 44 per cent in 1975, a figure which is projected to increase even further. The change in price differentials over the last ten years has also been considerable. In 1965 the price differential between the cheapest and most expensive of the vegetable oils was of the order of $60 per ton, but by 1973 this had risen to $150 per ton and in 1974 had reached an unprecedented $580 per ton. Differentials of this order of magnitude for what are essentially similar commodities cannot be maintained without major changes taking place in the pattern of utilization. It is inevitable that processors should seek to take advantage of the cheaper oil by extending its uses. The development of blended food products such as salad oils, margarine, compound cooking fat, and shortenings has increased the competitiveness and substitutability of a large number of vegetable oils. In the case of salad oils, virtually all the liquid edible oils can be substituted one for another while for use in margarine and compound cooking fat it is possible to substitute most vegetable oils which have been hydrogenated, and some in the natural and unhydrogenated condition.

230. In addition, competition from synthetic materials must not be overlooked. So far this has mainly affected the non-food products utilizing lauric oils, particularly detergents. The main reason for the introduction of synthetic

fatty acids and alcohols into end-products using lauric oils was that for many years the lauric oils were relatively highly priced, and, although they are presently somewhat cheaper, substitution in the inedible sector tends to be far more irrevocable than in the food sector. Furthermore, synthetic substitutes are now available and are well placed to take advantage of any instability or inadequacy of supply shown by the natural oils. As the developing countries become involved in setting up petrochemical industries, this source of competition will tend to become increasingly possible.

231. With the demand for oilmeal, a new set of variables comes into play. Substitution is again possible but constrained by the nutritional requirements of different types of livestock for which the oilcake or meal provides a feed. The demand for oilmeal for animal feed is therefore a derived demand depending upon the demand in consuming countries for livestock produce. In the developed and developing countries the main determinants of demand for these products are again income and population levels and growth rates.

232. As with other animal feeds the market for oilmeal is characterized by its large size, both as regards the sellers/importers, the shippers and the consuming units, the feed compounders. Moreover each consuming country produces a considerable amount of meal from imported oilseed, particularly soya. Again, these production units can be characterized by their large scale.

233. The demand for oilmeals thus depends on a variety of factors including the number of livestock on compound feeds; the price levels of oilcake/meal which influence both their inclusion in compound feed and the level of feed costs, which in turn effect the profitability of the livestock sector and therefore the intensity of feeding; and the general economic climate.

234. In general these factors are favourable for the late 1970s. However, a dampening influence on the demand could be tighter EEC regulations encouraging greater use of skim milk in animal feeds, and the more aggressive marketing of single-cell proteins, which could be given official encouragement in order to increase the Community's self-sufficiency and save foreign exchange.

235. Should the market for human consumption of oilseed protein products exand rapidly, this would also become a major influence on demand for oilmeals. The direction in which this market is likely to develop is not yet clear, however, and the main determinants of demand for such products have not been properly identified. In both developed and developing countries there are problems of acceptability of products based on vegetable protein for human use and there is a great danger that these will be identified as inferior substitutes for livestock products having higher consumer status. There could thus be a perverse effect on demand for these products as incomes rise. This is obviously a matter which has to be handled extremely carefully.

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236. In summary, the main influences on the demand for oilseeds and oilseed products are income and population growth rates, with somewhat lower emphasis on the income element in developed countries. For individual oilseeds the question of substitutability and availability is of prime importance and finds its expression on demand via relative prices of substitutable oils and meals.

IV. THE PRODUCTION AND SUPPLY OF OILSEEDS AND OILSEED PRODUCTS

237. In considering the utilization and demand for oilseeds and oilseed products in the previous chapter, it was useful in the case of the developing countries to distinguish between subsistence and commercial utilization. This distinction is obviously also relevant when considering the structure of production of oilseed products. Thus, in the developing countries the presence of a large subsistence sector usually means that processing methods are of the village type, using mainly manual or animal power, and having consequent implications for productivity and efficiency. This is in contrast to the commercial sector where the incidence of factory level processing tends to be greater, and which leads to a different situation with regard to the supply and quality of oilseed products. Consequently, the present chapter begins with a review of the main characteristics and relative incidence of the different types of oilseed processing methods.

238. The extend to which different types of processing facilities exist within individual countries varies enormously worldwide. It is not intended to provide here a detailed country-by-country account of processing facilities - the available data do not in any case permit this - but to discuss, very broadly, the role of the various technologies mentioned with reference to specific countries. Distinction between village-scale processing and large-scale processing is retained but there are a number of factors common to both sectors which can blur the distinction in certain countries. Similarly, although the commercial processing sector is often discussed as an entity, the diversity of processing techniques and the possible combination of techniques make for a very heterogenous sector, particularly when viewed on a global scale. The technology of oilseed processing in the commercial sector may be broadly classified into small-scale expellers, medium- to large-scale expellers and solvent extraction. The first category of mill is usually capable of processing 5-20 tons a day and the second in the region of 50-150 tons a day.

The incidence of village-scale processing

239. The geographical distribution of village oilseed processing is a wide one. To a greater or lesser extent, village oilseed processing is carried out in virtually all developing countries and even in some countries with a comparatively high gross national product. Village processing is primarily concentrated in Africa and Asia and may be applied to virtually any oilseed. The oilseeds most commonly processed at the village level tend to be those for local consumption since the amounts involved are small and in any case the collection of oil from so many small outlets would be a major problem of logistics if such outlets where the basis of an export trade. In Africa, the seeds commonly processed at the village level are sesame, groundnuts and oil palm. The latter is something of an exception since palm oil production is generally by factory processing. The major oilseed producing countries where village processing remains significant are Ethiopia, Nigeria, Senegal, Sudan and Zaire.

240. In Sudan, particularly in the sesame seed producing areas, there is a substantial amount of village level processing using assaras. The assara is basically very similar to the Indian chekku but generally camels are used to drive the mill instead of oxen. It has been estimated that about 60,000 tons of seed, mainly sesame, are processed by these animal powered mills, and this figure is probably a conservative estimate.

241. In Nigeria, groundnuts produced in the subsistence sector are shelled by hand or by pounding in a mortar. Oil extraction is carried out in the villages but is very inefficient. One method is to heat the kernels with sand for about thirty minutes in order to loosen the testa which is then removed by winnowing. The kernels are then pounded to a paste with a little water and pressed using a roller. After re-working the paste with more water, it is pressed again and the cake from the second pressing is made into small balls which are heated in a pot in order to extract further oil. Residual cake from this process still contains some 35 per cent of oil and goes rancid rapidly. Similarly palm kernel oil may be extracted in various ways. One method used in the eastern part of Nigeria is to steep the whole kernels in water for a few days and then the roast gently in a pot, sometimes with a little palm oil, until the palm kernel oil exudes. Due to the present shortage of oils and fats in Nigeria, it would appear that palm kernels are being processed in the subsistence sector to an increasing extent for domestic edible use.

242. Palm oil for the subsistence sector is extracted from fruit harvested from semi-wild groves and also from groves which have been replanted with improved material. The oil is extracted from the fruit mesocarp by methods which range from the very primitive to the use of hydraulic screw presses and power driven centrifuges. The most primitive methods have an extraction efficiency of only 40-45 per cent; the free fatty acid content is probably over 5 per cent and often very considerably higher. The oil is clarified by boiling with water and skimming off the clear oil. Probably the largest proportion of oil is still produced by such methods. In the Niger delta area "gard oil" with free fatty acid content of 30-50 per cent is made by allowing the loose fruit to ferment in a pit or in a long wooden canoe for several days. The extraction efficiency is only 20-30 per cent.

243. In spite of the widespread incidence of village oilseed processing in Africa, especially Nigeria, it is undoubtedly true to say that the most extensive use of such a technique is still found on the Indian sub-continent. In India itself village ghanis are estimated to process about 13 per cent of all oilseed crushings and the capacity of the ghanis has been estimated to be in the region of 2 million tons annually. The seeds most commonly processed at the village level are rapeseed, sesame and safflower seeds. Again, in Pakistan it is estimated that approximately 8 per cent of oilseeds are crushed by village ghanis. The seeds are predominantly rapeseed and sesame.

244. Rural coconut processing is widespread in South-East Asia generally, but village coconut oil production in Indonesia is particularly significant.

245. From this brief survey, a number of salient features pertaining to village oilseed processing may be noted. Firstly, such facilities, usually animal driven but possibly motorized, are widespread and are applied to most of the major oilseed grown in developing countries. Sesame seed, rapeseed, safflower seed, and coconut and oil palm are all extensively processed at this level. Secondly, absolute output levels are very limited. Many animal driven ghanis are capable of processing only 40 kg of seed a day and the maximum possible at the village level is not likely to be more than 1 ton a day. Thirdly, the oil extraction rates obtained using village methods are limited. Earlier paragraphs mention extraction rates as low as 40-45 per cent especially pertaining to oil palm and copra. Depending on the seed in question rates can be higher, especially after a second pressing, but it is probably fair comment to say that most village processing methods are no more than 50-55 per cent efficient. A further factor

is the quality of oil produced. With care, oil quality at the village level can be good and since the oil is mostly used quickly, the free fatty acid content is not usually excessive with the possible exception of palm oil, where a high content is sometimes preferred.

246. Finally, because there is seldom, if ever, any preparation of oilseeds before crushing, or refining facilities subsequent to crushing, the products of village oilseed processing are confined to two commodities: the crude oil and the oilcake. Both products undoubtedly have their uses but they are severely limited. More refined processing techniques open the way to a greater number of end uses. Generally speaking it would be to the advantage of the countries concerned if the degree of village processing could be reduced and replaced by more efficient techniques giving a grater yield of oil and an broader base for subsequent utilization.

247. However, it should be recognized that in many areas the village processing still has and will have in the near future a useful role - providing employment, assisting rural development and contributing to the food supply of the inhabitants with valuable nutrition.

The incidence of factory scale processing

248. By far the major share of oilseed crushing is carried out by some form of powered mechanical means. This might be either an end in itself or a prelude to further processing. However, the scale and variety of technologies varies enormously as does the structure of the oilseed processing industries. In many developed countries, pre-pressed solvent extraction is the most common technique, but in many developing countries numerous screw presses, often 20 or more years old, are the principal form of powered crushing unit. In some developing countries, however, solvent extraction units have been established. These units are commonly, but not necessarily, associated with mechanical pre-pressing facilities. Solvent extraction methods are also associated with a wide range of oilseeds.

249. Solvent extraction constitutes the most efficient method of recovery from oil-bearing material, particularly for those oilseeds or other materials low in oil content. Since minimum heat treatment is involved, the oil produced by solvent extraction is of maximum quality and the meal contains proteins subjected to a minimum amount of damage due to the effects of heat. However, solvent extraction equipment is relatively expensive compared with other extraction systems and in using inflammable solvents there is a safety factor involved. Some recent types of solvent extraction plants have provision for directly handling high oil content seeds.

250. The extraction of palm oils is one industry which, for technical reasons, is invariably carried out in producing countries. For example, virtually all Malaysian oil palm production is based on plantations supplying factories processing usually up to a maximum of 40 tons of fresh fruit bunches an hour, although one factory exists with a processing capacity of 80 tons an hour. The oil is extracted either by hydraulic presses or, in the more modern mills, by continuous screw presses. These mills provide both crude palm oil and palm kernels. In Zaire, palm oil production is similarly based upon large commercial estates and smaller plantations. Most of the oil of commerce is extracted in factories attached to the estates which also process bunches and loose fruit purchased from smaller plantations and villages.

251. In contrast, estate production of palm oil in Nigeria is very limited but utilizes hydraulic or continuous screw presses as in Malaysia. However, the seasonal variation in production is greater in Nigeria owing to the less even rainfall, and milling capacity must be able to cope with the peak harvest. Power-operated pioneer oil mills were designed and introduced into Nigeria in the late 1940s and early 1950s by the United Africa Company to process loose fruit purchased from small farmers. They were erected when labour was cheaper than at present and have proved unsuccessful on the whole because they are labour-intensive in operation despite a relatively high investment cost. Not enough fruit is brought to the mill by the farmers in the absence of organized transport since many are discouraged by distance, and it has proved difficult to find managerial skills at the required level for efficient operation. Hand-operated screw presses of the Curb type, which have been used in Europe for pressing grapes and cider apples, were introduced some years ago and it has been estimated that there are some 10,000 machines in use in the former Eastern Region.

252. In the Ivory Coast there are nine palm oil mills processing mainly estate produced palm fruit, and also the fruit from wild palms which is supplied to the mill by local growers. The mills are generally organized into production lines capable of handling 10 tons of fresh fruit bunch an hour, and the total capacity of the mills varies between 20 and 60 tons of fresh fruit bunch an hour. There is still a great deal of village level processing of palm fruit, but the tren is for small palm fruit producers to transport the fresh fruit to a mill in their area.

253. Palm kernel is the other oil palm product. A large proportion of palm kernels are exported but processing to a degree does take place in the producing countries. In Zaire, the production of palm kernels amounts to some 90,000 tons a year and these are all extracted in local mills, about which little information is available. Kernels originating from Unilever planations, which produced about 55,000 tons of palm oil and 19,000 tons of palm kernels in 1975, are expelled in Kinshasa. This factory has six expeller units and appears to be working at full capacity. About three-quarters of the palm kernel oil production is exported. In Malaysia, all the palm kernels produced are milled, the produce of Sabah and Sarawak (24,000 tons in 1975) being transferred to peninsular Malaysia for this purpose. Milling is carried out both by expellers and by pre-press solvent extraction.

254. The coconut is possibly the most widely used of the oilseed crops and its processing technology reflects this diversity. Copra processing in the Philippines, the world's largest coconut producer, is carried out in about 30 oil mills with daily capacities ranging from 14 to 600 tons. Total installed capacity is estimated at around 1.4 million tons of copra a year, but utilized capacity in 1971 was only about 67 per cent of this figure. Many of the mills are equipped with expellers which are at least 30 years old, but they are of the high-pressure type and are generally still reasonably efficient. There are at least three modern mills using a pre-press followed by solvent extraction, and there are plans for expanding the number of solvent extraction plants in conjunction with existing mills. The overall extraction efficiency of the milling industry is relatively good, with the residual oil content of copra cake being around 6-8 per cent and the free fatty acid content of the extracted oil within the range of 1-3 per cent.

255. There are 42 registered copra crushing mills in Sri Lanka and about 20 small non-registered mills. Nine of the registered mills each have a capacity for crushing over 10,000 tons of copra a year and together account for two-thirds of the total output of coconut oil. Total installed capacity of the registered mills is estimated at 275,000 tons of copra a year, but again, utilized capacity amounts to only about 50 per cent of the total available.

256. Similarly, there are estimated to be around 300 oil mills in Indonesia, ranging from small-scale factories processing well under one ton of copra a day to large, modern extraction plants capable of processing around 50,000 tons of copra or palm kernels a year. The installed capacity of the copra milling industry alone is estimated to be in excess of 1 million tons of copra a year, while the utilized capacity is thought to be less than 40 per cent. The majority of the mills, about 70 per cent, are situated in Java, although new mills are being erected in coconut producing areas.

257. In contrast, coconuts are not indigenous to the Ivory Coast, but as a result of the Government's agri ultural diversification programme coconut production has been expanding. The majority of coconuts are used for producing copra, of which about 12,000 tons a year are produced and processed for oil. A central processing unit for copra has been proposed with a capacity of 200 tons a day, but at present copra crushing is carried out in a number of small mills.

258. With the coconut industry playing such an important part in the economy of the Philippines, plans for setting up centralized processing plants have been considered. When the economics of integrated processing have been further studied, it would seem likely that the Philippines will be the first country to construct an integrated coconut plant for the production of oil, desiccated coconut, activated carbon, coir, hardboard, and specialized food products such as coconut cream, and nata de coco which is made from coconut water.

259. Groundnut processing capacity in developing countries is geared to processing a much larger crop than has been available in recent years. Two countries in particular, Nigeria and Senefal, have a substantial imbalance of supplies to processing capacity. Groundnuts constitute the major source of vegetable oil in Nigeria. However, since 1973, production has dropped very considerably due to drought, disease and internal marketing conditions. In recent years an increasing proportion of groundnut production has been milled in Nigeria but at the present time processing capacity is very much in excess of requirements. There are 13 processing plants, nearly all in Kano state, with a total milling capacity of nearly 1 million tons a year. Nearly all factories produce expeller cake and one has solvent extraction facilities

260. A similar but less severe imbalance of processing capacity over supplies occurs in Senegal. With a total annual crushing capacity of over 1 million tons of nuts in sh ll, in recent years the factories have been operating at little over half their full capacity. Furthermore, during years of low production due to drought, groundnuts have been imported by the oil-producing firms from neighbouring countries, in particular Mali, in order to sustain the throughput. In 1966, four out of seven factories used pre-press solvent extraction equipment which accounted for more than half the total milling capacity which at that time was 520,000 tons. All the factories have facilities for refining at least part of their crude oil production and for canning or bottling refined oil in quantities suitable for retail sale.

261. The largest producer of groundnuts in Africa, namely Sudan, has increased the selection of groundnut kernels for the edible market in recent years and expansion of the use of electronic sorting equipment by the Sudan Oil Seed Corporation is expected to boost the amount of confectionery grade groundnut kernels for export..

262. Cottonseed milling is possibly an area where there is a greater degree of opportunity for improvement and expansion than with most other oilseeds, especially in developing countries. The Sudanese vegetable oil milling industry depends predominantly on cottonseed as a source of raw material. There are 51 oil mills using expellers, and they vary in size from one mill with 35 expellers to many small mills operating just one expeller. Three large mills, located in Khartoum, each have a capacity for processing 180 tons of cottonseed a day. The other mills are distributed throughout the country and of these eight have a capacity of 50 tons a day, 11 have a possible throughput of 20 tons a day, 10 mills have a daily capacity of 10-20 tons a day, and one mill has a nominal capacity of 5 tons a day. The remaining mills are generally situated in the sesame and groundnut production areas and are equipped with one expeller and an oil filter, and process whatever seed is available. The oil from these mills is sold directly in the local markets. Total installed capacity of the mechanically equipped mills is estimated to be 700-800 thousand tons of oilseeds a year, but utilized capacity is only 50-60 per cent. The large mills are operated efficiently and yield oil-cakes with a 6 per cent residual oil content or less. However, the smaller mills and single expeller units have no quality control facilities and the residual oil content of the cake from these mills can be as high as 10-12 per cent. In contrast to the milling industry in some other developing countries, the average age of equipment used in the Sudanese industry is under 20 years, mainly because expansion of oilseed crushing took place only in the early 1960s.

263. Cottonseed processing in Afghanistan and Pakistan epitomizes many of the problems associated with crushing the crop in developing countries. In Pakistan the oilseed processing sector contains virtually all the processing levels previously delineated. The four principal sectors are:

(a) The traditional small expeller mills, of which there are about 400, varying in capacity from 7 to 30 tons of seed a day;

(b) Large expeller mills, 19 in number, with average capacities of about 100 tons of seed a day each. Large and small expellers together produce about 80 per cent of the oil;

(c) Solvent extraction plants, with average daily capacities of 165 tons each, producing about 11 per cent of the oil in 1973/74;

(d) The bullock-driven village mills (rohlu), of which there are perhaps 15,000 operating, each with a capacity of 1 maund (37 kg) of seed per day. They produce about 8 per cent of the oil, mostly rapeseed oil.

264. Expeller mills usually consist of a number of so called "Lahore" expellers, capable of extracting 65 per cent of the available oil by twice pressing the normal moist undelinted cottonseed (average linters content about 13 per cent). Crushing rapeseed, expellers usually attain an average extraction rate of 75 per cent. Large expeller mills use the same technology but have a greater number of expellers installed. The low average oil extraction rate for cottonseed of 70 per cent is largely explained in terms of the preponderance of the traditional expeller sector, which leaves more oil in the seed. Crushing well-delinted seed on a high performance expeller mill increases crude oil recovery to 85 per cent. There are about nine mills in Pakistan capable of such high performance. Taking

into account average refining losses, the oil lost to human consumption by processing on Lahore expellers is about 33 per cent compared with 19 per cent for imported high performance expeller mills. With efficient solvent (hexane) extraction, crude oil recovery of 95 per cent can be achieved. At present there are 19 solvent extraction plants in Pakistan but they are greatly underutilized.

265. The cottonseed produced in Afghanistan is crushed in expeller mills with a total annual capacity of 136,700 tons, but the factories are not running at maximum efficiency and, besides improvement in efficiency, additional milling capacity will be required over the next few years in order to handle the anticipated future cottonseed crop. There are seven mills in the country, each with cottonseed capacities between 10,000 and 24,000 tons a year plus some 15 small privately-owned mills with an estimated combined cottonseed capacity of about 16,000 tons a year.

266. By far the major share of the world's soyabean processing facilities are to be found in developed countries, mainly the United States and Western Europe. Of the developing countries only Brazil has a major interest in soyabean crushing. Total milling capacity for soyabeans is estimated to be about 3 million tons. Some mills also process cottonseed and groundnuts; the seasons for these crops are earlier in the year than soyabeans, so that there is generally no difficulty in fully utilizing the milling capacity. Total milling capacity for all three oilseeds is estimated to be about 7 million tons. The mills in Rio Grande do Sul crush only soyabeans and are operating a 33 day/year; the daily crushing rate is about 6,500 tons. Total daily crushing capacity is about 10,000 tons. The oil content of the soyabeans is about 21 per cent and the extraction rate is estimated to be about 18 per cent.

267. Although mechanical processing techniques account for an overwhelming proportion of developing countries' vegetable oil production a number of such countries have established chemical processing facilities in the form of solvent extraction units. These units are commonly, but not necessarily, associated with mechanical pre-pressing facilities. Solvent extraction methods are also associated with a wide range of oilseeds. In India most of the solvent extraction units are reportedly utilized for processing oilcake and most of the solvent extraction plants do not have expellers located on the same premises. There are about 92 solvent extraction plants in India with an installed capacity of about 6,000 tons a day, varying from older batch extractors with capacities as low as 10-15 tons of oilseed cake a day to modern continuous units with capacities as high as 100 tons a day.

268. In Sri Lanka there are three solvent extraction plants, one batch plant with a throughput of 5 tons a day, and two continuous plants with capacities of 122 tons a day and 61 tons a day respectively. However, these plants have not been used at anywhere near their full capacity. Most of the coconut oil domestically consumed is in the crude state, as there is consumer preference for the flavour, but small quantities of crude oil are refined and used mainly for the local manufacture of margarine and cooking oil. There are two large refineries operating mainly batch processing, although continuous neutralizers have been installed. The efficiency of the oil industry is reasonably good considering that most of the milling equipment is old.

269. In Indonesia solvent extraction plants are used to recover oil from the high residual oil content cake produced by many of the oil mills. There are five solvent extraction plants with an estimated processing capacity of over 120,000 tons of copra cake a year. These have been introduced with a view to improving the efficiency of the industry, since the majority of the mills are over 30 years old and are equipped with out-dated expellers and hydraulic presses.

However, the most recently constructed mills have installed modern expelling equipment combined with solvent extraction plant and are very efficient.

270. Pakistan has 11 solvent extraction plants operating in Sind and Punjab. Five mills in Sind were erected with a capacity of 910 tons of seed a day, but under current operating practice they are handling only about 670 tons a day. In Punjab the solvent mills appear to be capable of producing at the rated capacity. The total combined daily capacity of the expeller and solvent mills is about 9,450 tons a day. Although solvent extraction is by far the most efficient technical process, getting for example 92-97 per cent of the available oil out of cottonseed as against 60-80 per cent when expellers are used, the solvent extraction industry has not been able to develop rapidly because of adverse economic factors. One factor is the fixed price at which cottonseed oil has to be delivered to the vanaspati factories. The second factor is the relatively high local price for cottonseed expeller cake with a 6-8 per cent oil residue and a high percentage of hull and fibre.

271. A high proportion of vegetable oil produced in developing countries is used in its crude form. This applies to both village-processed and some of the larger processing facilities. Consequently, refining facilities are comparatively limited, except where oil is being exported or a large indigenous urban market is available. For example, there are 10 oil refineries in the Philippines, mostly operating a batch process, although some are equipped with continuous neutralizing and deodorizing plant. The installed refining capacity is estimated to be about 150,000 tons a year, and utilized capacity is about 60-70 per cent. Most of the refineries have glycerine recovery units and soap plants attached, in order to make use of the refining by-products. Similarly, in the Sudan, there are 10 oil refineries which are equipped for producing semi-refined and deodorized cottonseed oil, mainly operating a batch process, although two have modern continuous neutralizing and deodorizing facilities. The majority of the refined oil is utilized domestically as a cooking oil, about 60,000 tons a year, while around 10,000 tons a year is exported as semi-refined oil, mainly to Egypt. Groundnut oil is also being refined to the extent of about 14,000 tons a year, and is used for cooking purposes domestically. Unrefined groundnut oil is also used in the rural areas as a cooking oil to the extent of about 35,000 tons a year. Refining facilities are in use in a number of other developing economies but compared with the developed economies their extent is very limited. They are often under-utilized and in many cases do not take full advantage of the opportunities such facilities present for extending the number of end uses of the crude oil.

Conclusions

272. The brief outline of oilseed processing facilities, confined largely to the major developing country oilseed producers, serves to illustrate the wide spectrum of oilseed processing conditions generally, and highlights a number of the problem areas currently pertinent to a large number of oilseed producing countries. Broadly speaking, four principal levels of technology are recognized, namely village processing, small scale expellers, medium to large scale expellers and solvent extraction. Whereas there is undoubtedly a distinction to be drawn between the structure of the oilseed processing industry in the major developed countries as, say, represented by the United States or Western Europe and that in developing countries, for example, India, it is inadvisable to take generalizations too far. A number of developing countries, for example Pakistan, have an oilseed industry structure not far removed from that of more developed economies.

273. In aggregate the distribution of oilseed processing in the developing world between the technologies mentioned is broadly on the following lines:

Technology	Percentage of all processing
Village scale	8-10
Small-scale expellers	45-55
Medium- to large-scale expellers	25-30
Solvent extraction	12-18

This aggregation embraces a very wide range of individual country situations but does serve to illustrate the status quo which forms the basis of future expansion. It should also be appreciated that the outlined distribution reflects actual processing methods not merely the existence of processing facilities.

Derivative industries

274. While most developing countries have widespread facilities for the extraction of oil from oilseeds, the development of industries based on vegetable oils is less well established. The figure showed the wide variety of end-uses that exist, but the most important of these, from the point of view of further processing, are margarine and other prepared fats, and soapmaking. In each of these cases, the developing countries' share of production lags considerably behind that of the developed countries. Thus, in the case of margarine and other prepared fats, the developing countries in aggregate produced about 1.5 million tons in 1974, compared with the world total of 8.2 million tons.

275. A similar situation is evident in the case of non-food uses of vegetable oils, of which the main products are soap, and washing powders and detergents. Out of a world soap production of 6.1 million tons and a washing powder and detergent production of 10.6 million tons, the developing countries produced only about 2 million tons and 1.6 million tons respectively in 1974. For margarine, soap, washing powders and detergents taken together, the developing countries, with two thirds of the world population, produced only one fifth of world production, and in terms of oil content this accounted for about 3 million tons of oil from a total availability in the developing countries of 12.7 million tons. In the developed countries the vegetable oil content of the quantity of margarine, soap, washing powder and detergents produced amounted to approximately 12 million tons compared with an availability of 15.8 million tons for the ten major vegetable oils under study.

276. On a regional basis the principal producers of margarine, soap, and washing powders among the developing countries are found in Asia and Latin America. In Latin America, Brazil and Mexico have the largest vegetable oil industries, with the latter producing 166,000 tons of margarine, 180,000 tons of soap and 345,800 tons of washing powders and detergents in 1974. As table 15 shows, Brasil produces more soap than Mexico, though not quite so much of the other two items.

277. Brazil's large soap and detergent manufacturing industry provides the major outlet for non-food uses of vegetable oils. Soap production is about 300,000 tons a year. This figure includes washing and toilet soaps, and industrial, medicated and shaving soaps of good quality. However, there is a considerable amount of soap produced in small factories, generally of poor quality, which is nevertheless sold cheaply in rural areas. The production of washing powder and detergents is about 170,000 tons a year.

Table 15. Production of items incorporating vegetable oils in a selection of developing countries (Thousand tons)

Region or country	Latest available year	Margarine and other prepared fats	Soap	Washing powders and detergents
Latin America:		436.3	827.0	711.8
Mexico	1974	166.0	180.0	348.8
Brazil	1974	133.3	284.4	166.8
Argentina	1974	...	166.0	...
Colombia	1972	69.8	84.4	38.7
Venezuela	1972	14.7	26.4	48.1
Asia:		110.6	555.0	295.4
India	1974	...	212.7	84.7
Indonesia	1973	45.4	47.8	24.4
Philippines	1974	26.2	53.4	86.6
Korea	1974	18.5	83.2	31.0
Near East:		439.5	344.3	233.4
Iran	1972	194.0	30.0	89.0
Turkey	1974	152.0	44.5	34.4
Egypt	1973	87.7	143.1	19.1
Algeria	1974	4.6	41.1	18.5
Africa:		16.2	282.6	14.3
Nigeria	1974	5.0	47.1	...

Source: Yearbook of Industrial Statistics, Vol. II, 1974, United Nations, New York, 1974.

278. Information on Argentina is incomplete, although soap production is large, at 166,000 tons in 1974, while in Colombia and Venezuela margarine, soap and washing powders were all produced at levels generally less than half those found in Brazil and Mexico. The manufacture of these products in other Latin American countries is small, though farily widespread, with practically all countries at least producing soap.

279. Overall, the manufacture of vegetable oil products in Asia is about half the level found in Latin America, although the relative output of different items is similar and only the production of washing powders and detergents in Asia lags significantly behind that of Latin America. The main manufacturers of vegetable oil products in Asia are found in India, Indonesia, the Philippines and the Republic of Korea. With regard to India, information on margarine and other prepared fats is incomplete, but current levels of vanaspati production are estimated to be around 500,000 to 600,000 tons a year.

280. There are 78 vanaspati units in India with a total capacity of 1.2 million tons. Vanaspati was originally produced entirely from groundnut oil, but as consumption of this oil increased vanaspati manufacturers were compelled to include other oils to make up the deficit. According to government regulations, the vanaspati mix has to conform to the following requirements: a groundnut oil content of no more than 25 per cent, cottonseed oil content of not less than 30 per cent, liquid oil content of 10 per cent of which sesame oil should form 5 per cent. It is also required that the melting point of vanaspati should be 37°C. Imported oils, such as soyabean oil and palm oil, are also used in small amounts.

281. In Pakistan the vanaspati industry comprises 27 plants, of which the capacity ranges from 5,000 to 25,000 tons of final product a year. Their aggregate yearly capacity is about 400,000 tons. Actual production has developed rapidly in the last ten years, along with the rapid rise in consumption. The basic materials used for vanaspati manufacture in Pakistan are local cottonseed oil, limited quantities of rapeseed oil, and increasing quantities of imported vegetable oils such as palm oil. A typical present mix is about 50 per cent palm oil and 50 per cent cottonseed oil.

282. Small quantities of margarine and cooking fats are manufactured in Indonesia. Margarine manufacture uses mainly palm oil, about 6,000 tons a year, and around 3,000 tons of coconut a year. Practically all the cooking fat is made from palm oil and about 9,000 tons a year is utilized. In the Philippines only a relatively small amount of margarine is produced, between 6,000 and 8,000 tons a year, but 30,000 to 38,000 tons a year of shortenings are produced, and these two products utilize about 30,000 tons of coconut oil.

283. Very few developing countries process vegetable oils beyond the end uses previously mentioned. A major exception is Malaysia where the existence of substantial quantities of palm oil has led to secondary processing of the oil (fractionation). In 1974 there were only two factories in Malaysia carrying out this process, but by 1976 there were some 18 plants in operation. The fractionated products are used in the manufacture of liquid edible oil, vanaspati and shortening, the total production of these commodities in 1975 being some 87,000 tons, while margarine manufacture is planned for the future.

284. With a production of 212,700 tons in 1974, India is the continent's largest producer of soap. A major problem arising for the refining process in India is the disposal of soap stocks, particularly in the case of cottonseed oil refining. The 30,000 to 40,000 tons of soap stock available from the refining of cottonseed oil is especially difficult to utilize. At the end of 1970, there were 41 units engaged in soap manufacture and actual production was 232,000 tons. Rural industries probably account for at least a further 300,000 tons. Nearly 95 per cent of soap manufacture is in the form of laundry soap and about 4 per cent in toilet soap. About 66 per cent of soap is made by large-scale units and only 3 per cent in small-scale units, excluding the rural industry.

285. A number of other Asian countries, including Indonesia, Philippines and Republic of Korea, are major soap producers. For example, in Indonesia there are some 1,200 recorded soap factories with a production capacity of the order of 380,000 tons of soap. However, it is estimated that not more than half this capacity is fully utilized at present. Even so, some 70,000 tons of coconut oil are required each year by the soap industry. In addition to coconut oil, palm oil is used for soap manufacture in Indonesia, and the large factories sited close to the ports use about 70 per cent of palm oil and 30 per cent of coconut oil in their formulations. For the production of good lathering soaps the proportion of coconut oil should not be reduced below 20 per cent; so there is a limit to

the amount of palm oil which can be substituted for coconut oil in soap making. The small-scale soap factories for the most part are dependent on local supplies of coconut oil, but government assistance is being given to supplying some of them with palm oil in order to release more coconut oil for use as a cooking oil.

286. The serious shortage of vegetable oils for soap manufacture in several developing countries has led to the rapid growth of the use of synthetic detergents. This is particularly so if large multi-national companies are involved. A case in point is the Philippines where there has been a greater demand for detergents in the domestic market than soap, and it is estimated that the annual production of detergents is around 70,000 tons and of soap about 50,000 tons.

287. In the countries of the Middle East, slightly more vegetable oil products were produced than in Asia in 1974, but the ratio between margarine and other processed fats, soaps, and soap products was similar to that in Asia. Production of margarine and other prepared vegetable fats was similar to that in Latin America, but soap and washing powder production was considerably less. Patterns varied across the region however, with Iran and Turkey leading in the production of prepared edible fats producing 194,000 tons and 152,000 tons respectively in the most recent year, while Egypt produced the greatest amount of soap with 143,000 tons in 1973. Washing powders and detergents are produced in the same countries but are also produced in small amounts in many North African countries.

288. The vegetable oils industries in Africa have a different pattern from that found in other regions, reflecting the relatively low level of industrialization of most African countries. While most countries in Africa produce soap, only a few, such as Angola, Nigeria, Zaire and Zambia produce margarine, and even then only in small quantities; production in Nigeria, for example, was only 5,000 tons in 1974. Similarly, the washing powder and detergent industry remains small, making Zambia one of the main producers with 8,000 tons in 1972. In terms of soap production, Nigeria is the leading producer with a production of 47,000 tons in 1974, but other countries, such as Ghana, Kenya and Zaire also produce significant quantities.

289. However, in Africa, as in Asia, the combination of a traditional soapmaking industry and the more modern detergent manufacturing is also found. The Ivory Coast and Sudan are two countries where this combination is found though based upon entirely different vegetable oils. Soap production in the Ivory Coast is about 20,000 tons a year, and it is estimated that around 12,000 tons of palm oil are utilized by the industry. In addition, there is a small production of detergents, about 1,000 tons a year, which is expected to grow and to follow the general trend whereby the use of detergents expands while the market for soap remains static or even declines. Around 12,000 tons of cottonseed is utilized in the manufacture of soap and detergents in Sudan. Three of the large mills produce good quality toilet and laundry soaps, and one of the three also manufactures detergent. There are many small soap factories throughout the country using mainly poor quality locally produced oil, and in turn producing an inferior grade of laundry soap. Toilet soap production is estimated at around 24,000 tons a year but this figure would not include the amount of soap manufactured in rural areas.

Capacity utilization

290. The developing countries' share of the world oilseed processing industries is affected not only by the structure of the industry within these countries, marked by a high proportion of village processing, but also by the levels of operation that are achieved in practice from the total capacity that exists. As

has been indicated above, a number of developing countries' oilseed processing industries may be operating at something like 50-60 per cent annual capacity, and in some cases as low as 30-40 per cent. If this is so, then the 14.2 million tons of oil produced in 1975 is a significant underestimate of the size of the oilseed processing industry in developing countries. Assuming a much higher level of capacity utilization in the developed countries, then the proportion of oilseed industry processing capacity found in the developing countries will be higher than the 50 per cent implied by this figure. If average capacity utilization in the developed countries is taken to be 90 per cent and that in developing countries 60 per cent, then this would raise the proportion of oilseed industry processing capacity in the latter to about 60 per cent.

291. As under-utilization of capacity therefore appears to be a widespread phenomenon and has implications for the contribution which the developing countries can make to the future development of the world oilseed industry, it is useful to give some consideration to the likely reasons for its existence.

292. In extreme cases spare capacity in the oilseed processing industry may take the form of unused facilities. This occurs with items of machinery within a factory where other crushing facilities are being used and is most common in factories using a combination of expeller and solvent extraction, where the solvent plant is not used because the solvent is too expensive or unobtainable. It can also occur where power supplies are poor or non-existent, where technical knowledge is lacking, or where vital parts are missing. Fewer instances occur where an entire factory is unused. In such cases the reasons are generally political or due to staff shortages. The total amount of unused capacity available in developing countries is probably not more than 15 per cent of existing output, but this amount of unused capacity is by no means insignificant and can be cause for concern since it is so often related to the introduction of more modern machinery.

293. A second and more common form of spare capacity in developing countries is found where plant is under-utilized, that is, it is in use for only part of the day or year. Such cases arise for a variety of reasons, not all of which have been fully explored. In many cases under-utilization of capacity is due to seasonal variation in supplies and does not mean that financial losses are necessarily being made. However, the possibility of using these resources should be considered if the introduction of new oilseed crops into the country or region is proposed, especially if these have different harvesting times. For example, in Brazil, groundnut and cottonseed help to raise capacity utilization in mills which are primarily dependent on soyabeans. Improved storage facilities may also permit oilseed crushing to be staggered over a larger proportion of the year, and will also help to regulate supplies of oilseeds where these have been poorly organized in the past.

294. In other cases, a factory may have been built in anticipation of operating at a level of production that has failed to materialize, or which is still in the future. Thus supplies of oilseeds for crushing, although efficiently grown and marketed, may simply not exist in large enough quantities to keep existing factories running at full capacity. Alternatively, the demand for oil and cake may not be large enough at existing prices. Such factors should be taken into account when future expansion of the oilseed processing industry is being considered, as there is often a tendency to build new plant before fully considering the possibilities that exist for expansion of production within the existing industry.

295. It is also found that in oilseed processing factories, as in other industries in the developing countries, single shift systems are commonly in operation, and that a substantial amount of additional capacity is consequently

under-utilized. Additional shifts may be worked at times of seasonal pressure, but in general there is a wide-spread reluctance to expand this to a year-round basis. Reasons for this are unclear, but may be due to the effects of increased costs on low levels of working capital, to preferences of the work force or of management, or to shortages of certain types of skilled labour.

296. Another factor important in determining whether or not oilseed factories work to full capacity lies in government pricing policy. Sometimes prices of oilseeds are maintained, perhaps through a marketing board, at levels which benefit farmers but which make it difficult for modern plants to earn profits at prevailing prices for oil and cake. In such cases, village level and small-scale processors tend to thrive at the expense of the larger operators, and although the situation does not normally last for great lengths of time it does create unstable market conditions. This type of problem has recently affected groundnut processing in Nigeria. Price control is only one way in which government activity can influence capacity utilization in oilseed processing; in cases where the problem arises out of shortages of oilseed supplies for crushing, the Government could, for example, have to step in to intensify extension operations and to supervise buying and wholesale activities.

297. It is evident that there are many factors which can contribute to the under-utilization of capacity in the oilseed industry in developing countries. In addition to those already mentioned it is sometimes the case that communications and hence deliveries of raw material are affected by weather, that supplies of electricity, fuel and water are unreliable, that spare parts are subject to delays in arrival, and that supplies of bottles and other forms of packaging are irregular.

298. In general, under-utilization of capacity in the various ways described here is the major source of spare capacity in the developing countries and appears to be widespread, probably amounting to about 30 per cent of existing oil production in these countries. There are exceptions however, generally where the industry is export-oriented, as with soyabean in Brazil, oil palm in Ivory Coast and Malaysia, and sunflower seed in Argentina, where the oilseed processing industries operate at high levels of capacity utilization. Similarly, within many other developing countries there are individual factories which succeed in maintaining high levels of capacity utilization throughout the year.

299. A third type of spare capacity exists when oilseed processing plants are operating at less than full efficiency. A plant may be running continuously, but owing to inefficient procedures less than the optimal throughput of seed and oil is achieved. Problems of this nature are due to organizational deficiencies, shortage of skilled and semi-skilled labour, inadequate supervision and quality control, or the use of obsolete machinery which continually breaks down. Although such problems are thought to be widespread, they are in themselves responsible for production losses of only about 10 per cent of present vegetable oil production.

300. In summary, the main problems associated with under-utilization of capacity in oilseed processing industries are commonly distributed as follows. At the village level, where operations of the ghani type are predominant, the main sources of poor utilization of equipment are likely to be seasonal and due to inefficient techniques. It has already been pointed out that such methods leave as much as 12-20 per cent of the oil in the cake in most cases and this generally represents a loss of oil to subsistence consumption. Seasonal problems are difficult to overcome, since small-scale factories tend to have a rural base with limited possibilities for purchasing oilseeds grown in other parts of the country. Village processing may also be a secondary occupation of the owner, who is therefore less interested in achieving year-round operation.

301. At the opposite extreme, large-scale factory processing tends to be troubled by managerial and organizational problems, and by problems connected with ensuring regular supplies of oilseeds in large volumes. Other contributory factors include the demand for the final product, which could be low, and government policies with regard to prices and import protection. However, a large plant has the advantage that it is easier for it to buy from all over the country or from abroad and thus overcome seasonal variations in supplies.

302. In view of these various difficulties it would appear that medium-scale oilseed processors situated close to centres of population and communications are most likely to succeed in maintaining a run of high capacity utilization. The manager will know the local market; seed supplies can, if necessary, be brought in from outside; and organizational problems can be contained.

The supply of oilseeds and oilseed products

303. It is evident that the supply of oilseeds and oilseed products is a complex function of the structure of the oilseed industry. In the subsistence sector, the main incentive is the need to survive and to obtain adequate nutrition for human and animal use within the constraints of existing knowledge and practices, while in the commercial sector the overriding incentive must be provided by price and access to markets. The commercial sector of oilseed supply and utilization is therefore intimately bound up with the process of industrialization in any producing country.

304. In terms of the development of oilseed processing in developing countries, two basic situations apply. On the one hand, crops such as oil palm, sunflower, and in certain cases, soyabean, which already have a high level of commercial utilization, could be given encouragement for expansion, in the belief that future supply of these crops could be equally well integrated into the commercial sector. The same could be said for other oilseeds in particular cases, such as cottonseed and groundnuts in Sudan, or cottonseed in Pakistan, and possibly coconuts in the Ivory Coast, Malaysia and the Philippines, all of which have high levels of commercial utilization at present.

305. On the other hand, in cases where commercial utilization remains low, as is the case with many of the oilseeds under review in India, or groundnuts in Pakistan and Senegal (and possibly cottonseed in Brazil), encouragement could be given to increasing the proportion of the crop which is supplied and utilized commercially.

306. In each case, however, policy considerations must take account of different factors. Expansion of oilseed production in areas which already practice a high degree of commercial utilization can be done by increasing either yields or the area under cultivation. For the former, research, extension and credit schemes are usually needed, while in the latter, the type of support depends upon whether the land is to be newly cultivated, in which case direct assistance in the form of grants and credit may be required, or whether it is to be converted from some other use, in which case relative prices must be able to account for opportunity costs. Overall, an expansion of commercial utilization by the method of increasing the total amount of oilseed produced must also be backed by an adequate assessment of demand for the seeds in question.

307. Where the approach to the problem of greater commercial exploitation of oilseed resources is to encourage the subsistence sector to become more commercial, a somewhat different set of factors has to be considered. It is important in the first place to discover why cultivation in fact remains at subsistence level. It may be because of lack of incentives in the farm prices received by the farmer; because the marketing system is under-developed; or because of an inappropriate land tenure system, a shortage of land, or low yields based on poor cultivation

practices. Each reason requires its own remedy, and it should be remembered that whatever changes are proposed there must still be a price incentive sufficient to cover any opportunity costs to the farmer. A full investigation of the implications of the subsistence utilization of oilseeds and of any plans to reduce its significance would be desirable before accepting its eventual demise as the only possible means of increasing the value added element in the oilseed economy as a whole.

308. In practice, both approaches should be followed, with subsistence farmers being provided with assistance and incentives at the same time as existing commercial production is being expanded and improved. In the long run, the developing countries will increase their share of the world oilseed economy most effectively only if an integrated programme of development is followed which links up production activities at all levels with commercial processing and the demands of a monetary economy. Economic and social constraints make it unlikely, however, that the subsistence sector could be brought wholly into the area of commerical utilization in the foreseeable future. It may be possible in certain countries and in the case of specific oilseeds to reduce the significance of the subsistence sector in the short to medium term, but a significant proportion of oilseed production in the developing countries must be discounted as a basis for increasing the share of the global oilseed economy attributable to developing economies.

309. Corresponding to subsistence and commercial sectors of oilseeds production and utilization are the different techniques of oilseed processing. The subsistence sector is dominated by village-level processing, while various forms of mechanized procedures exist in the commercial sector. The technical inefficiencies associated with village level methods have a direct bearing on the supply and quality of oilseed production available for subsistence use and indications are that substantial supplies of vegetable oil are lost to human consumption by these means. However, in order to improve this situation it is necessary not only to provide technical assistance and price incentives, but also to examine the relationship of present methods with their socio-economic environment.

310. Supplies of oil from factory-level operations also tend to be constrained by problems of technical efficiency, though to a lesser degree, but it seems probable, as has been indicated above, that in the developing countries generally, oil production from present oilseed production levels could be increased by 15 per cent merely by using present techniques more fully. A further 15 per cent improvement could be obtained by adopting more efficient techniques, but not necessarily large-scale processing.

311. Another factor brought out in the present chapter and showing an influence on the supply of oilseed products is that the existence of certain types of processing methods does not necessarily imply that they are used to full capacity. Many developing countries are in possession of oilseed processing facilities that are often little more than half used and in some cases not used at all. The list of developing countries which appear to have excess capacity of one kind or another includes Indonesia, Nigeria, Pakistan, Philippines, Senegal, Sri Lanka and Sudan, just taking the important ones. There are many reasons why there can be apparent excess capacity, but the main reason appears to be an imbalance between supply and demand. Lack of sufficient supplies of raw materials is the principal reason for excess processing capacity in several of the countries listed, while large-scale technology or more-advanced technology is frequently adopted in many developing economies without due regard to its impact upon the existing processing sector or to the market potential for its products.

312. It is therefore evident that in a number of countries there is ample scope for processing a larger crop than at present. This does not, however, preclude the possibility that new processing facilities in these and certain other developing countries will be needed within the next few years. The most important of these are indicated at the end of chapter VI.

313. In the case of the supply of products which utilize vegetable oils, a comparison of the production of margarine and other prepared fats with that of soap and of washing powders in the four main developing regions illustrates a distinct pattern of development of the vegetable oils industries. In the least industrially developed continent, Africa, soap is the main item produced. This reflects the fact that production techniques can be relatively unsophisticated and also that a demand for soap exists even at very low income levels. As economic development proceeds, an increased urban labour force begins to demand more prepared fats while at the same time providing the labour force necessary for their production. Capital is also more readily available for the purchase of the more sophisticated equipment needed for hydrogenation and refining of the oils. This is the position already in many parts of Asia where vanaspati production is well advanced.

314. A third stage is reached when the manufacture of washing powders and detergents becomes feasible. Soap powders require little additional technical and capital investment compared with the production of soap, but a fairly sophisticated market must exist before powders can replace bars of soap in many forms of domestic use. Similarly, income levels must be sufficiently high to allow the purchase of both items in most households. The same can be said for detergents, which have the added complication of depending on more advanced techniques, since they are, for the most part, manufactured from petroleum-based inputs. A number of Asian countries have substantial washing powder and detergent industries but nowhere do they reach the levels found in Brazil and Mexico.

315. A final stage in the development of industrialized processing of vegetable oils is in the use of fractionated oils for a variety of specialized industrial purposes, which presupposes a highly developed industrial sector, unless exports are being considered. This stage has only just been entered in most developing countries. It is evident, however, that if the developing countries can maintain some level of economic growth over the remainder of this century, then there will be a large scope for the expansion and improvement of the prepared edible fats industries and the soap and soap powders industries, without calling for excessively sophisticated techniques. Where demand at present exists for these products it is often met by imports but small-scale production is possible and, if market size warrants it, import substitution should be encouraged.

316. There is a need to ensure that as great a proportion as possible of the raw materials used in the production of vegetable oil products is produced in the developing countries themselves, since in this way a maximum rate of increase of the share of developing countries in the world oilseeds economy will be achieved. However, at present imports into the developing countries of vegetable oil products from the developed countries do not always contain oils that are available in the importing country, and to this extent the prospective role of import substitution is reduced.

317. On the other hand, if locally available oils, or oils produced elsewhere in the developing world, can be substituted in finished products for oils produced in developed countries, the share of the developing countries in the world oilseed economy will be correspondingly higher.

V. MAIN VARIABLES IN THE OILSEED AND OILSEED PRODUCTS INDUSTRY

318. Chapters I and II surveyed world production and trade in oilseeds and oilseed products; the present utilization and processing patterns were examined in chapters III and IV. It is now possible to identify the essential features of the oilseed sector. The later chapters of this Draft Study are concerned with the future prospects for the oilseed industry in developing countries within the context of the Lima Declaration, but in order to provide a systematic basis for discussion in these chapters it is useful to bring together the salient features of the oilseed economy as outlined in chapters I - IV. This is the task of the present chapter, which is therefore seen as providing a link between the different parts of the study.

319. While many variables are obviously at work in world oilseed and related markets, there are some which carry greater weight than others and which can provide a foundation upon which to base a detailed analysis and forecasts of the oilseed sector. These are referred to as the main variables.

320. However, since even the main variables in the oilseed and oilseed products sector are extremely diverse and complex it is useful to divide the sector initially into sub-sectors according to the variables which most influence them. Three sub-sectors seem relevant: one dealing with oilseed production, one with the extraction and refining of oil and one with further processing in connection with oil-based derivative industries.

Oilseed production

321. In the case of the production of oilseeds there are a number of main variables, some of which affect the supply of oilseeds and some of which affect demand. In the list which follows items (a) - (g) are principally supply variables and (h) - (i) are demand variables.

(a) Availability of land. The amount and type of land available for oilseed production is obviously an important variable. In many countries, including a number of developing ones, the prospect of bringing uncultivated land into use is limited and any expansion of the area under oilseeds has to be at the expense of other crops. Where new land can be brought under cultivation its suitability for growing specific types of oilseeds has to be examined, as also has the willingness of local farmers to produce these crops.

(b) The physical infrastructure of production. The productivity of land for oilseed production is affected by the presence of irrigation facilities and ease of access to farmed areas for the distribution of appropriate fertilizers and equipment.

(c) Improvement of yields. The production and supply of oilseed and oilseed products is affected by the variety of plants cultivated. Research into high-yielding varieties is being conducted at many centres throughout the world and is concentrating on the yield of seed per plant or per ha, or on the yield of oil or protein from the seed itself.

(d) Technological knowledge and farm skills. Apart from research and development into new varieties of seeds, the supply of oilseeds and oilseed products is influenced by the degree to which farmers have adopted high-yielding varieties which are already known. This is often a question of cost and availability, but is also a function of the farmer's knowledge and willingness to adopt new techniques. Even with traditional inputs of seed there is often scope for improvement in farming methods which can have an effect on supplies of oilseeds.

(e) Availability and cost of farm imputs. The farmer's readiness to adopt new methods is affected by the availability and cost of fertilizer and other chemical inputs. The cost and type of available energy is an additional factor of increasing importance as agricultural production expands, while in certain cases labour can become a scarce factor.

(f) Access to and cost of investment capital. Private access to capital for purchase of new types of seed, developing irrigation facilities, and purchase of vehicles is important and can be counter-productive if interest rates and other conditions are prohibitive, whether or not the capital assistance comes from traditional money lenders, private commercial banks, or state agencies. In the case of access to capital for public uses, say for state farms or for state-sponsored schemes for the replanting of tree crops, the situation is rather different. A typical problem in this case is that returns to many state sponsored schemes are not realized until after a relatively long period of time and may not even accrue to the state itself. For this reason, the availability and access to capital funds can be an important variable influencing the supply of oilseeds and oilseed products.

(g) Degree of commercialization. The importance of this variable depends primarily upon the behaviour of the other variables listed so far, but it serves as a composite variable indicating the degree to which an agricultural sector is currently producing a surplus for domestic urban and external markets, and identifies areas of production which are more likely to be technologically inefficient.

(h) Internal market and its development. The internal market for oilseeds in any country has two main aspects. On the one hand there is the demand for oilseeds by consumers and industrial processors. This is believed ultimately to be largely a function of incomes, prices, and population, but can also be influenced by marketing and promotional activities. On the other hand, the efficiency of the marketing infrastructure is important and the extent to which demand and potential demand is satisfied can be influenced by the availability of transportation, storage, wholesale and retail facilities. A particularly important aspect concerns forward linkage with the oilseed processing industry: a fully integrated relationship in this respect simultaneously guarantees a market for the producer and raw material supplies for the processor.

(i) External market and marketing arrangements. The structure of the oilseed sector in a country and globally is strongly influenced by the role of export markets. Again, transportation, communications, harbour and shipping facilities are important but so is information on quality requirements, arrangements for payment and help in opening up new markets. Future expansion of oilseed protein for human use could provide a new stimulus in domestic and external markets, particularly if it leads to higher oilseed prices.

(j) Institutional infrastructure. An important variable which has influence over practically all others, on both the demand and supply sides, is the institutional infrastructure. The nature of this variable is generally within the control of the State and hence government policies can be significant for farm practices, land ownership patterns, prices, fiscal infrastructure, marketing structures, consumer incomes and trade incentives. Not only policies but also institutional arrangements expressed via different types of bureaucracy can also have important effects on the supply and demand for oilseeds.

Oilseed processing industry

322. A number of similar variables are at work in the oilseed processing sector, though the emphasis is somewhat different, and several new areas have to be considered. Land, for instance, is seldom a constraint in this sector but the cost and availability of capital remain important in both a market and an institutional sense. The main variables are as follows, once again putting supply variables first:

(a) Access and cost of raw materials. Both the supply and cost of producing oilseed products, such as vegetable oil and meal, are influenced by the availability of raw materials in the crushing factories. Irregular supplies of oilseed for crushing tend to increase unit costs by forcing factories to operate at less than full capacity and affect the regularity of supplies of finished products. Similarly, the cost of raw materials, if too high in relation to the price obtained for oil and meal, can act as a disincentive to the processor. Regularity of supplies of oilseeds is best obtained where backward linkage with growers is guaranteed by contractual arrangements.

(b) Physical infrastructure. Oilseed processing on a modern industrial scale requires adequate and regular supplies of water and power. Power may come from a mains electricity supply or from a factory-based diesel driven source, but in either case supplies should be regular in order to guarantee continuous production lines throughout each 24 hour period if necessary. Drainage is also an essential requirement. For transporting raw materials to the factory and for the distribution of oil and meal to consumers a suitable transportation network is needed. This involves roads, vehicles, maintenance services, and sometimes railways. Some infrastructural services can be provided by the factory, for others government assistance is necessary.

(c) Technical skills and efficiency of operation. An important variable in determining the efficiency of operation of a crushing factory lies in the technical skills of the staff. Although in traditional crushing technology the basic process is straightforward, skill is required for maintaining equipment, in controlling the quality of vegetable oil that is produced, and in obtaining waste-free levels of operation. Managerial skills are also required in order to maintain smooth running of the factory, in dealing with supplies of raw materials and sales of final output, and in supervising other personnel. In large factories, organizational tasks become more demanding, and in the case of solvent extraction of oil a considerably higher level of technical understanding is required.

(d) Access to technology and innovations. This variable is not so important in the oilseed crushing industry as it is in other industries where more rapid technological changes are taking place. It is, however, important to be aware of it in the context of developing countries since the channels for communicating technological advances in oilseed processing are not particularly well developed in many countries.

(e) Access to and cost of investment capital and working capital. As in the oilseed production sector this is an important variable in the oilseed processing sector. In chapter IV it is pointed out that the cost of a modern medium to large-scale oil extraction plant with all facilities can be between $7-15 million. Expansion of the oilseed industry can therefore be crucially influenced by the availability and cost of this type of finance. For the small processor, on the other hand, conditions are similar to those of the farmer in the oilseed sector: conditions laid down by private and public lenders of capital can act as disinscentives if not carefully supervised. Since the major part of a crushing factory's operating cost will be for raw materials, working capital is usually quite a large amount and this can give rise to additional problems, especially if the raw materials are not accepted as collateral for a loan.

(f) Pollution hazards and safety. These variables are becoming of increasing importance as the oilseed industry expands in developing countries. Adequate drainage and sewage for sludge materials is essential in an urban setting for reasons of health, but also in rural areas where the ecological balance can be disturbed to the detriment of other activities such as fishing. In any industrial setting safety requirements should be met, but in the case of solvent extraction these have to be more strictly observed, in view of the potential danger of explosion.

(g) Degree of commercialization. As in the oilseed production sector, this is principally a composite variable determined by market development, prices, infrastructure, and other variables, but again it serves as an indicator of the distribution of types of extraction equipment and of the overall efficiency of oil and meal extraction in the country in question.

(h) Employment impact. Industrialization is often considered to have a major impact on employment, but in the case of commercial oilseed processing the scope for labour-intensive activities is limited, except perhaps in the handling of raw materials and finished products within the factory compound. In general the employment impact is not considered to be large.

(i) Internal market and its development. The internal market for the products of the oilseed processing industry is important and complex. The market for vegetable oils is a function of their end uses, either as liquid edible oils or as ingredients in the margarine, soap and other industries, but ultimately, as with the derived demand for oilseeds themselves, the main determinants are income, price and population levels. Each end use is influenced in a different way by each of these factors. In the case of oil meal the immediate source of demand is traditionally the animal feeds sector, which reflects consumer demand for meat and other livestock products, again controlled largely by incomes, prices and population. However, the efficiency of the livestock industry utilizing various feedstuffs is also an important element. As with oilseeds, the determinants of consumer demand have to operate within a given marketing structure and the efficiency of the marketing system for vegetable oils and meals is an important variable in this sector, calling for an adequate transportation network, storage facilities, wholesale and retail outlets, and an efficient commercial infrastructure. Forward linkage with margarine, soap, paints, and compound feeds industries is also an important element in introducing stability to the market.

(j) External market and marketing arrangements. This is a variable of growing significance in the oilseed processing sector from the point of view of the developing countries. As industrial facilities have expanded in developing countries there has been a consequent need to expand export markets for processed items such as vegetable oil and meal, in contrast to the traditional overseas markets for oilseed. This requires knowledge of quality requirements and ability to meet them, storage facilities, access to markets, sales promotion, guarantees of delivery, and general government understanding of the problem involved. Within each overseas market the domestic variables affecting demand as outlined under (i) have to be understood in order to secure the best outlets for the exported goods. Tariffs, discriminating particularly against semi- or fully-manufactured products, should also be mentioned. Tariff escalation, increasing with the degree of processing, is a serious problem for developing countries.

(k) Institutional infrastructure. Once again, overriding all other variables is the institutional infrastructure within which the oilseed industry has to operate. Being largely under the control of Government this can affect incentives and efficiency through choice of taxation structure, safety regulations, price control schemes, development of physical infrastructure, and other items.

Oil-based derivative industries

323. The list of variables discussed in the section concerned with the oilseed processing sector is to a large degree common to a number of agro-industries and changes only in their emphasis as different industries are considered. This is particularly the case for the oil-based derivative industries, and little purpose is served by listing the same set of variables once more; instead a brief account is given of the principal ways in which emphasis can be expected to change in these industries.

324. In view of the high degree of substitutability now possible between oils and fats in many uses, the access and availability of raw materials is of less significance, though technological and institutional constraints on the use of certain oils do exist, and it is important that a margarine, vanaspati, or soap factory should not be established on a site or on a scale which makes it difficult to guarantee supplies of raw material.

325. The variables concerned with the physical infrastructure, pollution and safety have a similar role in this sector to the one they have in the oilseed processing sector, as does the access to and cost of capital. However, in view of the higher level of technology required in manufacturing prepared fats and soaps, the emphasis placed on technical skills will be somewhat greater. Similarly, in the development of new processes and products, such as in the human use of oilseed protein, it is important to have access to new technological developments.

326. The degree of commercialization is of less significance in this sector, since the final products tend to have few competitors in the traditional sector, although exceptions in the form of artisanal soap making and competition from locally produced ghee should not be ignored. On the other hand, the opportunities for employment creation are likely to be higher because of the increased number of stages involved in manufacturing and packaging the final product.

327. With regard to marketing arrangements and market development, the same points as before can be made, although additional elements appear through possible competition from other products such as ghee and butter in the case of edible prepared fats, and detergents in the case of soaps. Again, in the development of new uses of oilseed protein the nature of the market has to be carefully taken into account. This is also true if refined and fractionated oils are being considered as end products. Finally, as with each of the other two sub-sectors the institutional infrastructure affects all other variables with a degree of emphasis common to all sectors.

Conclusions

328. It is evident that the oilseed and oilseed products industry is influenced by a number of complex interlocking variables and that a complete understanding of the overall system is difficult to attain. However, the delimitation of the oilseed and oilseed products sector and identification of the main variables, as conducted in this chapter, can serve as a foundation for future analysis and predictions about the oilseed economy.

VI. MEDIUM TERM PROSPECTS - THE SITUATION IN 1985

329. The Lima Declaration called for studies to be made of various agro-industries in order that all possible means of increasing the share of the developing countries in these industries by 2000 be identified. As part of this process it is necessary to examine the prospects for the oilseed industry up to 2000 and so to identify the potential of the developing countries and the constraints which are likely to limit its realization.

330. The basis of such an analysis is to be found in chapters I - V of the present Draft Study. The list of main variables in chapter V provides a frame of reference in which present and future trends in the oilseed industry can be discussed and prospects up to 2000 analyzed.

331. However, in the case of the supply of oilseeds a number of decisions have already been taken with regard to planting and planting intentions, which to a large degree pre-determine the supply situation in the medium term. Similarly, on the demand side, medium-term rates of growth of such important factors as population and <u>per capita</u> incomes have been estimated, with some degree of agreement amongst different experts, and these trends can be regarded as fairly stable in the medium term. It therefore follows that an examination of the medium-term situation in some detail would be worth while and would provide an additional datum for the longer term analysis up to 2000.

332. For the medium term it is assumed that no radical changes will affect any of the main variables outlined in chapter V and that present trends will in general continue. The situation in 1985 can therefore be approached through an analysis of the main trends in supply and demand. Chapter VII, concerned with the year 2000, gives greater attention to individual variables.

333. The fact of the medium-term supply situation being to a large extent pre-determined is clearly brought out by an examination of individual country plans for oilseed production. In view of the importance which the supply of oilseeds plays in the future development and potential for the oilseed industries in the developing countries, it is useful to make a preliminary review of the plans and prospects for the major developing country producers of oilseeds before entering into discussion of the demand and supply balance of oilseeds products. This review is the subject of the following section.

The future production trends of oilseeds by regions and countries

334. In chapter I the conclusion was reached that sixteen countries are responsible for the bulk of production in the developing world. It follows that if the developing countries are to increase their participation in the world oilseed economy over the remainder of this century then much will depend in the first instance upon the plans and potential for sustaining or preferably increasing production and processing of oilseeds within these countries. This part therefore examines each of sixteen countries in greater detail and indicates where future growth in production is to be found.

Far East

335. Within the group of major producers there are six Far-Eastern countries. These are, in decreasing order of oilseed production, India, Philippines, Indonesia, Malaysia, Pakistan and Sri Lanka. India and Indonesia are characterized by the wide variety of seeds that are grown in significant quantities. This diversity is on contrast to a predominantly one-oilseed economy like the Philippines. The Pakistan oilseed economy is dominated by cottonseed and rapeseed, while Sri Lanka, like the Philippines, depends almost entirely on coconuts. Malaysia has only a slightly more diverse oilseed economy producing palm oil,

palm kernel and coconut. Of the six countries reviewed, three, namely India, Philippines, and Malaysia, stand out as being growth leaders in oilseed production during the remainder of this century. In India, the two major crops, groundnut and coconut, are planned to expand by 6.5 and 3 per cent a year respectively during the current planning period, and if irrigation practices are extended and other policy measures sustained, then such growth rates could well continue beyond the current plan. In Malaysia the major oilseed crop is oil palm, which is planned to grow at a rate of 16 per cent per year up to 1980 though dropping somewhat thereafter, and in the Philippines coconut production is expected to expand at a minimum rate of 5 per cent per year. In the case of India most production will disappear in the form of domestic usage but Malaysia and the Philippines are the world's major exporters of palm oil and coconut products respectively. Since in all three cases the targets seem likely to be met it can be concluded that these three countries are in a strong position to increase their share of world oilseed production.

336. The remaining countries, Indonesia, Sri Lanka and Pakistan, are not so well placed. Indonesia has a planned expansion of coconut production of only 1.5 per cent per year, though this still leaves the country as the world's second largest producer. However, when the present phase of replanting and rationalization is completed it is likely that output will increase at a somewhat faster rate than currently planned. Both Pakistan and Sri Lanka have been hit by recent poor climatic conditions but if the effects of these can be mitigated in future by the adoption of appropriate policy measures, the longer-term prospects for oilseed production in these countries are facourable.

Middle East

337. Iran and Iraq are major vegetable oil and oilseed importers, while Turkey and Sudan are major oilseed producers. There are great possibilities here for regional co-operation. In Turkey, the main oilseed crops are cottonseed and sunflower seed, while in the Sudan they are groundnuts, followed by cottonseed and sesame seed.

338. The demand for oilseed in Turkey is projected to increase at an annual rate of 5.5 per cent between 1972 and 1977, the period of the third five-year development plan, while the production of cotton is planned to grow at just under 5 per cent a year and that of sunflower at 6 per cent over the same period. It is evident that in relation to these crops Turkey will do little more than maintain its present level of virtual self-sufficiency. It should be noted that Turkey is also a major producer of olives, and that the demand for and utilization of olive oil would have to be considered if a more detailed analysis of the country's oilseed economy were to be conducted.

389. Oilseed production in the Sudan has been forecast by a 1973 FAO perspective study to grow at between 3.5 and 5.5 per cent a year between 1970 and 1985, with the higher estimate corresponding to the Government's five year plan, for 1970-1975. The same FAO source forecasts that seed cotton production will expand by 2.5 to 4 per cent a year, implying a slight decrease in the relative importance of this crop, thereby leaving the main increase in future oilseed production to come for groundnuts. A major part of Sudanese oilseed production is exported either as seed or, increasingly, as oil. If indicated growth rates of oilseed production are achieved, then Sudan's contribution towards increasing the share of the developing countries in the world oilseed economy will be positive and valuable, though a more significant effect is likely to be achieved in the longer term as the country's full potential is realized.

Africa

340. Given the inclusion of the Sudan as part of the Middle East group of countries, the bulk of African oilseed production is concentrated on the west of the continent. Of the producers of oilseeds under review, Nigeria is easily the largest in volume terms, followed by Senegal, Zaire and Ivory Coast. The only major producer elsewhere on the content is Ethiopia. With the exception of Ethiopia, the most important oilseeds in these countries are palm oil, palm kernels and groundnuts, plus smaller amounts of cottonseed and coconuts.

341. In conclusion, of the five main African producers of oilseeds, only two, the Ivory Coast and Senegal, seem certain of consolidating their already secure position as important producers of palm oil and groundnuts respectively. Nigeria is much the largest producer of the group but faces a number of problems before any rapid rate of expansion of oilseed production can be foreseen, while Ethiopia and Zaire have organizational problems to overcome before their full potential can be realized. Over the long-term African producers could expand at rates similar to those planned for the major Far Eastern producers, but, with the exception possibly of the Ivory Coast, these are unlikely to be achieved during the next decade.

Latin America

342. Three countries, Argentina, Brazil, and Mexico, dominate production in Latin America of the oilseeds under review, with Brazil significantly ahead of the others in terms of volume produced. Soyabean is the main crop in Argentina and Brazil, but in Mexico it takes third place in volume terms to coconut and cottonseeds, although a variety of oilseeds is produced in all three countries.

343. In recent years Brazil has attracted attention as a major producer and exporter of soyabeans, yet the country is also the continent's largest producer of cottonseed, groundnuts and palm kernels, and its second largest producer of coconuts. No other oilseed, however, has expanded production at such a rapid rate as soyabean nor made such an impact on world markets. Production between 1970 and 1975 increased at an average annual rate of over 40 per cent, though the 1975/76 crop appears to be only some 13 per cent above that of 1974/75. Although rates of expansion as high as those of the early 1970s are unlikely to be sustained, continued expansion is part of the Government's strategy, and improvements are planned in internal transportation, storage, and port facilities, while producers' co-operatives and crushing facilities are also receiving extra support. Much of the earlier expansion was due to new areas being turned over to soyabean, but future production is likely to come from yield improvement and double cropping after wheat. This is likely to produce lower growth rates than in the past. The national development plan for 1975-1979 anticipates that oilseed production will expand over the planning period by an annual amount of 10 per cent, and in the light of past experience it is likely that this rate will be achieved.

344. The major oilseed producers of Latin America are likely to enter the future led by the continued strong expansion of Brazilian soyabean production, supported by the substantial Argentinian output of soyabean and sunflower seed, and followed on a less spectacular level by Mexican production of soyabean, safflower seed, together with some recovery of cottonseed.

Conclusion

345. The overall picture in terms of production is therefore reasonably encouraging, with a number of the major producers likely to achieve growth rates of oilseed production of 5 per cent per year or more. If fully realized, such rates of growth of oilseed production in the countries discussed would result in a considerable increase in their share of global production by 1985. At

present the sixteen countries reviewed account for 35 per cent of world oilseed production. This figure would rise to 47 per cent if their plans were realized and all other producers continued to expand at the historical rate of growth. It seems probable that this exaggerates the likely position but the tendency is one that is readily apparent. The countries reviewed above seem well placed to improve their share of global oilseed production.

The demand and supply balance in 1985

Vegetable oils

346. The evidence of the previous section is that supplies of oilseeds from the developing countries in the medium term are likely to increase at a fairly rapid rate, subject to climatic conditions, and therefore that on an overall basis raw material supplies are unlikely to provide a major constraint to the supply of vegetable oils. The situation with regard to the developed countries is somewhat similar, though expansion programmes are likely to be more modest, depending upon relative price and income incentives to farmers and on trends in seed technology.

347. However, since the vegetable oils sector has direct links with both the oilseeds sector and the derivative industries sector it is convenient to focus analysis on supply and demand for vegetable oils themselves rather than upon oilseeds. The following paragraphs therefore present the most likely situation for 1985.

348. In developed countries demand for vegetable oils has been seen to be high and is indeed expected to reach saturation point by the early 1980s, while in developing countries consumption is still low, though in most cases oils are becoming an increasingly important component in the diet. It is predicted that this gap will be narrowed to some extent during the remainder of this century. FAO agricultural projections to 1980 indicated an increase in total demand for food fats and oils of about 2.7 per cent a year. The fastest rate of total consumption increase was projected for developing countries with an annual average increase in demand of about 4 per cent. Developed countries' consumption is expected to rise by only 1.6 per cent a year. Broadly speaking, these rates of growth are confirmed by USDA projections.

349. A recent up-dating of the FAO projections carried out by UNIDO and extending the period to 1985 has indicated little change in these figures. On a low growth rate assumption the rate of growth of demand for fats and oils in devloping countries is estimated to be 3.7 per cent a year, while that of the developed countries should follow from the earlier FAO forecasts. Assumptions of higher growth rates have the effect of raising the average developing country rate of growth of demand for these products to 4.5 per cent a year and that of the developed countries to 1.8 per cent a year.

350. The implications of these demand projections for the developing countries' oilseed economies are highly significant. Although the developing countries produced 14.2 million tons of the vegetable oils under review in 1975, the net effect of international trade in those oils is to reduce the availability in developing countries to 12.7 million tons. In other words, the developing countries are now exporting a considerably greater quantity of vegetable oils than they are importing. However, the likely pattern of future demands indicates that the developing countries could become the most important market for vegetable oils and fats. With overall demand likely to stabilize in the developed economies, it is expected that consumers will also become more discerning in their use of vegetable oils. The oils most likely to benefit will probably be those with particular characteristics, such as a high or medium polyunsaturated fat content, for example, sunflower and soyabean, and also the lauric oils, coconut and palm kernel. However, overriding many if not all of these specific characteristics will be the continuity of supplies and relative prices of the

oils. In view of the fact that vegetable oils are becoming increasingly substitutable the really important relationship will be whether or not a given price differential is sufficient to bear the cost of modifying an oil for use in a role not previously considered.

351. On the production side table 16 restates the situation in 1975 and suggests that the vegetable oils most likely to be in abundant supply by 1985 will remain soyabean oil and palm oil with sunflower seed oil a close third, thus extending the trend of recent years. If demand is concentrated upon these oils, in volume terms the developing countries as a whole will see little improvement in their market position, although the major palm oil producers will benefit. In view of the importance of soyabean as a source of protein, and the likelihood of continued government support for growers, soyabean oil production is likely to remain concentrated in Brazil and the United States. By 1985 United States production is estimated to reach around 6 million tons and Brazilian production 2.8 million tons (oil equivalent). This represents 66 per cent of the world total in table 15. World palm oil production is expected to increase by about 11 per cent a year between 1975 and 1985. Some 40 per cent of the palm oil consumed in 1975 was used in developed countries. By 1985 it is estimated that around 2.5 million tons, or 45 per cent of a total consumption of 5.6 million tons, will be consumed in the EEC and Japanese markets and the United States, the EEC and the United States taking more than 1 million tons each. This increased penetration can be achieved only at the expense of other oils.

352. However the real growth points are expected to be the palm oil producers' domestic markets and increased exports to other developing countries. Two developing countries whose consumption of palm oil is expected to increase substantially are Iran, where consumption is expected to expand to 200,000 tons by 1985, and India, where expansion from 53,000 tons to 125,000 tons between 1974 and 1985 has been estimated. The penetration of palm oil into these markets will undoubtedly boost the developing countries' share of the total world market, but equally, such a trend is also going to benefit a very small number of developing countries and add considerably to the import bills of many more.

Table 16. Vegetable oils - production in 1975 and projections to 1985

Type of vegetable oil	1975		1985	
	Million tons	Percentage of total	Million tons	Percentage of total
Soyabean	8.5	29.8	13.4	33.1
Groundnut	3.2	11.0	4.3	10.6
Coconut	2.7	9.6	3.3	8.1
Cottonseed	3.2	11.3	4.0	9.9
Palm	2.9	10.3	5.6	13.8
Palm kernel	0.5	1.8	0.8	2.0
Sunflower seed	4.0	14.2	5.0	12.3
Rapeseed	2.6	8.9	3.0	7.4
Sesame seed	0.7	2.5	0.7	1.7
Safflower seed	0.2	0.6	0.4	1.1
Total	28.5	100.0	40.5	100.0

Source: TPI.

353. Using the estimated rates of increase in demand previously mentioned and the estimates of production shown in table 15, the projected situation in 1985 is that the developing countries will be utilizing between 18.3 and 19.7 million tons of oil but may well be producing 20.9 million tons. In contrast the developed countries are expected to be consuming between 18.2 and 18.5 million tons of vegetable oil by 1985 but producing in the order of 19.6 million tons. Consequently the implied total demand in 1985 of between 36.5 and 38.2 million tons seems more than likely to be met by the projected supplies of 40.5 million tons. In practice, it is highly unlikely that a physical surplus will be produced but the gap between potential supply and demand implies pressure on price levels and increased competition for the available market.

354. In summary, as income levels increase in the developing countries an increasing proportion of the supply of vegetable oils will go towards meeting demand in these countries, although in the longer term some countries may be experiencing a slackening of the rate of growth of demand as basic needs are satisfied. In the developed countries, demand is expected to grow not much more than population growth rates, and the potential from supplies in these countries could produce problems for the developing countries if domestic processing industries are faced with increasing competition from highly competitive imported oils.

Oilmeals

355. As joint by-products of oilseeds, the supplies of vegetable oils and oilmeals are likely to expand at similar rates, though some variation is possible if the distribution of oilseeds by type of seed undergoes any radical change. In general, however, the implications which the supply of oilseeds has for the subsequent supply of vegetable oils will be the same for the supply of oilmeals. It therefore, follows that the optimistic view taken of oilseed production in the developing countries is likely to lead to a higher rate of increase of oilmeal supply in these countries than in the developed ones.

356. A similar situation is also to be expected with regard to the utilization of oilmeals. In general, however, it has to be remembered that the demand for oilmeals is a derived demand, and that even although they are an important source of protein there is relatively little straight feeding of oilmeal in the commercial livestock industry, the more common practice being to make use of oilmeal in the compound feed industry.

357. Thus, in the developed countries after a rapid growth in the 1960s and early 1970s production levelled off and is not expected to grow by more than 1.5 - 2.0 per cent annually in the foreseeable future. This is due to the falling-off in the consumption of livestock products in Western Europe and the United States as a result of the slowing down in both population and income growth. This is further aggravated by the various butter, skim milk and beef "mountains" that are chronically plaguing the EEC and depressing the agricultural sector. An additional restraint on growth is the continual improvement in husbandry and feed technology, and the genetic changes in livestock which are reducing feed conversion ratios: that is, weight gain is increasing while feed intake is being reduced.

358. Feed ingredients. The European Economic Community possesses the world's most sophisticated feed industry, particularly as regards flexibility and expertise in utilizing various feed inputs. The demand pattern for these inputs is very much determined by the Common Agricultural Policy (CAP). Broadly speaking, the CAP has led to high cereal prices within the Community. The livestock industry can mitigate this by using compound feeds. Cheap protein can be imported for inclusion in compound feeds in the form of oilcake and meal. This also applies to cheap energy feeds, e.g. manioc, citrus and beet pulp pellets. All these items can be imported either at a low rate of duty or at a reduced levy. Since in the future the total Community demand for compound feeds is expected to be

relatively stagnant, the main activity on the import market will consist in a constant shuffle between various ingredients, with a tendency towards the cheaper ingredients. Progress in nutritional science and feed technology, and reduced profit margins, will be strong incentives to search for the best feed at the lowest prices. As regards Denmark, Italy, and the United Kingdom, an increased use of cereal substitutes can be expected, mainly in the form of cassava. However, there are serious constraints in the form of high transport costs to inland areas where some feed plants are located, particularly in the United Kingdom, and the problem of handling.

359. On the other hand, intensive livestock development, and consequently the rapid growth of the compound feed industry, are promising in Eastern Europe and increasingly so, in certain developing countries having high density urban centres. In the case of the latter, intensive monogastric production, notably poultry, is the simplest and most efficient solution to the problem of rapidly increasing the supply of first class protein for the human population. This sector of the livestock industry can therefore be expected to grow rapidly in the hinterland of a large number of metropoli, e.g. Baghdad, Caracas, Istanbul, Lagos, Sao Paolo, Seoul, Tehran, and this will require an accompanying development of the feed industry.

360. Assuming that rates of growth of demand for livestock products are of a similar order of magnitude to those for vegetable oil products in the developing countries, but being influenced mainly by per capita income levels and population growth rates, then the overall supply and demand balance for oilmeals will tend to be similar to that for oils.

Implications for investment in developing countries

361. Taking the situation for vegetable oils as a guide it was calculated that, by 1985, utilization of vegetable oils in developing countries could be 18.8 million tons, compared with the 1975 production of 14.2 million tons, and using an annual growth rate of demand of 4 per cent. On the conservative assumption that the unused and under-used capacity in oilseed processing industries in the developing countries as a group is of the order of 30 per cent, then vegetable oil production of 14.2 million tons could theoretically be raised to 19.0 million tons if the full processing potential were to be realized. This is clearly sufficient capacity to satisfy requirements and would indicate that no additional investment is necessary over the next ten years.

362. Full capacity utilisation, however, implies that the various problems described in chapter IV can be completely overcome, which is an unrealistic assumption. In instances where spare capacity is connected with the use of obsolete equipment, or with equipment which has not been used for some time, the additional costs involved in increasing their use could bring the potential returns down to levels less than these which could be obtained by purchasing new equipment and setting up new plans. In other instances, as when there are labour and administrative problems, time is required for their solution and the costs of delay may defeat the object of the exercise. Nevertheless, new resources should be established only if similar problems can be guaranteed not to recur within the new establishments.

363. However, in addition to their own needs, the developing countries by 1985 are also expected to be producing an additional 2.0 million tons of oil, making their total processing requirement equivalent to almost 21.0 million tons of oil. In practice, therefore, additional processing capacity is likely to come from both the more efficient utilization of existing plant and the establishment of new facilities. Nevertheless, on the basis of previous assumptions, a major proportion of the increased processing requirement that developing countries are estimated to need by 1985 could come from the rehabilitation and more efficient utilization of existing plant.

364. A large proportion of the new investment required is accounted for by the production plans of only a few of the major producers. If Malaysian palm oil maintains the rate of growth of output laid down in the present development plan for the full period up to 1985, then additional processing capacity of about 800,000 tons will be required. This can be anticipated with some certainty since palm fruits must be crushed within the country of harvest, though in the case of other oilseeds predictions with regard to processing needs are most difficult to make. In the case of soyabeans about 56 per cent of Brazilian production in 1975 was crushed within the country, and if this proportion only remains constant for the next ten years, then additional processing capacity for the production of about 1.5 million tons of soyabean oil will be required by 1985. Similarly, in case of coconuts in the Philippines, where some 62 per cent of production is crushed, an additional 500,000 tons of coconut oil capacity will be needed by the same year. Thus these three countries alone account for at least an additional 2.0 million tons of capacity by 1985. Other countries where new investment seems a distinct possibility are Argentina, India, Indonesia and the Ivory Coast.

365. New investment will tend to concentrate on modern screw-press and solvent extraction methods but the possibility of some expansion of ghani-type methods should not be ruled out, especially in areas where new land is brought under cultivation or converted from other uses, or where existing oilseed producing areas begin to increase yields through improved selection of seeds. To a certain extent, however, the possibility of expansion of traditional methods will depend upon whatever measures are taken to introduce modern methods elsewhere.

366. As pointed out in chapter IV, if it is to run at anywhere near full capacity, a medium or large-scale plant must be backed up by an adequate marketing and pricing system, both for the supply of raw materials and for the sale of final produce. Generally speaking, if these conditions are not met, then the traditional crushers will be the beneficiaries.

367. However, if the developing countries intend to increase their share of the oilseed processing industries in the long run, then they must concentrate on the higher productivity technologies, and, where it is government policy to encourage small-scale producers, some form of subsidy may be necessary, together with the provision of credit for the purchase of modern small screw presses. The bulk of new investment in oilseed processing will be in medium or large units, and although there is likely to be an increase in the use of solvent extraction methods, the rate of increase will continue to be constrained by such factors as the availability and price of solvent, and the training of the labour force.

Capital cost of investment in the oilseed industry

368. Without further reference to specific country situations it is impossible to generalize about the cost of investing in the oilseed industry. Not only do local conditions with regard to land, labour, potential market size, and other factors differ, but different oilseeds often call for different types of industrial arrangements. Palm oil, for example, generally has to be extracted within hours of harvesting the fruit bunches in order to minimize the formation of free fatty acids which are detrimental to the final quality of the oil. However, by taking some examples it is possible to give some idea of current orders of magnitude. In the case of palm oil, the oil extraction plant is usually integrated with an oil palm estate and the cost of the crushing facilities accounts for about 30 per cent of total estate costs which could be themselves $40 to 50 million for a 10,000 ha estate. This means $12 to 15 million for plant and equipment. For coconut oil the capital requirements for a crushing plant having the capacity to produce 38,000 tons of oil a year are some $7 million, while for a groundnut oil factory which includes solvent

extraction and refining equipment, and a capacity of 28,000 tons of oil a year (250 tons of groundnuts a day), the cost is about $11 million. In Brazil the cost of a 300,000 tons/year soyabean processing plant, including land, storage, and solvent extraction, the capital requirement is about 10 million. The estimated average capital expenditure for a pre-press solvent 600 tons/day rapeseed crushing plant in 1977 was 16.2 million.

369. It is evident from these examples that the expansion of the oilseed industry in developing countries represents a substantial call on the capital resources of these countries and that great care has therefore to be taken in appraising individual projects and in arriving at suitable financing arrangements.

370. Altogether, if investment does take place as indicated, such that by 1985 some 21.0 million tons ofoil are being produced in the developing countries, including production for export, then this will represent 51.6 per cent of expected world vegetable oil production by that year; very similar to the present figure of just under 50 per cent. However, bearing in mind the projected growth rate of the oilseed economy as a whole, this represents a significant expansion which could be improved if per capita incomes in the developing countries increase at a more rapid rate than expected, thus stimulating local demand, or if substantial inroads into the markets of the developed countries can be achieved.

371. Nevertheless, if new investment of the amounts indicated is forthcoming and the developing countries can consequently supply most of their own needs for vegetable oils, then this in itself will be a considerable achievement. Countries will not only benefit from the creation of value added and saving of foreign exchange in producing their own vegetable oils, but will also be better placed for the development of secondary industries.

VII. THE LONG TERM - 2000

372. The development of the world oilseed economy after 1985 is best considered in the conceptual framework of chapter V, which identified the main variables. The present chapter therefore begins with a review of the role which particular variables are likely to play in the oilseed economy over the remainder of the century, with particular emphasis on changes in end uses. With this information as background the chapter then concludes with a tentative analysis of the likely demand and supply balance in the vegetable oils industry by 2000. The conclusions of this chapter are not intended to be in any way definitive, but rather to offer benchmarks against which the potential of the developing countries for increasing their share of the world oilseed industry can be estimated.

Changes in the main variables

373. The three sub-sectors discussed in chapter V are considered in the same order as before. From the point of view of oilseed production the situation for the medium term to 1985 was seen to be fairly optimistic, but it is difficult to be confident that the high rates of growth experienced by some oilseeds in the 1970s and anticipated for the early 1980s will continue in the future.

374. The main reason for this is that possibilities for bringing new land into cultivation will tend to become increasingly limited and future growth rates will have to depend more on increasing yields, unless other non-oilseed crops are displaced. On the other hand, considerable research is going on around the world into the development of new varieties of seed, adaptable to local conditions, in many cases emphasizing soyabean in view of its high protein yield. Significant improvement in seed technology can therefore be expected over the next 23 years, but the effect is expected to be gradual rather than dramatic.

375. Of greater importance, possibly, will be the increased adoption in developing countries of seed varieties and cultivation techniques whose existence is already known. This will come about through the gradual improvement of extension services, skills, techniques, infrastructure, and availability of capital.

376. With regard to markets, these will depend upon the trends in incomes and population in developed and developing countries, and in the case of the latter, upon the relative expansion of oilseed processing and derivative industries, all of which can be expected to change only gradually (at rates discussed later in this chapter). Overseas markets for oilseeds will remain important, though increasing quantities will be crushed domestically, but the position with regard to trade barriers is difficult to predict, depending considerably upon general economic prosperity and policies of the developed countries which form the main import markets. Significant changes in trade barriers could occur within a relatively short space of time with considerable effect on the developing countries but it is virtually impossible to predict these over a period as long as 23 years.

377. In the case of oilseed processing, the general situation up to 2000 with regard to the main variables is somewhat similar to that for oilseeds. No dramatic changes are foreseen and in the developing countries gradual improvement in skills, operating efficiency, infrastructure and backward linkage with oilseed producers is expected to continue. Similarly, with regard to primary extraction methods no radical innovations are expected, though research with such methods as wet processing will continue, and gradual improvements will be found in the versatility of machinery.

378. The principal change in the developing countries as a whole will be a steady spread of the more advanced technologies that are already available. Thus, village-

level methods will tend to give way to commercial screw presses and medium-scale commercial operations will expand into pre-pressed solvent extraction. There may also be some expansion of rural technologies specifically designed for use in developing countries.

379. With regard to markets the domestic situation is again dependent upon income, population, tastes, and relative prices, but for export markets the presence or absence of import regulations for vegetable oil is of greater significance than in the case of oilseeds, though equally unpredictable.

380. The third sub-sector discussed in chapter V is that which involves further processing of vegetable oils and their use in derivative industries such as margarine, vanaspati, and soap making. Once again, depending on income and population growth rates, steady expansion can be expected of these industries in the developing countries with the main technological changes coming from the adoption of known techniques rather than from technological breakthroughs.

381. However, although the markets for these conventional types of industrial products will provide the main source of revenue for the vegetable oils industries up to 2000, there are possibilities of expansion in non-traditional markets. With increased industrialization generally taking place in the developing countries, and at more sophisticated levels, there will for example, be increasing demand for individual vegetable oil fractions. Similarly, following research mainly conducted in the developed countries, there is a possibility of increased use of oilseed protein in human diets. In view of the inherent potential of such activities they are considered in somewhat greater detail below.

Possible new uses of oilseed products

382. With the development and sophistication of the margarine, vanaspati and soap and detergent industries in the developing countries there will be an increased demand not simply for refined vegetable oils but also for individual fatty acids and fractions to be used in developing suitable blends. This is likely to affect palm oil initially more than others partly because of the ease with which palm oil fractionation can be carried out, and partly because of Malaysia's concern with increasing domestic value added in relation to palm oil, and finding an outlet for the rapidly increasing output of this oil, which is expected to continue for some years as new plantations come to fruition. There are also indications that certain of the fractions obtained from palm oil will be increasingly used, sometimes in place of groundnut oil, as cooking oils, and as constituents of cocoa-butter substitutes. Other possibilities for the use of this oil are in the isolation of carotene, a vitamin A precursor, usually lost in the bleaching process, and in the extraction of tocopherols, natural anti-oxidants also currently lost in refining.

383. In the case of palm kernel and coconut oil new uses of some potential are as cocoa-butter substitutes used for chocolate-type fillings and coatings common in confectionery. Interest in this area has increased as the price of cocoa-butter itself has risen. These oils also contain medium-chain triglycerides which have a small demand in developed countries for use in easily digestible foods, and as dieting control in developing countries becomes more sophisticated, this outlet may also become possible in those countries.

384. The use of conventional rapeseed in developed countries has been restricted for use in human consumption because of the presence of a high proportion of erucic acid. The spread of low erucic acid types from developed countries to developing country rapeseed producers, such as India, will make this oil more acceptable in commercial food products. Rapeseed oil also contains tocopherols which could be worth isolating if large-scale refining is established. It also

contains quantities of lecithin, a family of chemically related substances used widely in the food industry and, normally derived from soyabeans, in developed countries as an emulsifier and dispersing agent. Although the quality found in rapeseed is not so good as that found in soyabeans, increased demand in developing countries for "home-grown" lecithin could lead to its increasing extraction. It should also be noted that rapeseed is a potential source of certain steroids which, after processing, yield various medicinal compounds.

385. As far as sunflower oil is concerned, increased demand will tend to be confined to an increasing use in poly-unsaturated fat margarines. There may also be an increasing demand for groundnut and cottonseed oils in such products, and the flower may also be utilized if refining is carried out on a large enough scale, for the supply of lecithins and steroids.

386. High-quality soaps and cosmetic products are also areas in which certain oils are likely to find increasing uses, especially the laurics, and possibly lecithin from rapeseed in the case of cosmetics if it does not prove to be entirely acceptable for edible uses.

387. Finally, it is perhaps worth observing that sesame contains synergists for pyrethrum-based insecticides; although a synthetic analogue exists, home-grown sesame could reduce the need to import in this industry.

388. It can be seen that none of the end uses mentioned in this section is likely to constitute a major new market for vegetable oils. Many, such as the production of lecithins and steroids, are really an extension of existing practices and could be expanded comparatively easily given the required growth in the markets for these products. Other aspects, such as the increasing use of oils high in polyunsaturated fatty acids, undoubtedly imply changes in the relative demand for different oils but the process is essentially one of substitution rather than absolute expansion of vegetable oils uses. On the other hand, a tendency to replace products such as butter, made from animal fats, with margarine, made from vegetable oils, would lead to an increased total demand for vegetable oils. However, nothing in the foreseeable future leads one to conclude that the overall pattern of demand for vegetable oils could change markedly, although marginal changes in the relative proportion of demand met by the individual oils could take place.

389. The situation with regard to oilmeals could be somewhat different as considerable interest in developing oilseed protein for human consumption exists throughout the world. This aspect of the oilseed industry is most highly developed in the United States where the dominance of soyabeans has meant that the technology of protein products derived from oilseeds is also overwhelmingly concentrated on the use of soyabeans for this purpose. The range of products and uses is wide and includes meat extenders and substitutes, often in texturized form; in beverages as either milk fortifiers and extenders or for use in other beverages; and as flours for use in the protein fortification of bread and other bakery products.

390. Although the present importance of these products in the developing countries is small in relation to total oilseed utilisation, there has been fairly widespread activity in this area on a small scale for a number of years. Thus, in 1973 a study undertaken by the Tropical Products Institute, London, identified 69 enterprises which were operating or which had formerly operated in some 30 developing countries. Information was available about the ingredients of 47 products. In 43 an oilseed was used as the only or as a major source of protein. The dominating oilseed used was soya, in 25 products. Groundnut and cottonseed were also used. Eight to nine thousand tons of groundnut flour were used anually in one Indian protein-rich food. Two other oilseeds, sunflower and sesame, had also been used in one or two products.

391. However, the emphasis on soya-based products, which continues, is not always to the b[illegible] advantage of those developing countries for which this oilseed is not a t[illegible]tional crop. This has lead to a situation where some countries are importing vegetable protein from North America while they are experimenting with the production of soyabeans in their own agricultural sectors. Interest in soyabean production is, of course, also stimulated by its potential as an animal feed in livestock production.

392. Research is also continuing on the use of other oilseeds, more traditional to the developing countries, for protein products. Thus, in beverages it has been found that groundnut protein is considerably more soluble than that of soyabeans and produces a smaller increase in viscosity, while cottonseed protein has certain advantages in the fortification of carbonated beverages. It has also been suggested that the water-soluble fraction from coconut processing could be converted into a beverage that might be placed between milk and the pleasure beverages. In the case of flours, it has been shown that groundnut and sesame flour are more compatible with wheat flour than is soyabean flour, while low-cost protein flour from glanded cottonseed has been proposed as a protein product of some potential.

393. These protein-rich foods are not generally intended to displace products of animal origin but rather to supplement the diets of those to whom animal protein is either not available or is available only in minimal quantities, generally because of its cost. Provided sufficient effort is devoted to the enterprise, products which are acceptable to the consumer can be made, using vegetable materials as the main protein source. However, where the main target groups are the very low-income sectors in developing countries, even the "low-cost" protein-rich foods tend to be too expensive. The protein-rich foods cannot yet be said to have made an impact on malnutrition in global terms but interest in them is still very strong and some of the research now being carried out into the use of oilseeds for edible purposes is directly connected with this market, for example, work on rapeseed.

394. In conclusion, it is expected that research and investment in protein derivatives from oilseeds for human use will continue over the remainder of this century. The impact on the oilseed and oilseed products economy from the point of view of the developing countries could be substantial and there is every reason to anticipate a significant increase in this sector of the industry, provided that problems of quality and consumer acceptability can be controlled.

<u>The situation in 2000</u>

395. On the basis of the foregoing discussion of the main variables, and taking account of the expected situation by 1985, it is possible to consider, in aggregate terms, the prospects for the world oilseed and oilseed products industry by 2000.

396. Of the three sub-sectors discussed in chapter V, it is useful to concentrate on that of oil extraction as it alone has direct links with each of the others. Statements about 2000 are therefore made principally in terms of vegetable oils, although assumptions have been made about variables in all three subsectors. The ultimate situation in 2000 will be the result of a complicated interplay between demand and supply considerations. Since a workable model of this interplay is still to be developed, it is convenient to begin with demand aspects and work gradually toward an opinion about the overall market situation.

Trends in demand for vegetable oil

397. Depending upon end-uses, therefore, the demand for vegetable oils is largely a function of income levels, prices of competing products, and tastes. In the case of the developed countries, the trend toward increased consumption of polyunsaturated fatty acids noted in the forecast for 1985 is likely to slow down at the latter part of this century, although the trend towards increased substitutability between oils in various end-uses could continue. The incentive for researching into substitutability possibilities depends, however, upon relative prices of different oils in their existing uses. In view of the relatively high levels of consumption of oils and fats already attained in the developing countries, future demand for edible and non-edible uses is commonly expected to increase in the long term at a rate not much higher than that of population growth, although some additional trend from animal fats to vegetable fats is possible. The latest United Nations estimate of population growth in the developed countries up to 2000 is 0.6 per cent a year and on this basis the demand for vegetable oils will be around 19.9 million tons in these countries, assuming from the previous chapter that consumption in 1985 would be approximately 18.2 million tons.

398. In the case of the developing countries, demand for fats and oils is expected to continue to rise in proportion to anticipated rises in *per capita* income, and therefore income and population growth rates are seen in these countries as being the most crucial variables affecting demand. As far as population growth rates are concerned, the most recent United Nations estimates of population growth rates in developing countries between 1980 and 2000 imply an average annual increase of 2.1 per cent over the 20-year period. No readily available estimate exists for the expected growth rate of GDP or of GDP *per capita* for the developing countries as a whole over the same period.

399. However, in UNIDO's recent exercise in updating the FAO projections to 1985, mentioned in chapter VI, a series of upper and lower projected growth rates of GDP by country for some 70 developing countries was established. Taking the lower bound of this range as a conservative assumption for 2000, a representative sample of the largest of these countries indicates an average rate of growth of GDP of 5.1 per cent a year. If this can be accepted as a reasonable order of magnitude and if it is further assumed that the income elasticity of demand for fats and oils in developing countries has a value around 0.8, which is typical of the values calculated in the earlier FAO study, a rate of growth of demand for fats and oils of about 4.4 per cent a year is implied. On this basis the level of demand in the developing countries would be some 34.9 million tons by 2000. Taking the developed countries into account the total demand by 2000 is therefore expected to be about 54.8 million tons. On a somewhat lower rate of growth of GDP in developing countries, say only 4 per cent a year, implying, when population is taken into account, a rate of growth of *per capita* GDP of just under 2 per cent a year in these countries, this total will fall to 51.0 million tons.

400. In terms of consumption *per capita* the figure of 54.8 million tons implies that for the developing countries *per capita* consumption of 4.4 kg in 1975 will have risen to only 7.1 kg by 2000, still under half of that already achieved in the developed countries.

401. By implication this discussion of demand has assumed that real relative prices for vegetable oils remain at their present levels throughout the period considered, but this will only be the case if the supply of oils remains in line with demand at the same set of relative prices. There are some grounds for optimism in this respect.

Trends in supply

402. To meet the demand and the increased requirements of both a quantitative and qualitative nature, gradual improvements can be assumed in all fields of the oilseed economy. On the agricultural side extended research will lead to improvement of varieties and productivity, while on the processing side the adaptation of existing technologies and of technologies under development at present in developed countries will continue to expand their application in developing countries.

403. Oilseed production in developing countries is dominated by 16 main producing countries. Each region has some countries whose prospects for future production are stronger than others, but all have been expanding and are likely to expand their total oilseed production. The countries which are best placed in this respect are Argentina, Brazil, India, the Ivory Coast, Malaysia, the Philippines, Senegal and Sudan.

404. This group of eight countries currently accounts for almost 70 per cent of the oilseeds produced by these 16 major producing countries. Although the remaining eight countries have somewhat lower expected rates of growth, they still appear to have the potential, through improved yields and cultivation practices, to raise output in excess of that currently planned, if resources in terms of finances and manpower become available. That is, their physical limits have not yet been reached. Other developing countries have the potential to increase their role because of land availability, climate, under-utilized labour and other inputs.

405. In discussing the oilseed supply prospects for 1985, the conclusion was reached that the overall picture in terms of production was reasonably encouraging, with a number of the major developing country producers likely to achieve growth rates of oilseed production of 5 per cent a year or more. While these growth rates may tend to slow down somewhat toward the end of the century, the general situation is likely to remain much the same, and if fully realized, such rates of growth of oilseed production in the countries discussed would result in a considerable increase in their share of global production. It was also pointed out in chapter VI that at present the 16 countries reviewed account for 35 per cent of oilseed production, and that even by 1985 this figure would rise to 47 per cent if their current plans are realized and all other producers continue to expand at historical rates of growth.

406. On a simple growth trend, therefore, using the results obtained in the previous chapter, with oil production from the 10 major seeds at 28.5 million tons in 1975 and about 40.5 million tons in 1985, the extrapolated production level for 2000 would be 68.6 million tons. This is composed of 37.2 million tons from the developing countries compared with 20.9 million tons estimated for 1985, and 31.4 million tons from the developed countries compared with 19.6 million tons in 1985. Such figures can be no more than benchmarks, and are possibly overestimates, but the overall indication is that the world supply of oilseeds will be ample to meet the expected global demand for oil, given previous assumptions about production efficiency and technology of oil extraction. There is even some danger of over-production.

407. A similar situation is likely to arise in the case of oilmeals. The demand for protein for animal feeds is likely to increase in developed countries at a rate of not much more than population growth and although year-to-year fluctuations will continue in response to change in the corn/soya price ratio, the general upward trend will be reflected in the demand for oil meal in these countries. However, if a substantial increase in the provision of protein from

bacterial sources, using different kinds of raw materials, including hydrocarbons, agricultural and industrial wastes, occurs, then the demand for oilmeal could be significantly affected. The protein from fermentation processes, however, seems not to be a threat to oilmeal in the near future but note should be taken of this factor when planning future development.

408. In the developing countries the demand for oilcake will tend to increase as incomes rise and as livestock programmes expand, but as already noted the outlook of the developing countries as producers of oilseed is likely to be one of confidence.

Implications

409. Given reasonable assumptions about demand and supply variables, it seems that the market for vegetable oils in 2000 could well be in balance, with the possibility of some excess supply. What is important from the point of view of the Lima Declaration, however, is the proportion of world oilseed production that is processed into oil and cake in the developing countries. The current proportion has been estimated at around 50 per cent, with the possibility of unused capacity of a further 10 per cent. If current trends continue, then the proportion actually crushed in developing countries is likely to rise to about 51.5 per cent in 1985 and to only 53.4 per cent by 2000. While these ratios are well in excess of the Lima Declaration's aim of having 25 per cent of industrial capacity in the developing countries by 2000, they do not represent particularly rapid rates of change and it has to be decided whether or not they satisfy the spirit of the Lima Declaration when it called for the proportion of industrialisation in the developing countries to be increased "to the maximum possible extent and as far as possible to at least 25 per cent". The question is, therefore, whether the continuation of present trends in the oilseed industry in the developing countries represents "the maximum possible".

410. In asking this question two features of the previous discussion can be highlighted: one is that the main increase in demand for vegetable oils and related products is widely expected in the coming years to originate from within the developing countries, and the other is that the developing countries as a group appear to have unexploited potential for a substantial increase in the production of oilseeds. It is obvious that the link between these two features is provided by the oilseed and vegetable oil processing industries and that the opportunity exists, or will exist, for future development of these industries to take place within the developing countries themselves.

411. With regard to the developed countries, although demand for fats and oils is expected to grow at a much lower rate than in the developing countries, the absolute level of demand is currently greater than that of all the developing countries taken together and therefore still represents a market of considerable potential, and one which contains a number of substantial importers of oilseeds and oilseed products. For the developing countries to increase their share of these markets, however, it is of prime importance that their industries be geared to optimal levels of operation.

412. Taking such considerations together, therefore, it would appear that the continuation of present trends with regard to the proportion of the world oilseed industry found in the developing countries represents a comparatively modest rate of change. However, although the potential may exist for increasing the share of the developing countries in the world oilseed industry, a number of constraints exist which have to be overcome before the potential can be realized. The following chapter therefore examines the main constraints on the future development of the oilseed-based industries in the developing countries and offers direction on the evolution of strategies for the elimination of those constraints.

VIII. CONTRAINTS, OPPORTUNITIES, STRATEGIES

413. The major constraints on the development of the oilseed industry may be classified as technical and economic. In the developed countries the major economic constraint is often expansion of the market for oilseed and oilseed products in their domestic and overseas markets. In the developing countries, however, the situation is much more complex, involving a wide variety of factors at all levels from the production of oilseeds, through the different stages of processing, to the final market. The technical constraints in developed economies are those largely associated with new product development and new processing techniques. On the other hand, many of the developing economies face technical constraints in the implementation of comparatively well-tried processing methods. For the purpose of a brief analysis, discussion is made under four broad headings, namely production and storage, processing, marketing and institutional constraints, opportunities for further processing.

Production and storage constraints

414. Production constraints in developing economies arise mainly from inadequacies in the supply of services and factors of production. In Asia and the Far East, in contrast to Africa and South America, land is relatively scarce, resulting in severe competition among various crops, housing and industry for the limited land available. Sri Lanka is an example of a situation where acquiring additional land for oilseeds would entail the sacrifice of some other crop. In other Asian countries, however, though land is on the whole a limiting factor, expansion of production in agriculture is additionally hindered by land ownership problems. Due to these problems, under certain circumstances potential arable land can often be left uncultivated or used as rough grazing only. Land tenure problems of this nature are not always amenable to quick remedies.

415. In South America and many parts of the African continent, in contrast to Asia and the Far East, potentially cultivable land is more available. In these areas the absence of physical infrastructure in the form of drainage, irrigation, transport, communications and services is one of the major constraints to the expansion of agriculture, particularly of crops which need to find an urban or export market. The labour supply is another factor which has significantly constrained oilseed production and expansion in developing countries. There are certain aspects of oilseed production that cannot be mechanized, for example, harvesting of coconuts and oil palm fruit. These operations require regular supplies of large quantities of unskilled labour which are in short supply in several countries, Nigeria being a case in point. In Sudan also, where cotton picking is undertaken manually, labour shortage has been a significant factor in preventing further expansion. The lack of the capital necessary for acquiring land, clearing land, installing infrastructure, promoting research and education and acquiring equipment and supplies to aid oilseeds production should not be under-estimated. This constraint applies at the level both of the individual farmer and of Government. Developing countries, generally, except the oil-rich states, have very limited capital resources to undertake such investments, and international loans, even at favourable interest rates, often only add to a growing debt burden.

416. The commercial initiatives of many multi-national companies may be politically unacceptable, and many developing countries are exercising

restraint even in entering into joint ventures to solve the capital shortage problem. Capital shortage therefore remains a major constraint on the expansion of oilseed production in most developing countries.

417. The major technical constraints at the production level are principally associated with the need for higher yielding varieties and for a measure of control over disease problems. However, a very high proportion of oilseed production in developing countries is grown during a dry season when a plant's survival depends upon residual soil moisture or unpredictable showers. Under these circumstances it is extremely difficult to obtain yields which justify the use of, for example, pesticides. Higher yielding varieties suitable for dry land conditions could be bred but the process is very much a long-term operation. In the short term, yields could probably be significantly increased only by giving the oilseed crops higher priority for the available water resources. Given the necessity to expand staple food production, especially the cereals, it seems unlikely that oilseeds will achieve a higher priority in this area.

418. However, even accepting that a major expansion of annual oilseeds is limited, given their present role in most farming systems in the developing world, there are improved varieties and cultivation techniques available which could bring about a significant improvement if widely adopted and if the necessary ancillary inputs are made available to the farmers. The most fundamental constraint upon their adoption is a lack of knowledge which can be remedied only by better agricultural extension services. The need for such services is widely accepted but presents a major problem where such expertise is in short supply. Nevertheless, it is felt that the absolute levels of oilseed production are one of the most fundamental constraints upon greater developing economy participation in the global oilseed economy, especially with regard to the major annual oilseeds. If this constraint is to be overcome, then oilseeds must be given a higher priority in the allocation of the materials and services that are available for agricultural development.

419. The storage of oilseeds can limit their expansion in two principal ways. Firstly, inadequate storage facilities can result in oilseeds being wasted completely. This is particularly true of the annual oilseeds which are harvested and then have to be stored as processing proceeds throughout the succeeding months. If the storage facilities are not available then seed may not be considered for processing but may well be used as animal feed or other alternative use. Secondly, if storage facilities are of poor quality a variety of undersirable results could adversely affect the processed product. The most important forms such deterioration can take are infestation by insect pests, lipolysis of the oil in the seed, fungal attack and discolouration. The extent to which these processes occur is governed by such factors as the extent of physical damage to the seed before it was stored, moisture content and temperature.

420. Among the factors that must be controlled if deterioration in stored seed is to be avoided are the moisture content (both of the seed itself and of the ambient atmosphere), temperature of storage (since the rates of growth of insects and fungi are temperature dependent), maturity of the seed going into storage, infestation by insects, fungi and rodents and the handling of the seed during harvest (to reduce mechanical damage of the seed coat).

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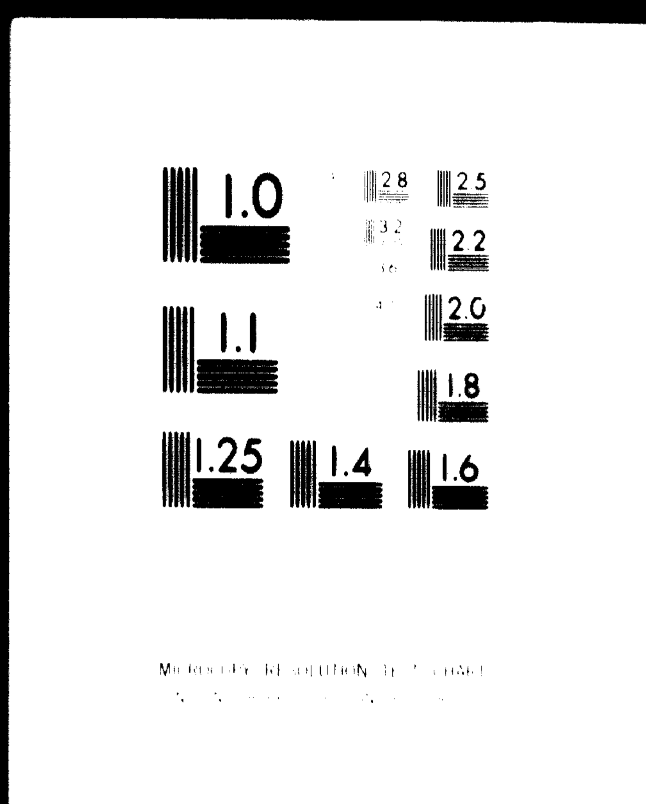

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Processing constraints

421. The preceding comments on production and storage are all basically concerned with one of the most important factors that any processing facility must concern itself with, namely continuity of supply of the raw material. One of the major problems confronting the oilseed processing industry in developing countries is that continuity of supply cannot be guaranteed. This results in under-utilized capacity and a consequent increase in processing costs for that proportion of seed which is processed. This high cost of processing will normally be passed on to the consumer and effectively limits the market for the end products. This sequence of events can be overcome only if supplies are forthcoming when needed. The large-capacity expeller and solvent extraction facilities are particularly vulnerable in relation to breakdowns in supplies, in view of their cost structure.

422. In addition to having continuous supplies, a processing facility needs supplies of a reasonable quality. The use of technically unsound or poor-quality oilseeds in the manufacture of oil inevitably produces an oil of low quality. Poor-quality oilseeds are likely to yield oil high in free fatty acids which is difficult to refine and leads to high refining losses. Such oilseeds might have been grown, harvested, transported and/or stored under non-ideal conditions which permitted fungal attacks and pest infestations to occur. Oilseeds where kernels are damaged or broken through poor decortication or by pest attacks and in which moisture content is too high for efficient storing are more liable to deteriorate. There have been innumerable cases where, for example, cottonseed has arrived at mills in developing countries in such a state of deterioration that the protein structure of the kernels had almost completely broken down and very little oil could have been won by expelling. Oilseeds deteriorate for a variety of reasons and at different stages. The importance of adequate storage has already been mentioned, but suitable transport and marketing mechanisms are also important. Irrespective of which stage of the cycle is at fault, the fact remains that poor raw material quality is a major factor limiting the output of vegetable oils in developing countries.

423. For oilseed processing the land requirement is minimal. Generally its supply is not considered as an inhibiting factor though difficulties can be experienced in acquiring the optimum site. Less than optimum siting results in additional operating costs.

424. Water is necessary in both expeller and solvent extraction plants for washing, raising steam and also, in solvent plants, for the condensation and recovery of solvent. Alternative sources of power are also frequently necessary when the main source of power fails. In a location where water and alternative sources of power are difficult to obtain regularly, the technical efficiency of the plant can be greatly affected. Water and power are seldom limiting factors but do affect the level of efficiency and often influence the location of a plant. If either one or the other service is in short supply a location that is not optimum can result in excessive operating costs due to, for example, the greater distance needed to bring raw materials.

425. Many oilseed processing machines are designed for the efficient processing of a single oilseed or a particular class of oilseeds. Although there can be considerable economic advantages in processing different oilseeds in the same mill technical difficulties can arise if the overall operation is not carefully planned and adequately equipped. In Nigeria, for instance, the milling of cotton

seed in machinery originally designed for groundnuts only may be undertaken without equipment for delinting or decorticating of the cottonseed - processes which are essential for efficient extraction. Attempts to put specific machines to multi-purpose use are prevalent in several developing countries, partly because of the structure and organization of the oilseed industry in these countries, and partly owing to a lack of resources to acquire additional equipment.

426. In some cases, owing to the lack of knowledge of conditions in developing countries, the manufacturers in developed countries produce machines which are technically unsuited to developing countries. Seed-cleaning equipment may not be adequate, thus permitting foreign material including sand, stone and metal to enter the mill and cause the breakdown of fan blades, impellers and expeller worms. Decorticating equipment may not have been allowed for or may be inadequate, resulting in loss of oil which is absorbed by the shells, reduced extraction rates and undue expeller wear or even breakdown. In some cases where machines or replacement parts (such as cage bars) are those manufactured in developing countries, technical difficulties can arise from the use of inferior steel in the manufacture of the machine or parts. In the case of palm oil mills the use of equipment with obsolete design poses problems of reduced extraction efficiency. It has also been the experience that modern continuous screw presses, while eminently suited to modern tenera type materials with a large percentage of mesocarp, are not suitable for thick shelled Deli dura material from older plantations in the Far East. In most cases the inappropriate use of machinery is not an absolute constraint, but it inevitably affects the level of efficiency in the processing industry: for example, it must reduce the total amount of raw material that can be handled.

427. In the oilseed processing industry a considerable amount of technical knowledge has to be brought together, namely knowledge of the oilseeds, their composition, conditions of storage and preservation, chemical processes in oil extraction, handling, packing and preservation of the product, building design, and machine operation and maintenance. In the developing countries there is often a considerable gap between required and prevailing knowledge in many of these fields. In adequate maintenance of machinery and equipment, owing to the lack of skilled personnel, is a common technical constraint in developing countries. The use of solvent extraction equipment, for example, enables a greater proportion of oil to be removed from an oilseed than does the use of screw expellers. Under optimum conditions cottonseed expeller cake contains 4.5 per cent oil by weight, while the residual meal from solvent extraction should contain less than 1 per cent of oil and usually contains 0.6 per cent. A solvent extraction plant, however, requires considerably more discipline and skill in handling than does an expeller mill. In developing countries the lack or absence of the necessary skills to undertake the more technologically advanced operations greatly inhibits the use of more efficient technology.

428. Another aspect of the manpower limitation in many developing economies is the acute shortage of managerial and entrepreneurial expertise. The former is vital to the efficient running of an industrial process but in many developing countries the shortage of such expertise leads to a very high opportunity cost and to its use in areas such as government administration at the expense of the industrial sector. Consequently, the expansion of oilseed processing in developing countries, at least if associated with the more advanced technology, will often need a degree of expertise not found in many developing countries.

429. The need for entrepreneurial expertise is a slightly different problem in that it can be, and is, associated with very small businesses. In many parts of the world, both developed and developing, the small business sector is a flourishing one. However, the incidence of such expertise does tend to be geographically specific and is very much stronger in those parts of the world with the tradition of a small business community. Where entrepreneurial skills do exist the principal need is for Government to provide an appropriate economic and political framework which provides adequate incentives. Measures commonly used include tax concessions or tax holidays for new businesses, credit facilities at low or competitive rates of interest and appropriate pricing policies. Too-centralized government control or a burdensome bureaucracy tend to inhibit the expansion of private investments and in a number of countries government measures are positively discouraging to the private entrepreneur although the expansion of the oilseed sector may be a government objective.

430. The structure of the oilseed processing industry in most developing economies ranges from village processing with a throughput of perhaps one ton a day to large-scale expeller and solvent extraction plants with throughputs of perhaps 150-200 ton a day. Consequently, the expansion of the oilseed processing sector presents a number of alternatives in terms of development of strategy. In many developing countries village-scale processing of oilseeds is a m a major sub-sector and if an oilseed producing country is to obtain the maximum returns from its oilseeds, then clearly efforts should be made to up-grade the small-scale processing sector. Improvements could be made by the adoption of such simple techniques as effective cleaning, decortication, especially of groundnuts, before crushing and the construction of small cookers to make the removal of oil easier. Many of these operations are undertaken but a great deal more is possible. However, the large number and widespread distribution of village processing units and the resources generally needed to make an impact are a major constraints.

Marketing constraints

431. Market constraints occur at both the domestic and international level. At the domestic level, demand for the product, the price to the producer and the marketing mechanism are all vital to the level of production. With the notable exception of the premium liquid oils, for example, safflower and olive oils, most fats and oils can be regarded as raw materials for the fats and oils processing industry that will be transformed into margarines, shortening, cooking oil and, in the case of developing countries such as Iraq and Pakistan, vanaspati. The marketing problem basically consists in satisfying their requirements. This can be achieved by ensuring the delivery of a good (low free fatty acid content) product in regular quantities. Supply management schemes aimed at preventing undue price fluctuations of vegetable oils are now under consideration by UNCTAD and other bodies. These schemes will involve investment in bulk storage, loading and transport facilities.

432. The consumption of oilseed products is very largely determined by the level of income, which in the majority of developing countries undoubtedly adversely affects overall demand for these products. Consequently, a rapid expansion of domestic markets for oilseed products cannot be expected without a real increase in incomes and growth in the economy generally. It would be unrealistic to propose a significant expansion of oilseed processing aimed at

processing for the domestic market without a corresponding underlying growth trend in the economy as a whole. The easing of constraints at the processing level, however, will help to ensure that costs and hence prices are kept at a level which allows maximum advantage to be taken from growth in domestic purchasing power.

433. At the producer level, there must be adequate economic incentives in terms of remunerative commodity prices available to the farmer. In some countries producer prices have been allowed to stagnate because of concern to hold down the general cost of living. This can lead to producers turning to other crops, resulting in inadequate supplies to the processing industry. Alternatively, producers may confine themselves to providing for their own immediate family needs and show little, if any, interest in providing a surplus for urban consumption.

434. Allied to the problem of remunerative prices is the need for an effective marketing mechanism capable of distributing the products from production to consumption areas. This can be done either by private traders or through an institutional framework such as a marketing board or co-operative or a combination of both.

435. At the international level, a favourable pattern of trade can serve as a powerful incentive to the expansion of a commodity. With the development of oilseed production in the developed countries, the growth of processing capacities in the developing countries and the formation of the EEC as major world economic block, considerable changes have taken place in the trade relations between the developed and developing world in the recent years. There has been a progressive dismantling of trade preferences and a simultaneous erection of trade barriers in different forms. Members of the EEC who formerly gave special concessions to certain developing countries have had to give up all their individual preferential treatment arrangements and operate the Common External Tariff on oilseeds and vegetable oils. Only certain types of oilseeds and oils from Associated States are allowed to enter duty-free. At the same time, the EEC gave subsidies for the production for oilseeds within the community. EEC regulations also allow for the imposition for a compensatory levy if the country of origin of imports into the EEC grants in any way a subsidy to exports or if situations arise which prejudice the production of oils and oilseeds in the EEC. There is continuing concern amongst developing countries about the EEC's future policies with regard to these topics, especially in the case of highly processed products subject to discriminative tariffs; however, there have been some improvements, such as the removal of the duty on coconut oil.

436. Above all else, the expansion of the oilseed sector or any part of it requires a commitment on the part of Government to encourage such development. Government policy in the form of a clear strategy with specific targets is a prerequisite for most industrial development in developing countries.

Opportunities for further processing

437. It has already been pointed out that the main source of future demand for oils and fats should come from the developing countries rather than from the developed ones, so there is substantial potential to be realized in the manufacture of these products in developing countries. This concerns not only the basic extraction of vegetable oil but also its refining and further industrial processing in both food and non-food uses. However, development of these

markets will be gradual and it is important in the medium term to look also at the potential for increasing sales of these products in the markets of the developed countries. Although potential exists on a world-wide basis a great number of factors are involved. For example, there are considerable problems in the handling, storage and transporting of oils over long distances. If this results in quality deterioration of fully refined oils, then re-refining in the consuming country becomes necessary, and large-scale production of fully refined fractioned oils for the export market could be rendered un-economic. Although having lower value added, the production of semi-refined oils does not have this problem to the same extent and could become more common in developing countries, particularly in view of the growing pollution control regulations that are increasing the refining costs in many developing countries, especially in Japan and on the west coast of the United States and in some developing countries too. More research which will benefit developing countries is needed to overcome these problems. A further problem affecting the ability of developing countries to capture an increased share of the market for vegetable oils in the developed countries concerns the capacities of the developed countries to produce their own supplies from their existing factories. So long as alternative supplies of raw materials can be obtained economically, notably the United States soya beans, then these industries will continue to compete with sources of vegetable oil from outside their area geographically.

438. A possible exception to the general situation is palm oil in view of the massive increase in palm oil supplies particularly from Malaysia. Since palm oil is necessarily produced in the growing country, for quality reasons, the only possibility for future development of the industry lies in further processing. This involves investment in:

(a) Storage, loading and transport facilities, particularly tankers in various sizes;

(b) Facilities for further processing, including fractioning and refining.

439. Many difficulties remain, however. The particular strength of palm oil lies in the fact that it is cheap, but although refined bleached palm oil is an important ingredient of the food and soap industries of the developed countries, the palm oil fractions, stearin and palm olein, cannot yet be sold at prices below their competing products, principally tallow. Moreover, developing countries do not have themselves an industry fully capable of using the stearin fraction domestically. Although fractionated palm oil requires more careful handling than crude palm oil, there is little experience in handling and transporting such fractions.

440. The main trend in further industrialization of the lauric oil industry in the producing countries is in crushing the palm kernels and copra locally. This involves also investments in storage and transport facilities, both to guarantee supplies and avoid price distortion due to uncertain supplies, and to avoid quality deterioration in the transport. Crushing copra to produce coconut oil in the country of origin may also be regarded as a means of maintaining quality standards. Moreover, copra crushing is not vital to the fats and oils crushing industry in the developed countries.

441. On the other hand the crushing industry in developed countries is becoming increasingly geared to crushing soyabeans, and to a lesser extent, locally grown rapeseed. This industry can be considered as vital in view of

the heavy dependence on soya meal to meet the protein requirements of the livestock industry. As long as the United States exports soyabeans, the viability of the European crushing industry is largely ensured. As already mentioned, this places exports of fats and oils from other sources at a disadvantage, and will continue to do so if market structures remain unaltered.

442. It is unlikely that there will be any significant new entrants in the world soyabean market. Although there is considerable interest in soyabean cultivation around the world, additional volume will remain generally small. Domestically grown soyabeans, for example from tropical countries other than Brazil, will be extracted mainly to satisfy the growing local demand for both oil and protein. Production costs would often not be competitive with the world market. In addition, it has to be remembered that soya meal has overwhelming dominance in the world market of oilmeal. Together with fishmeal which in recent years has experienced uncertain supplies, soyabean meal is rich in lysene and so is virtually essential to feed rations of monogastric animals, particularly in feed-deficit countries such as Japan and in Western Europe. The structure of the oilseed industry in the above areas is geared to soyabean extraction; soyabeans are available in large quantities, permitting bulk handling and processing.

443. There is, however, a possibility of initiating adequate joint ventures in vegetable-oil processing in developing countries that have emerged as net importers of fats and oils. The Brazilian soyabean co-operative COTRIJUI, for example, is planning to crush some 300,000 tons in Iran. Palm oil exporting countries could set up storage and refining facilities in India, Iraq and Pakistan.

444. In conclusion, the establishment of a viable export-oriented chemicals derivates industry in the developing countries, given the present structure of world markets, is uncertain. Although such products are relatively easy to manufacture, their marketing is difficult in that there is often no domestic commercial market. For this reason the opening of markets in the developed countries could improve the situation. The only possible exception could be methyl esters which are stable and easy to transport and convert. However, again, they do not have a ready commercial market, which implies that an agreement must first of all be reached to ensure that these products will be used in the manufacturing of oleo-chemical derivates.

Strategies

445. Given the most likely trends and the main constraints, the final problem is to arrive at strategies to reduce the constraints so as to improve the trend performance of the developing countries. The framework for the derivation of strategies is provided by the degree of influence which each interest group in the oilseed industry has over the variables and constraints in the sector. As a first approximation, it is convenient to divide the interest groups into four: developed exporters of oils and oilseeds, developed-economy importers of these products, developing-economy exporters, and developing-economy importers.

446. The developing economies have a greater degree of control over their own internal industry and markets, and an obvious strategy is for them to give full encouragement to the development of these spheres of development. Since the developed countries' markets for vegetable oil are expected to expand only

slowly, this means that competition to expand the share of these markets will be difficult and developed-country producers of vegetable oils will themselves be looking more towards the developing countries for their markets. In this situation, the developing countries have the difficult task of ensuring the long-term protection of their own developing industries while simultaneously seeking the elimination of protection in the developed countries. In the latter case, agreement should be sought for the developed countries not simply to allow their industries to be exposed to world competition, but for them to take positive action on the gradual restructuring of their economies in accordance with changing international comparative advantage. The situation should be seen as one not of conflict but of globally efficient allocation of resources.

447. In order to achieve this, however, agreement is also needed among the developing countries themselves, and with such a wide variety of products having high degrees of substitution and spread over a large number of producers, sustained agreement will be essential especially if there is any tendency to over-supply.

448. It is within a general framework of this nature that policies and strategies for enabling the developing countries to realize their maximum industrial potential in oilseeds and oilseed products up to 2000 in accordance with the Lima Declaration has to be evolved. The last two sections of this Draft Study have demonstrated where the greatest potential for the developing countries lies, between now and 2000, and have outlined the major contraints which, if left alone, are likely to stand in the way of achieving this potential. It is obvious, therefore, that the strategies should focus attention on the elimination of constraints to the maximum extent possible.

449. Principal measures for action and strategies to this effect can be suggested on the basis of the findings of this Draft Study. These include:

(a) Appropriate measures to expand the capacity of the oilseed and oilseed products industry in the developing countries;

(b) Efforts to control marketing problems associated with the increasing degree of substitution between end uses of oilseed products from developing countries;

(c) The establishment and support of price-stabilization schemes geared to the problems of developing countries, and guaranteeing supplies;

(d) Agreement on the removal of trade barriers which affect imports of oilseeds and oilseed products in developed countries;

(e) The unconditional use of bilateral and multilateral aid for developing countries;

(f) The commitment by the developed countries to seek means of controlling the expansion of their own oilseeds and oilseed products industry;

(g) The provision of improved market information services to developing-country producers of oilseed products;

(h) Improvement of the flow of information with regard to technological trends and innovations in the oilseed and oilseed products industry;

(i) Agreement among developing countries themselves as how best to coordinate the interests of those developing countries whose oilseed industries are comparatively well advanced with those which are still at an early stage of development, and with those having an oilseed deficit;

(j) The establishment of means for increasing the overall degree of international co-operation in the promotion of the oilseed and oilseed products industry;

(k) The development of means for monitoring national plans for expansion of production of oilseeds and oilseed products in order that situations of oversupply in international markets be either avoided or anticipated sufficiently well in advance for remedial action to be agreed.

450. However, it is also important that such strategies should form part of a co-ordinated effort to improve the position of the developing countries and that their combined effect should represent an integrated attack on the major constraints. This calls for agreement on their implementation not only between the developed and the developing countries, but also amongst the developed countries themselves and the developing countries themselves.

Part two

I. OILSEED PROCESSING METHODS

Farm/village processing methods

451. The extraction of oil from oilseeds is principally the same whether the process is carried out at the village level or industrially. Before oil extraction can start, the oil-bearing material, with few exceptions, is dried, cleaned, broken into small particles and heater or "cooked". Palm fruit is treated differently, as it is either allowed to "ferment", to facilitate the removal of the individual fruits from the bunch, or boiled in water prior to extraction, both to facilitate the removal of the fruits and to inactivate the lipolytic enzymes. The pressing of palm fruit is commonly done by simple, traditional methods, that is, stamping with the foot or squeezing in the hand followed by water displacement. Alternatively, hand-operated, or small mechanically-driven hydraulic pressed may be used, when yields of about 70 per cent of the total oil in the mesocarp can be obtained.

452. The majority of oilseeds or oil-bearing materials such as copra, are dried by spreading on the ground, and are left in the sun for some time. In the case of fresh coconut kernel, which has a moisture content of about 50 per cent, small, cheap, locally-made dryers are used to assist moisture reduction. In addition to speeding up the drying process, these simple copra dryers generally produce a good quality copra.

453. For the removal of vegetable debris, dirt, and other foreign matter, some form of sieve or screen is employed. The screens are usually made of wire mesh, wire cloth or perforated metal, and are shaken by hand to remove sand and earth. Larger pieces of foreign matter such as stones and vegetable stalks are removed by hand.

454. Size reduction of oilseeds is also necessary prior to extraction since it facilitates the removal of the oil. At the village level the method which is most commonly used is grinding in a wooden mortar with a pestle, generally also made of wood. Where animals are being used to operate a water wheel or press, oilseeds such as groundnut kernels are strewn in the animals's tracks and reduced in size by trampling.

455. Extraction of the oil from the pre-treated oilseeds is done under pressure, and one of the simplest systems that has evolved is the weighted pestle rotating inside a stone or wooden mortar where the pressure is exerted between the mortar wall and the pestle. This type of rural extraction equipment is widely used in Asian and African countries; a typical example is the Indian chekku. The capacity per charge is 16-17 kg depending on the oilseed, and the time taken to process a charge is about 45 minutes to 1 hour for copra, and up to 1½ hours for sesame seed. Daily capacity is about 100 kg and the oil content of the residual cake from improved animal driven chekkus ranges from 11-13 per cent.

456. The efficiency of this type of animal-powered press has been improved by adopting a motorized version, which increases the throughput, and also extracts a further 4-5 per cent of oil.

457. In many coconut producing countries, fresh undried coconut meat is processed for oil at the farm level. Fresh grated coconut meat is pressed by hand, then mixed with water and pressed a second time. The mixture of oil and water resulting from the hand pressing procedure is transferred to a pan and boiled, when the oil and water separate. The oil is skimmed off the surface of the water, while

the residue on the press is used as a human food material in a variety of dishes. An example of this method is the klentik method practised in Indonesia.

458. Hand-operated hydraulic presses are still used in the rural areas of many developing countries, particularly Nigeria, where they are used to extract the mesocarp oil from palm fruit. However, mechanical hydraulic presses fitted with metal cages, which are more efficient and do not require the use of press cloth, are gradually replacing hand-operated units in many developing countries.

459. These general methods of village-level processing are universal but local modifications to the basic principle are often found. Some of the more locally important village processing methods are discussed in greater detail in the final section of this chapter. However, irrespective of the precise method used, village processing is very limited in its absolute level of output and tends to be a comparatively inefficient extraction process, leaving a high proportion of oil in the residue.

Commercial processing methods

Post-harvest handling, storage and preparation of oilseeds

460. After harvesting, oilseeds require to be handled and stored in such a manner as to avoid damage and to minimize the natural deteriorative factors which lead to increases in free fatty acid contents and the development of objectionable odours, flavours and colours in the extracted oil, as well as reducing the value of the residual oilcake or meal.

461. Oilseed materials can be handled by most conventional handling conveyors. Free-flowing seeds such as soyabeans, sunflower seed, safflower seed, shelled groundnuts, sesame seed, delinted cottonseed and rapeseed, lend themselves to being handled in much the same way as corn and wheat grain. Quite different conveyors, however, are needed for the bulkier and less free-flowing oilseeds, such as undelinted cottonseed, copra and palm kernels.

462. The successful storage of oilseeds, prior to processing, is dependent on the observation of certain conditions. Attention must be paid to critical moisture levels, above which the proliferation of fungi and bacteria and the activity of enzymes lead to rapid deterioration.

463. Prior to processing, the oilseeds are prepared in a number of ways. Firstly, the seeds must be cleaned to remove foreign material. Sticks, stems, leaves and similar trash are usually removed by means of revolving screens or reels. Alternatively, a pneumatic system can be employed, where the light material is pulled through and the heavy material, usually the oilseed, is gravitated out.

464. Wherever practicable, oilseeds are preferably decorticated before they are extracted. The first step in the dehulling is the cracking of the seeds' hulls with machines. The two principal types of machine used for this process are bar hullers and disc hullers.

465. When decorticated, different seeds vary considerably in the readiness with which they fall out of the split hulls. For example, groundnuts are loose in the shell and separate readily while cottonseed kernels or "meats" are more adherent to the hull. Generally, therefore oilseed hulls are customarily passed through a hull beater to detach small meat particles after the first separation of hulls and meat by screening. The separation systems used usually consist of various combinations of vibrating screens and pneumatic lifts. It is necessary not only to separate the hulls from the meats, but also to separate and recycle a certain

proportion of uncut seeds which escape the action of the huller. Some oilseeds such as rapeseed and sesame are usually processed without decortication.

466. The next step immediately prior to oil extraction is the reduction of the seed to small particles. Hammer mills, attrition mills, and other devices are sometimes used for the preliminary process when large oilseeds such as copra and palm kernels are being processed, but for the final process it is common practice to use milling rolls which subject the seed particles to progressively increasing pressure and form them into thin flakes. The flakes thus formed are more satisfactory for hydraulic pressing than the irregularly shaped particles obtained by grinding. Flaking rolls are essential for preparing oilseeds for continuous solvent extraction since no other form of mill is capable of forming particles which are thin enough to extract readily yet large enough and coherent enough to form a mass through which the solvent will pass easily.

467. If oil is extracted by mechanical expression, the oilseeds yield their oil more readily after cooking. Cooking coagulates the proteins in the seed causing coalescence of the fine oil droplets and making the seed permeable to the flow of oil. The affinity of oil for the solid surfaces of the seed is also decreased, and the increased fluidity of oil at elevated temperatures assists its outflow. Important secondary effects of cooking are drying of the seeds to give the seed mass the proper plasticity for efficient pressing, insolubilization of phosphatide, destruction of fungi and bacteria, and, in the case of cottonseed, detoxification of gossypol, in rapeseed inactivation of the enzyme myrosinase, and, in soyabeans, inactivation of anti-nutritive factors. The moisture content of the seed is controlled during the cooking operation as very dry seeds cannot be efficiently freed of their oil. The optimum moisture content of cooked seeds varies widely according to the variety of the seed and the method used for expression.

Extraction of oil

468. The oldest method of oil extraction comprises the application of pressure to batches of oil bearing material confined in bags, cloths or cages. Levers, wedges, and screws have been used as a means of applying pressure in early types of presses, but modern presses are almost invariably activated by a hydraulic system. Batch presses are divided into two main classes: the open type requiring the oily material to be confined in press cloths, and the closed type, which is equipped with a form of cage to confine the oily material. Some oilseeds of high oil content, such as copra, are difficult to express satisfactorily in batch equipment by a single pressing, and are preferably processed in continuous screw presses or expellers. With a given lot of seed, cooked and ready for pressing, the oil yield will depend upon the rate at which pressure is applied, maximum pressure attained, the time allowed for oil drainage at full pressure, and the temperature or viscosity of the oil.

469. Continuous expellers or screw presses have now almost completely replaced hydraulic presses for the mechanical extraction of oilseed. Expellers may be high-pressure machines designed to effect oil recovery in one step and may be modified to process a particular oilseed. Special low-pressure expellers are often used for pre-pressing prior to solvent extraction, although high pressure presses may also be used, operated at low pressure and increased capacity. In areas where various oilseeds are handled by the same equipment it is common practice to press the seeds in two or three stages at increasingly higher pressures in each stage. Continuous presses require less labour than hydraulic systems and eliminate the need for press cloth. They are adaptable to a wide variety of materials, and in most cases produce a higher yield of oil. However, their power requirements are relatively high, fairly skilled labour is needed for their operation and maintenance, and they are not well adapted to intermittent operation.

470. The pressure necessary to force the oil out of the cooked flakes is obtained by means of a continuously rotating wormshaft and worms, fitted with a choke mechanism at the cake discharge orifice to control cake thickness. The main wormshaft and worms are designed to exert a pressure of 5-15 tons per square inch (79 to 2,370 kg/cm^2) on the seed being processed and to convey it through and out of the pressure chamber. Different wormshafts may be employed, depending upon the material to be processed and whether or not expression is to be complete or merely a pre-pressing operation preliminary to later solvent extraction. With adequate preparation and cooking of the oil bearing material, the capacity of an expeller is a function of the shaft arrangement and speed. For example, the meats from 25-100 tons of cottonseed per day can be expressed leaving cakes containing 3-9 per cent oil.

471. For the pre-pressing of oilseeds prior to solvent extraction, although high pressure expellers may be operated at low pressure and increased capacity, specially designed machines are more satisfactory and are normally used in new installations. As most of the oil is removed by pre-pressing, only a minimum size of solvent plant is required. Low pressure expelling also produces a meal of high protein quality. Cakes pre-pressed for subsequent solvent extraction generally have an oil content of 15-18 per cent.

472. The processing of palm fruit involves procedures distinct from normal oilseed processing. After cutting, the average acidity of the oil in the fruit rises very rapidly, especially in the injured exterior fruits which will particularly undergo enzymatic hydrolysis. This increase in acidity can be stopped only by sterilization. The quality of the palm oil is therefore conditioned largely by the maturity of the bunches and by the speed with which they are processed after cutting. The first operation in the process consists of cooking the bunches for 60-90 minutes in steam sterilizers under 3 kg/cm^2 pressure at 140°C. This stops the development of acidity and aids the removal of fruits from the stem as well as loosening the palm kernels in the nuts. Sterilizer capacity can vary from 6-20 tons of bunches per hour and two or three sterilizers ensure continuous feed for the extractors. After cooking, the bunches are fed into a picker, the fruits are detached and conveyed to a vibrating strainer and washed with boiling water before being fed to digesters. The digesters operate by vigorously mashing the fruit to detach the pulp from the nut and break down the oil-bearing cells. The oil is separated from the digested mash usually by the use of expellers or sometimes by hydraulic presses or a battery of large centrifuges. The palm oil obtained, mixed with about 65 per cent water, vegetable debris and sand, is heated to 100°C in a preparation tank and passed through a straining circuit equipped with a sand cyclone to remove high density foreign matter. The remaining palm oil and water are then separated by centrifuging followed by re-clarification of the palm oil in a second centrifuge or a decantation vat. The oil is then dried, preferably under vacuum, to less that 1 per cent moisture and pumped into holding tanks.

473. Solvent extraction constitutes the most efficient method of recovery from oil-bearing material, particularly for those oilseeds or other materials low in oil content. A figure of 3 per cent is about the minimum oil content to which cake can be reduced by mechanical expression. Consequently, as the oil content of the seed decreases, the amount of oil unrecoverable by mechanical expression increases in relation to the total amount present. Also, since minimum heat treatment is involved, the oil produced by solvent extraction is of maximum quality and the meal contains proteins subjected to a minimum amount of damage due to the effects of heat. However, solvent extraction equipment is relatively expensive compared with other extraction systems, and in using inflammable solvents there is a safety factor involved. Also, low oil-content meal tends to be dusty,

and in the case of the extraction of raw cottonseed flakes and uncooked soyabean meal, the relatively mild processing may not inactivate the toxic or anti-nutritional materials present and further treatment of the oilcake may be required. Low oil content seeds such as soyabeans are solvent extracted most easily, while optimum solvent extraction efficiencies of high oil-content seeds are not readily achieved without a preliminary pre-pressing operation as they tend to disintegrate more readily, producing troublesome finely divided material. However, some recent types of solvent extraction plants have provision for directly handling high oil-content seeds.

474. The most common solvents used are light paraffinic petroleum fractions and the hexane fraction (boiling point 146°-156°F, 63.3°-68.9°C) is the most widely used and preferred for oilseed extraction although the heptane fraction (194°-210°F, 90°-100°C) is also used. Because of the potential fire and explosion hazard involved when hydrocarbon solvents are used for extraction, non-flammable solvents like trichloroethylene (boiling point 188°F, 86.7°C) are sometimes employed in their place. However, trichloroethylene requires to be carefully handled because of its toxicity, corrosion is a serious problem, and its relatively high cost is not counterbalanced by proportionately lower solvent losses.

475. Solvent extraction procedures provide the means of bringing the oilseed and solvent together in a counter-current flow in order that the seed is extracted with solvent of progressively decreasing oil content as it passes through the system. Conversely, as the solvent is brought into contact with seeds of progressively increasing oil content, it is finally discharged with the highest possible oil content, minimizing the cost of solvent recovery. This principle of mixing the solvent and oil in continuously moving counter-current streams is the basis of continuous counter-current extraction. Although batch counter-current extraction may theoretically be brought to an efficiency approaching that of continuous counter-current extraction by sufficiently increasing the number of extractors, the system becomes increasingly cumbersome. In practice, therefore, solvent extraction is carried out on a large scale only in continuous systems which are entirely automatic in operation, achieving the highest economy of power, labour and materials.

476. There are a variety of different designs of equipment for continuous extraction. Percolation extractors are the most widely accepted as there are a number of advantages in their use. The principal advantage is that the system yields a very clean miscella with a minimum content of fines. It is also more adaptable to large throughput in a limited space.

477. The final stage in obtaining the crude oil is to remove the solvent from the miscella. The most common method of removal is in a rising film evaporator, a series of long tubes contained in a vertical cylindrical shell which is heated by steam. The solvent to meal solids ratio in modern extractors is about 1.1:1.3. The concentration of oil in the miscella leaving the extractor is about 20-35 per cent depending on the oil content of the extracted seed material. The amount of solvent left in the meal after extraction in a percolation type extractor is about 30-35 per cent.

478. Crude oils from soyabeans and rapeseed contain about 2-3 per cent lecithin gums which are removed by a degumming process at the oil mill or extraction plant before the oils are shipped or placed into storage. If the gums are not removed they will cause trouble by settling out in storage tanks and will tend to produce large refining losses. If the removed gums are to be used for commercial lecithin production, they are dried as soon as possible. Generally only soyabean gums are used to produce lecithin as rapeseed lecithin is of low value because of its dark colour and unpleasant taste and odour, and its separated gums are usually fed back into the desolventizer-toaster where they help the meal powder to agglomerate more easily.

Filtration of crude oils

479. Suspended impurities in crude oil are removed using filter presses, leaf pressure filters, vacuum filters, or centrifuges. As filter presses are rather heavy in labour charges and usage of filter cloths, the leaf pressure filter has found application in the oil and fats industries, although plant and frame presses remain the usual equipment for filtering bleaching earth in most edible oil refineries. Continuous rotary drum filters (vacuum filters) are used in oil extraction plant and refineries, particularly for the filtration of crude oil, but have not found much application in edible fats factories. As fairly open weave cloths are used it is frequently necessary to give the oil a second filtration. High speed centrifugal separators have found wide application for a number of purposes in oil treatment plants and refineries and are particularly useful for clarification of oils containing fine suspended impurities.

Refining of crude oil

480. The removal of substances detrimental to the use of fats and oils for edible purposes is most frequently carried out in four operations: degumming, de-acidification, bleaching and deodorizing. Degumming and de-acidification are often combined in one operation. Traditionally, these have been carried out as batch procedures but modern plants employ continuous systems. Other refining systems employing steam refining and miscella refining are also sometimes used.

481. Alkali refining is the most common form of process used in the refining of crude oil. The free fatty acid content of crude oils and fats normally represents the largest amount of impurities to be removed and normally the process of neutralization (de-acidification) is carried out with solutions of sodium hydroxide (caustic soda), termed "lyes" and measured in term of their specific gravity expressed in degrees Baume. In order to reduce losses arising from emulsification of neutral oil in soap stock and from saponification of the neutral oil, weaker alkalis such as sodium carbonate, capable of reducing the free fatty acid content without saponifying the oil, are sometimes used either before or after a caustic soda refining stage. Weak alkalis used alone, however, do not decolourize or reduce the free fatty acid content of oils as effectively as caustic soda. Thus the technology of alkali refining is concerned with the proper choice of alkalis, amounts of alkalis and refining techniques, to produce the desired purification without excessive saponification of neutral oil and with methods for the efficient separation of refined oil and soap stock. (Soap stock is itself a useful raw material. Consisting chiefly of water, neutral oil, the sodium salts of fatty acids and free alkali, it can be used as a source of fatty acids for soap-making or for fatty acid distillation). After alkaline treatment the oil is preferably washed with soft water, as the calcium and magnesium salts from hard water can dissolve in the oil. Immediately after washing, the oil is dried under vacuum to avoid hydrolysis. As refining removes some of the oil's natural antioxidants, the storage of dried and refined oil before bleaching is kept as short as possible and the oil is protected by nitrogen in closed tanks to minimize oxidation.

482. After pre-treatment and neutralization there are natural pigments and sometimes coloured degradation products which remain in the oil and require to be removed by a special bleaching process which is usually carried out by heating the oil under vacuum with an adsorbent material onto which the pigments become adsorbed irreversibly. Usually a contact time of 10-15 minutes at 220°-240°F (104°-115°C) is ample decolourizing time, and the extent to which a fat is bleached depends upon its future use. Besides decolourizing, adsorbents also remove traces of soap from alkali refined oil.

483. Deodorization, the final process in the refining of crude oil, removes substances which impart undesirable odour and taste to the fats. The concentration of volatile materials in oils is relatively low, generally around 0.1 per cent. Most oils and fats, either because of their natural flavour or because of changes arising during storage and processing, require a final deodorization to give them a bland or mild flavour which is considered essential for their successful use in the manufacture of edible fatty products such as cooking fats, shortenings, margarine and salad oils. In the case of some regions of the world where the flavour of the oil has traditionally been a culinary component, for example, rapeseed oil in India, complete blandness may not be necessary. The process of deodorization removes the undesirable flavour compounds by passing a current of dry steam through the neutralized fat under vacuum in deodorizers. The refining process destroys a considerable proportion of the natural antioxidants which occur in crude oils and consequently refined oils are often more prone to oxidation. Many refiners, therefore, add some ingredients to the oil in the deodorizer to increase its resistance to oxidation during the high temperature treatment and subsequent storage.

484. During storage, finished oils have to be protected against contamination from atmospheric adulterants, internal contamination by water and soaps, over-heating and exposure to oxygen. Usually oils are stored in completely closed iron tanks provided with internal heating or cooling coils and an agitator to help heat transfer and avoid localized over-heating. Stainless steel storage tanks are used when it is desired to maintain the highest stability of the finished oil.

II. TECHNICAL ASPECTS OF OILSEED UTILIZATION

485. Current usage of vegetable oils by the food and non-food industries is primarily concentrated in a comparatively small number of products, namely cooking/salad oil, margarine, shortening, soap and paints. It is likely that the major proportion of vegetable oils will continue to be used in these products in future but that the increasing substitutability of individual oils may affect the quantities of each oil used. Modern technology has enabled manufacturers to substitute one oil for another. The extent to which this is possible is firstly a technical problem, but once the technical constraint is overcome, absolute availability and the relative prices of the oils and fats concerned very much influence the decision regarding the choice of raw material. This chapter explores the factors affecting the substitutability of vegetable oils and fats, discusses, in relation to substitutability, possible changes in the pattern of vegetable oil utilization in major end-products, and explores additional potential uses for the oils under review.

A. Substitutability of oils

Physical and chemical characteristics of vegetable oils and fats

486. Fats and oils are interchangeable when their chemical and physical characteristics, either natural or acquired by processing, make them suitable for the same end use. Vegetable oils and fats are composed mainly of fatty acids and triglycerides. One molecule of glycerol is combined with three molecules of fatty acids consisting of various chain lengths, with usually between four and 24 carbon atoms contained in the chain. Mono-and di-glycerides are also constituents of natural oils and fats to a smaller extent, where one or two fatty acids are combined with one molecule of glycerol. When all the carbon atoms in the fatty acid chain are linked to two hydrogen atoms (except for the terminal carbon atom which is linked to three hydrogen atoms) the acid is "saturated", but when one or more adjacent pairs of carbon atoms in the chain are each linked to only one hydrogen atom or to none at all, double or triple bonds are formed and the acid is "unsaturated". All naturally occuring vegetable oils consist of saturated and unsaturated fatty acids in varying proportions and impart to the oil certain chemical and physical properties. Generally, the higher the saturated fatty acid content of an oil, the more solid it will be at 15°-20°C, while vegetable oils containing a major proportion of unsaturated fatty acids will be completely liquid in this temperature range.

487. Unsaturated fatty acids are classified into mono-unsaturated acids having only one double bond in the carbon chain, and di- and tri- unsaturated (poly-unsaturated) acids having two or three bonds in the carbon chain. The commonest occuring mono-unsaturated fatty acid is oleic; olive oil contains about 82 per cent oleic acid. Linoleic acid is the most frequently found di-unsaturated fatty acid in vegetable oils, ranging from about 1 per cent in palm kernel oil, to 58 per cent in sunflower oil. Linolenic acid, which has three double bonds in the carbon chain, occurs to a much smaller extent in vegetable oils, with one or only a trace in edible oils such as sesame, sunflower, coconut, and palm kernel, between 2 and 9 per cent in soyabean, but about 45 per cent in linseed oil, which, although it is possible to use as an edible oil, is generally used in the manufacture of non-food products such as paints, linoleum and varnishes.

Technical considerations affecting substitutability

488. The degree of saturation of an oil or fat can be determined chemically and is expressed as an iodine number of value. This characteristic of an oil or fat is important when considering the substitutability of oils. Table 17 gives details of the fatty acid composition and iodine value of the vegetable oils under review. The oils and fats which are composed mainly of saturated fatty acids are more stable and resistant to chemical deterioration than those containing a large proportion of unsaturated fatty acids. The most widely used method of modifying oils so that they can be readily used as substitutes is hydrogenation, whereby the addition of hydrogen to unsaturated oils renders them more saturated and thus more stable. Theoretically it is possible to hydrogenate most unsaturated oils and by so doing make them into substitute oils for the natural saturated oils. However, there are limits to the degree of substitutability since the end product may be required to have certain properties such as plasticity at low temperatures for suitable storage in a refrigerator, or to have a completely bland flavour. In this situation the manufacturer, in order to obtain these characteristics, may be restricted in his choice of oils and fats as raw materials for modifying.

489. Although the main criterion for the substitutability of oils and fats is probably based on the degree of saturation/unsaturation and iodine value, other factors need to be considered. Characteristics such as viscosity at different temperatures, solidification point, and the odour, taste and colour required in the final product, need to be considered when deciding on which oils and fats to use for raw materials.

490. Another important factor affecting substitutability is the availability of an oil or fat in the highly competitive world market. Thus an oil or fat which becomes in excess supply in its traditional markets is likely to be used as a raw material by manufacturers in both the food and non-food processing industries. An example would be the widespread use of soyabean oil by manufacturers because it has tended to be readily available and supplies have been generally predictable on a short-term basis. Palm oil is being increasingly used as end-users are able to assess that future supplies are fairly assured due to the already substantial planting of oil palms in Malaysia and with the prospect of an increase in supplies from new plantings in Indonesia. The result of intensive competition between soyabean and palm oil will probably be that each oil will find uses in an increasing number of new end-products.

Methods used to modify the natural characteristics of oils and fats

491. The majority of vegetable oils which are utilized as raw materials for processing into other end-products have already been modified to some extent by refining techniques such as washing with aqueous alkali, decolourizing by heating with bleaching earth, and deodorizing with steam. These treatments do not generally alter the natural characteristics of the oil or fat but are employed to remove colour pigments, aldehydes, ketones and phospholipids.

Hydrogenation

492. The modified process which is most frequently used to render oils and fats interchangeable is hydrogenation. In the presence of a catalyst it is possible to add hydrogen to fatty acids which have one or more double bonds, and convert them from being unsaturated to saturated. The process reduces the iodine value, and increases melting point of the oil. A reduction of one whole number of the iodine value of one ton of oil or fat, with a corresponding increase of the

Table 17. Fatty [illegible] [illegible]position,a/ [illegible] and [illegible]dine value [illegible] some vegetable oils

	[illegible]lm oil	[illegible] kernel	[illegible]	[illegible]	[illegible]	Sesame	Soya	Sunflower	Sa[illegible]	[illegible]
Saturated acids										
Caproic	-	-	[illegible]	-	-	-	-	-	-	-
Caprylic	-	2.4-[illegible]	3.4-9.5	-	-	-	-	-	-	-
Capric	Trace	[illegible]	[illegible]-3.7		-	-	-	-	-	-
Lauric	0.03-0.11	[illegible]-52.0	[illegible]-51.3	-	-	-	-	-	-	-
Myristic	0.5-5.9	14.1-[illegible]	13.1-18.5	-	Trace	0-0.3	-	-	-	-
Palmitic	30.0-47.0	6.5-10.[illegible]	7.5-10.5	7.5-12.5	20.0-25.0	7.8-9.4	7.0-14.0	3.5-6.5	6.0-7.0	2.0-7.0
Steafic	2.0-6.0	1.3-3.5	[illegible]	2.8-[illegible]	[illegible]	3.6-5.7	2.0-6.0	[illegible]-14.2	2.0-3.0	-
Arachidic	-	0-1.5	0-1.5	1.3 [illegible]	-	[illegible]-1.2	-	Trace	-	-
Unsaturated acids										
Oleic	40.0-52.0	10.5-18.5	5.0-8.2	[illegible]	[illegible]-33.0	35.0-49.4	23.0-34.0	14.1-43.1	13.1-17.6	[illegible]
Linoleic	5.0-11.0	0.7-2.5	1.0-2.6	13.9-[illegible]	[illegible]-55.0	37.7-48.4	52.0-60.0	44.2-73.4	73.6-79.0	11.0-[illegible]
Linolenic	-	-	-	Trace	-	-	2.3-3.0	-	-	5.0-16.0
Erucic	-	-	-	-	-	-	-	-	-	41.0-[illegible]
Iodinic value	46-60	14-20	7-10	[illegible]	97-113	104-116	120-141	113-143	130-150	97-101
Solidification	24-30	24-27	14-25	[illegible]	2-4	-6to-3	-13to-8	-18to-16	[illegible]	[illegible]12

a/ Per cent by weight of total fatty acids.

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melting by 1°C needs about 1 m^3 of hydrogen. The hydrogen is usually prepared by an electrolytic process and to produce 1 m^3 of hydrogen requires about 4.5 Kwh of electricity. It is therefore possible to calculate in terms of hydrogen and electricity the cost of hydrogenation for oils and fats in relation to their degree of unsaturation and iodine value. However, the major cost of hydrogenation is in the specialized equipment necessary to carry out the operation and its efficient utilization.

493. Hydrogenation procedures vary according to the raw materials and the requirements of the end product. The reaction can be controlled: for instance, to ensure that the two double bonds of linoleic acid become saturated before the single double bond of the oleic acid is saturated. Selective hydrogenation is thus the relative efficiency with which the hydrogenation reaction is controlled so that hydrogen is added to the greatest amount of the most highly unsaturated acids before it is added to the less unsaturated acids. In practice this is an important technique since,for example, if cottonseed oil were to be used as a raw material for addition to margarine it would be selectively hydrogenated until a fat with a melting point of about 33°C was produced. However, if cottonseed oil were to be used as a constituent of a cooking fat then the oil would need to be virtually fully hydrogenated to a fat with a melting point of 21-23°C. Processing by hydrogenation is also applied to increase the stability of an oil and to increase or decrease the plasticity so as to render the oil more suitable for blending with other oils and fats. Soyabean oil, which is prone to flavour reversion, is hydrogenated until its iodine value is reduced by about 20 units to produce a non-reversing oil.

494. During the hydrogenation a number of side reactions occur to form both positioned and geometrical isomers of oleic acid. Iso-oleic acids have the same iodine value and molecular weight as oleic acid, but the melting points of almost all of them are appreciably higher. Thus oleic acid (cis 9-octadecenoic) which has the double bond in the 9:10 position has a melting point of about 13°C, while elaidic acid, the trans-isomer of oleic acid has a melting point of around 44°C. Another isomer with the double bond innthe 12:13 position is trans -12-octadecenoic with a melting point of 52°-53°C. About 23 different isomers of oleic acid have been reported, most of them not naturally occuring, but several are certainly present in hydrogenated fats. In the manufacture of "hard butters", such as cocoa-butter substitute from liquid oils, a product is required which combines relative hardness with non-greasiness, and a short plastic range. A high proportion of iso-oleic acids in this type of product is a distinct advantage and some hard butters produced from groundnut oil have an iso-oleic acid content of 53-54 per cent. The operating conditions that favour the formation of iso-oleic acids are acheived by modifying the hydrogenation, usually by increasing the concentration of catalyst, lowering the pressure of hydrogen, and by a higher reaction temperature.

495. While discussing methods of hydrogenation, it is worth mentioning that it is possible to desaturate or dehydrogenate saturated fatty acids in the laboratory, but on an industrial scale it presents many technical difficulties which are costly to overcome. Nevertheless, the possibility remains that an economic process could be evolved should the demand for unsaturated fatty acids not be met by the production of naturally occuring unsaturated oils and fats.

Esterification and transesterification

490. These two processes are being increasingly used,by both the edible and industrial oils and fats manufacturers, to modify oils in order to use them as substiture materials. When oils and fats are reacted with monohydric aliphatic

alcohols, mono-alkyl-esters are formed. The alkyl-esters can be used as chemical intermediates for introducing fatty acids into a reaction. A practical application is, for example, the removal of lower fatty acids from coconut oil by reacting it with methyl esters of fatty acids with 12 or more carbon atoms.

497. Mono-glycerides and related compounds are used as emulsifiers in the manufacture of margarine, cooking fats, shortenings, ice cream and other fat-containing foods. They are prepared from refined, deodourized oils and fats by reacting them with glycerol in the presence of an alkaline catalyst at a temperature of about 245°C. A mixture consisting of 50-60 per cent mono-glycerides and 30-45 per cent of di-glycerides, together with some tri-glycerides and glycerol is produced. Separation of the mono-glycerides is carried out by molecular distillation. Other polyhydric alcohols can be used in place of glycerol such as sorbitol, mannitol, and polyglycerols, and the use of propylene glycol mono-esters of edible fatty acids for addition to shortenings for bread making was one of the earliest patents for this type of fat modification.

498. The reaction of a tri-glyceride with a mono-glyceride ester, in the presence of a suitable catalyst, and with removal of one of the product esters by distillation during the reaction so that the reaction proceeds to completion, is a method known as random transesterification. Oils and fats consist of mixtures of triglycerides and as an example of this type of transesterification it is possible to modify coconut oil by reacting it with ethyl stearate to replace some of the fatty acids in the oil by stearic acid and removing the ester formed in the reaction by distillation. The change in properties produced by transesterification of natural oils and fats depends upon their fatty acid composition and the natural arrangement of the fatty acids in the glycerides. Generally, transesterification will result in the oil or fat undergoing a change in consistency and having a considerably raised melting point.

499. Directed transesterification occurs when a mixture of tri-glycerides react with a highly active catalyst such as sodium methoxide so rapidly that the temperature of the reaction is lowered to such an extent that crystallization commences. The low temperature causes the higher melting point glycerides to crystallize out from the reaction mixture. Transesterification of palm oil when carried to equilibrium at higher temperatures produces a fat which contains about 12 per cent of fully saturated tri-glycerides. However, when the transesterification is carried out at about 38°C the high melting point saturated tri-glycerides crystallize out, and the continuous removal of the least soluble fraction from the reaction by crystallization unbalances the equilibrium and palm oil with a fully saturated tri-glyoeride content of around 28 per cent can be obtained. This method has been used to increase the fully saturated tri-glyoeride content of other vegetable oils including soyabean, groundnut, and cottonseed oil.

Fractionation

500. Two processes are involved in the process of fractionation: (a) holding the oil at a controlled temperature to allow crystallization and (b) separation of the crystals. This process was formerly applied to coconut and palm kernel oils by packing the solidified oils, after slowly cooling to about 23°C, into small cloth bags and subjecting them to hydraulic pressure to expel the liquid "olein", leaving solid "stearin" in the bags. However, this process is costly and has been virtually superseded by hydrogenation, where the harder (higher melting point) fractions are required. However, fractions suitable for use as cocoa-butter substitutes are obtained by fractionally crystallizing these oils.

501. The winterization of liquid oils such as cottonseed, sunflower and groundnut oils is a long established application of fractionation. This involves the removal of a small amount of natural waxes and high melting triglycerides which would otherwise cause these oils to be cloudy or semi-solid in cold weather. Their substitutability is thus increased as salad or table oils.

502. The fractionation of palm oil is of particular current interest since the process is operating in producing countries. More than 45 per cent of the tri-glycerides in palm oil have a melting point of 34°C or higher and these are the main constituent of the stearin fraction. The majority of the glycerides comprising the olein fraction have a melting point of 19°C and therefore an olein fraction which remains liquid at ambient temperatures below about 19°C cannot be obtained from palm oil in significant quantities no matter how efficient the fractionation process used. In practice, perfect separation of the glyceride groups cannot be obtained by crystallization because of mutual solubility, mechanical entrainment, and the presence of minor constituents with intermediate properties. Fractionation is improved by using a two stage process. The highest-melting glycerides are removed in a first stage. The liquid fraction is then cooled to a lower temperature and a second crop of stearin crystallizes. In this way, three products are obtained: an olein of improved low temperature stability, a stearin of high melting point and a stearin of intermediaite melting point. Although fractionation can be carried out on the crude oil, crystallization is usually improved with degummed neutralized oil. If fractionation is combined with directed transesterification, an olein with very good low temperature stability, at least equivalent to olive oil, can be obtained but the yield is inevitably limited by the natural content of unsaturated acids. A very high melting point stearin in also produced. The main fractionation processes used comprise: (a) simple filtration, (b) centrifugal separation with the aid of detergents and (c) solvent fractionation.

(a) (a) Simple filtration. The oil is held at a controlled temperature in large tanks fitted with slow stirrers. Crystals form and build into aggregates several millimetres in diameter and are filtered off;

(b) Centrifugal separation. After controlled crystallization, the crystals are broken up and intimately mixed with an aqueous solution of detergent and magnesium sulphate. As a result, the crystal surfaces are wetted by the detergent, displacing the liquid oil. The slurry is separated in a centrifuge to yield an olein fraction and a (stearin + detergent solution) fraction. The latter is heated and separated in a second centrifuging operation;

(c) Solvent fractionation. The oil is dissolved in a controlled quantity of hexane solvent. Crystallization is effected at a reduced temperature and the solids filtered off. The solvent is distilled off separately from the olein and stearin fractions. A patented process uses isopropanol as the solvent in which the crystallization results in a two phase system, the olein as the lower phase and solvent with stearin crystals suspended in it as the upper phase. Separation is by decantation.

503. In general palm oil olein competes with other liquid oils, and palm oil stearin can be substitued for hydrogenated fats.

Polymerization

504. Polymerization as a method for modifying oils and fats is mainly applied to vegetable oils destined for industrial usage. The reaction of fatty acids and esters involves the formation of new chemical bonds between molecules. The bonds are formed at unsaturated groups in the fatty acid chain or at a position activated by these groups and the result is an oil or fat with an in reased molecular weight. The principal practical advantage of polymerization is that the viscosity of oils can be increased and the method is used in the heat-bodying of unsaturated oils for use in the paints and varnishes industries.

505. Safflower oil is of considerable value as polymerized oil to the paints industry since it produces good gloss retention properties, and the formation of uniform polymers imparts good film flexibility. Alkyd resins are produced when polybasic acids are introduced into the molecules of high molecular weight oils, and safflower oil so modified is considered to have unequalled rapid-and even-drying, non-yellowing, and colour-retaining properties, compared with dehydrated castor oil which is also widely used in alkyd resins.

Substitutability of individual oils

506. The following sections outline the characteristics of individual oils and review the type of processing needed to make each oil suitable, if possible, for specific end uses. Table 18 provides a summary of the main form of utilization and the processes associated with each for the individual oils.

Palm oil

507. Palm oil is composed of approximately 50 per cent saturated fatty acids, primarily palmitic acid, and 50 per cent unsaturated fatty acids, mainly oleic and linoleic acids. It is very different, therefore, from other commercial vegetable oils such as sunflower seed, safflower, and soya bean oils, which are composed principally of unsaturated fatty acids, and from palm kernel and coconut oils which contain predominantly short-chain saturated fatty acids. In addition, palm oil is a highly coloured oil due to the presence of fat soluble carotenoids, mainly alpha and beta carotenes.

508. The major end use of palm oil in the main importing countries is in the manufacture of margarine, compound cooking fats and shortenings. For use in these products, palm oil competes with partially-hydrogenated soya bean, cottonseed, and marine oils and it is very much a question of relative price as to which is used. Palm oil has no specific end uses and although it can be and is used as a substitute oil, it is also vulnerable to being substituted by other vegetable oils. On the basis of present knowledge, it is highly likely that, with assured supplies of palm oil of good quality, it will be used as a substitute oil in increasing quantity. When utilized for the manufacture of margarine and some biscuit fats, palm oil can be used in the form of bleached deodorized oil without previous hydrogenation. For use in compound cooking fats and shortenings, palm oil is generally hydrogenated or partially hydrogenated depending on the melting point and plasticity required for the end product.

509. The technique of fractional crystallization applied to palm oil has widened the range of end uses for the oil. The liquid fraction can be used as palm olein cooking oil and would thus become a substitute for groundnut, maize, soya bean and sunflower oils, which are more often used as domestic cooking oils. The solid or stearin fraction can be used for the manufacture of margarine and shortening

Table 18. Modifications needed in oils and fats for their major end uses

Oil	Processing to prepare basic oil	Refined natural oil		Modified oil						
		Cooking oil	Salad oil	Margarine	Shortening	Imitation dairy products	Soap and detergents	Protective coatings and varnishes	Emulsifiers	Lubricants
Palm	Removal of free fatty acids, bleached, deodorized	Fractionation	Fractionated oil blended with other vegetable oils	Basic oil or partially or fully hydrogenated or fractionation	Partially or fully hydrogenated or fractionation	Esterification and trans-esterification	Distilled fatty acids	-	Esterification and transesterification	Distilled fatty acids
Palm kernel	As above	Basic oil (tropics)	...	Basic oil	Basic oil or fully hydrogenated	Basic oil or partially or fully hydrogenated	Blended with other oils for soap reacted with acid di-ethanolamine condensates	Polymerization to form alkyd resins	Esterification and transesterification	Lauric oil derivatives
Coconut	As above	Basic oil (tropics)	...	Basic oil	Basic oil or fully hydrogenated	Basic oil partially or fully hydrogenated	Blended with other oils as above	Polymerization to form alkyd resins	Esterification and transesterification	Lauric oil derivatives
Cottonseed	As above	Basic oil	Basic oil	Selective hydrogenation	Fully hydrogenated	...	Soap stock	...	...	...
Sesame seed	As above	Basic oil	Basic oil	Partially or fully hydrogenated	Fully hydrogenated	...	...	...	...	...
Soya bean	As above	Basic oil or blended with other oils	Basic oil or blended with other oils	Partially or fully hydrogenated	Fully hydrogenated	...	Fatty acids from "foots"	Polymerization	...	...
Sunflower seed	As above	Basic oil	Basic oil	Partially or fully hydrogenated	Fully hydrogenated	...	...	Polymerization to form alkyd resins	...	...
Safflower seed	As above	Basic oil	Basic oil	Basic oil	Partially or fully hydrogenated	...	...	Polymerization to form alkyd resins	...	...
Rapeseed	As above	Basic oil mainly used in Asia	Not widely used	Hydrogenated	Hydrogenated	...	Sodium salt of erucic acid	Reacted with sulphur	...	Basic oil blended with mineral oil

without hydrogenation. Stearin prepared from fully-hydrogenated palm oil has been used extensively as a substitute for cottonseed oil stearin in shortenings and frying fats in the United States.

510. Vanaspati, a ghee fat substitute, is manufactured in several countries from fractionated palm oil, and it has been suggested that a blend consisting of about one third palm olein, one third groundnut oil and the remainder natural palm oil is suitable for this product. The palm olein in the blend would substitute for cottonseed oil. Palm oil can be substituted also for tallow which is used primarily in the soap and animal-feed industries, but generally tallow is lower priced and therefore has the competitive advantage in these markets. Low-grade palm oil, that is with a free fatty acid content in excess of 5 per cent is used in low-quality so p and candles, while palm oil with even higher free fatty acid content can be used in tin plating. In addition, palm oil could be used for the manufacture of bio-degradable detergents for which lauric oils are preferred at present.

Coconut and palm-kernel oils

511. The similarity between the fatty-acid composition of coconut oil and palm kernel oil enables these oils to be considered together from the point of view of substitutability. They are composed mainly of the glycerides of short-chain fatty acids, between 6 and 14 carbon atoms in the chain, and which are fully saturated. Lauric acid, containing 12 carbon atoms, is present to the extent of 45-48 per cent, and these oils are generally referred to as lauric oils.

512. The lauric oils are used extensively in the manufacture of margarine and compound cooking fat and shortenings They have been displaced in table margarine to some extent by the introduction of polyunsaturated fatty acids, but when the lauric oils are competitively priced they are used as a substitute for other vegetable oils in the production of cooking margarines. In recent years there has been a decrease in many developed countries in the use of compound cooking fats for frying and baking, preference being given to other forms of vegetable oils and consequently a major outlet for lauric oils has declined. However, lauric oils are being increasingly used as a substitute for butterfat and natural liquid cream in imitation dairy products which include filled milk, cream fillings and coffee whiteners. Filled milk is natural milk from which most of the butterfat has been extracted and replaced by vegetable oil, usually coconut oil because it provides the preferred flavour. The keeping property of the filled milk is better than natural milk, while being similar in taste. Similarly, dried coffee whiteners made from lauric oils have a longer shelf life than the corresponding dried product made from natural milk and this is due to the fact that lauric oils are less prone to oxidation than natural milk fat. Hydrogenated lauric oils are used in the preparation of biscuit creams in preference to other vegetable oils because their melting point gives the desired effect of the cream melting in the mouth.

513. The major non-food use for lauric oils is in the soaps and detergent industries. Soap manufacturers, particularly of high quality toilet soaps, prefer to use lauric oils because they produce, when blended with other fats, soap with good lathering properties. When the price of lauric oils are relatively low the soap manufacturers tend to increase the amount of these oils at the expense of other oils and tallow.

514. The lauric oils have many industrial uses based on the high percentage of lauric acid they contain and are therefore unlikely to be substituted in these uses by other vegetable oils, although in the United States, for some end uses, synthetically produced lauryl alcohol from petroleum sources is used. Specific products such as sodium lauryl sulphate and sodium lauryl sarcosinate are used in the cosmetics industry, and diethanolamine condensates of coconut oil acids, or lauric acid diethanolamine condensates are used in appreciable quantities as foam boosters by detergent manufacturers, and are unlikely to be substituted for by other vegetable oils containing only a small percentage of lauric acid. Other lauric oil derivatives include di- and polyethylene mono- and di-laurate, which are used as emulsifiers in the food industry by the bakery trade, and in the manufacture of specialized detergents. The potassium and sodium salts of mixed coconut fatty acids, which comprise the major constituent of liquid hand-washing soaps, and a mixture of crude coconut oil and coconut oil sulphate is preferred as a leather lubricant after tanning and dyeing pale coloured leather as it does not discolour the final product.

Groundnut oil

515. Groundnut oil contains 40-67 per cent oleic acid, and 13-35 per cent linoleic acid, but only trace amounts of linolenic acid; so although it is a very unsaturated oil, it remains comparatively resistent to oxidative rancidity. Refined groundnut oil is mostly used by various food industries, while poor quality and crude oil may be used for the manufacture of soaps and detergents. From the point of view of substitutability, the use of groundnut oil in both food and non-food uses is more likely to be affected by economic than technical considerations, since the oil has very few specific end-uses which cannot be substituted for by other vegetable oils.

516. As an edible, groundnut oil is as excellent for deep frying and pan trying, with a smoke point of 226.5°C. It can be clarified and re-used many times for frying foods of a different flavour. It has been reported that for this use it is superior to cottonseed, maize, and soya bean oils. The oil is also used in the manufacture of shortenings, when it is hydrogenated and blended with other vegetable oils. Groundnut oil is also preferred for making salad dressings to be stored below -12°C, since groundnut oil solidifies in an amorphous form that does not break the emulsifying layer on freezing.

517. The major non-food uses for groundnut oil are in the manufacture of cosmetics, soaps and detergents. Poor quality groundnut oil may be used by the soaps and detergent industries, which is the general end use of most low-grade vegetable oils. The cosmetics industry uses groundnut oil to form the base of many face creams, shaving creams and hair lotions. It is specific for some of these products since the oil is believed to have an energizing effect on the skin when applied by massaging, and it is extensively used in this respect on polio patients.

Cottonseed oil

518. Cottonseed is a valuable by-product of the cotton fibre industry. The oil contains a high proportion of unsaturated fatty acids; oleic acid,18-30 per cent and linoleic acid 40-55 per cent,with the remainder being saturated acids, predominantly palmitic acid 20-25 per cent and stearic acid 2-7 per cent. Crude cottonseed oil is a

very dark coloured oil with a pronounced odour and flavour, but after refining to remove gossypol and related pigments along with free fatty acid, and chilling for removal of its higher-melting glycerides, a light-yellow coloured oil is produced which can be used as a salad oil.

519. Fully refined and deodorized cottonseed oil is virtually all used for the manufacture of salad and cooking oil, and, when hydrogenated, for the production of margarine and shortening. Technically the oil has no specific natural characteristics which make its use desriable for particular end-products, and the use of cottonseed oil by the food industries is therefore largely decided by availability, quality, and price. In the United States, where considerable quantities of cottonseed oil are always available, research and development work on new and improved products based on the oil has been proposed. Some suggested products are: edible coating materials prepared by combining the fatty acids with starch, cellulose and other polyhydric compounds of high moelcular weight; edible high-viscosity oils and hard waxes prepared by incorporating the fatty acids with polyols of intermediate molecular weight, and food grade emulsifiers made by combining fatty acids with sucrose, other saccharides and glycosides. However, from the technical point of view other vegetable oils could also be used for these end-products, and the use of cottonseed oil would probably depend upon economic considerations.

520. Poor-quality cottonseed oil and the soap stock obtained from the refining process can be used for soapmaking. Research work carried out in the United States has shown that some of the amides of modified cottonseed fatty acids are excellent low temperature plasticizers for polyvinyl chloride resins and other plastic materials. These amides can be substituted for plasticizers such as di-2-ethylhexyl phthalate, an ester of phthalic acid, which has caused some concern with regard to environmental contamination. Current research on cottonseed oil fatty acids is also being carried out to formulate substitute extreme pressure and anit-wear additives, which were formerly based on sperm whale oil and can no longer be imported into the United States.

Sesame seed oil

521. The relatively high price and uncertainty of supply of sesame oil restricts its use to food, rather than non-food uses, and even in the edible oil market it use is principally confined to substituting for olive oil, as an adulterant for olive oil, or top quality salad and cooking oils. The major fatty acids of sesame oil are oleic and linoleic acids, 35-49 per cent and 37-48 per cent respectively. However it is not the fatty acid characteristics which impart special properties to the oil, but the unsaponifiable matter containing sesamin, sesamolin and sesamol. Sesamol is a phenolic compound formed by the hydrolysis of sesamolin and sesamin and its presence in sesame oil helps to make the oil highly resistant to oxidation. Only small quantities of free sesamol are found in the crude oil, but it is liberated from the other compounds when the oil is bleached with acid-activited bleaching earths, by dilute mineral acids and also during hydrogenation.

522. Refined sesame oil is an exceptionally good edible oil, and is used directly as a bland salad oil and for cooking purposes. It compares very favourably in these uses with olive oil and this often leads to sesame oil being used as an adulterant of olive oil, rather than straight-forward substitution. Due to its relatively high price, sesame oil is also frequently adulterated with cheaper vegetable oils, usually groundnut or cottonseed. Sesame oil can be used in the manufacture of margarine and shortening but for these products it is not very competitive with the cheapter vegetable oils such as soyabean, cottonseed and groundnut.

523. At one time the unsaponifiable fraction of sesame oil containing sesamin and sesamolin was extracted and widely used as synergists for pyrethrin insecticides. This end use largely disappeared with the introduction of the more effective synergists, such as pipronyl butoxide. Because of its high stability compared with other vegetable oils, sesame oil also has some specific end uses in the pharmaceutical industry which employs the oil as a vehicle for medicaments which are required to be administered subcutaneously or intramuscularly. It may also be used in the preparation of liniments, plasters, ointments and special soaps. Small quantitits of sesame oil have been used in the perfumery industry as a fixative, but cheap synthetic products have tended to replace this use.

Safflower seed oil

524. Safflower oil is unusual in having a very high percentage of unsaturated fatty acids, but virtually no linolenic acid. It has the highest linoleic acid content (76-79 per cent) of any commercial vegetable oil and this characteristic has been exploited for both food and non-food uses. The crude oil is golden yellow in colour due to the presence of beta-carotene, but this is removed during normal refining and bleaching processes.

525. The high linoleic acid content has made safflower oil popular on the edible-oil market owing to the demand for oils containing high proportions of polyunsaturated acids. These acids tend to reduce a high serum cholesterol level in the blood. As a result, specialized food products containing safflower oil and other very unsaturated vegetable oils have been produced, particularly in North America, for persons suffering from hypercholesterolemia. Products such as imitation dried eggs, filled milk, salad dressing, margarine, and imitation cream are also made using safflower oil and the oil is very suitable for use as a cooking oil. For use in compounded products such as margarine, all-purpose shortening, and emulsified cake and bread shortening, safflower oil is equal or superior to other vegetable oils in ensuring that these products remain plastic over a wide temperature range.

526. Industrially, safflower oil is used in the manufacture of alkyd resins and protective coatings. For the production of alkyd resins the oil is valued for its unequalled rapid- and even-drying, non-yellowing and colour-retaining properties. Dehydrated castor has been widely used for the manufacture of alkyd resins, but safflower oil is preferred since it produces resins of superior quality. In particular, safflower-oil-based alkyd resins do not develop synaresis, or "after tack" some days subsequent to application or exhibit wrinkle or "gas check" in a foul atmosphere. However, the substitution of safflower oil for dehydrated castor oil in these uses would probably depend on the availability of each oil and their relative prices. Protective coatings prepared with safflower oil have good gloss and gloss-retention properties, exhibit little wrinkling, and have good climatic resistance combined with good film flexibility. Exterior housepaints based on safflower oil remain essentially white, compared with colour changes in linseed oil paints, which show a marked increase in yellowing when in shadow. Varnishes prepared with modified safflower oil have been found to be superior to those formulated with linseed oil. Substitution of linseed oil by safflower oil in paints and varnishes is technically desirable, but manufacturers of these products would probably not change their formulations based on either oil unless there was a substantial price difference between the oils.

Sunflower seed oil

527. The fatty acid composition of sunflower oil makes it very suitable for edible purposes. It is relatively low in saturated fatty acids with 3.5-6.5 per cent of palmitic acid, and 8.7-14.2 per cent stearic acid, but has a high percentage of linoleic acid, 44-75 per cent, and a varying amount of oleic acid between 14-43 per cent. The oleic and linoleic acid composition vary widely and inversely, with each other, and generally oil extracted from seed grown in cooler climates contains higher levels of linoleic acid and a higher ratio of polyunsaturated to saturated fatty acids. The demand for vegetable oils containing high proportions of polyunsaturated acids has also popularized the use of sunflower oil as a cooking and salad oil. Sunflower oil has a high smoke point (232°C) which makes it particularly well suited for frying chips, doughnuts, nuts, meat products and other foods. The oil is also used in the manufacture of margarine and compound cooking fat. With a fatty-acid composition similar to safflower oil but with a lower and more variable ratio of linoleic to oleic acid sunflower oil can be used as a substitute for safflower oil in edible products, and has the competitive advantage of being more readily available on the world market.

528. The major non-food use of sunflower oil is in the manufacture of paints and varnishes. For the latter purpose oil originating from seeds grown in cooler climates with its higher proportion of linoleic acid is preferred. Essentially it imparts the same properties to these products as safflower oil. Sunflower oil can therefore be substituted for safflower oil and linseed oil in paint and varnish end-uses, and since its availability in the world market is comparatively well assured, which is reflected in the price of sunflower oil compared with the other two oils, it is a highly competitive oil for these end-uses.

Rapeseed oil

529. The essential characteristic of rapeseed oil is the presence of erucic acid in amounts varying from 35-53 per cent. The oil also contains the more commonly occurring unsaturated fatty acids, oleic (6-55 per cent), linoleic (11-31 per cent), and linolenic acid (5-16 per cent), but with only small amounts of saturated palmitic acid (2-7 per cent). The wide variation in the fatty acid composition of rapeseed oil is due to the introduction in recent years of cultivars of rapeseed which have produced oils with low erucic acid content and an increased content of oleic and linoleic acids. A cultivar of Brassica napus, winter type, is characterized by large amounts of erucic acid, typically 48-53 per cent. The variation of B. napus, summer type, is much larger, from 10 per cent to around 45 per cent in Canadian and European cultivars. The summer annuals of B. campestris, including the types grown in India and Pakistan, have an erucic acid content ranging from 30-55 per cent and an oleic acid content of from 10-27 per cent. In Canada, "zero" erucic acid rapeseed oil has already been produced and is known as "Canbra" oil. It seems very likely that in the future oils of rape and turnip rape from many countries will no longer have the characteristic erucic acid present in substantial amounts.

530. Although refined rapeseed oil is odourless and has a bland flavour, the presence of 5-16 per cent of linolenic acid in the glycerides renders the oil more susceptible to auto-oxidation than oils such as groundnut, making it similar to soyabean oil in its tendency to develop off-flavours. In addition, when the oil has been fed to animals under experimental conditions in quantities of 10-20 per cent or more of the dietary fat, it has produced growth retardation, in certain cases pathological abnormalities, and in most animals it has been found to reduce food consumption. These reactions could be due to the erucic acid content, but another factor which could be responsible is the balance between saturated and mono-enoic fatty acids in the oil.

531. The rapid growth of rapeseed oil utilization in Canada, where is is now second in importance to soyabean oil, combined with the expansion of production within the European Economic Community, must inevitably increase the competitiveness of the oil in the world vegetable oil market. Recent technical improvements have considerably broadened the utilization base of rapeseed oil, and hydrogenated oil is certainly competitive with other hydrogenated vegetable oils in their use for food products such as margarine, compound cooking fat and shortenings. In Europe and Canada the oil is mainly used for margarine. In Asia the major proportion of rapeseed oil is used for cooking purposes. Because of the dietary factors discussed above, rapessed oil is not altogether satisfactory for the production of salad oil, and its use in food dressings such as mayonnaise may give rise to breakage of the emulsion under refrigeration owing to the crystallization of the oil.

532. Industrially, rapeseed oil is used in compound lubricants: as a cutting oil blended with mineral oil, as an additive in quenching oil, and as a core oil for making castings. Probably the principal industrial outlet for the oil in many developed countries is the manufacture of factice (a rubber substitute or additive used not only as a rubber extender, but also to modify the properties of drying oil products, such as varnishes and linoleum). It is also used for the preparation of chemicals employed in the textile industry for scouring, washing, and dyeing processes. The sodium salt of erucic acid is used in hot-water detergents and in water-repelling agents. Certain long-chain fatty amides of erucic acid either alone or in mixed rapeseed-oil fatty acids have proved to be good plasticizers for vinyl chloride resins and ozonolysis of erucic acid yields pelargonic and brassylic acids, products which could have considerable industrial potential. In Canada, brassylic acid esters are used in the manufacture of nylon. The oil is used in the fat liquoring or tanning process of leather and in the production of specialized inks and varnishes.

Soyabean oil

533. Soyabean oil is the major vegetable oil traded in the world market and there is no indication that this situation will change in the foreseeable future. Soyabeans are grown principally for their protein content. Refined soyabean oil consists principally of the triglycerides of oleic (23-34 per cent), linoleic (52-60 per cent), and linolenic acid (2-3 per cent), together with the saturated acids palmitic (7-14 per cent) and stearic (2-6 per cent). In the refining procedure the phospholipid fraction may be precipitated by the action of moisture, and centrifuged out of the oil. This constitutes the degumming process, and forms part of the process for the manufacture of commercial lecithin.

534. The major proportion of soyabean oil is used in the manufacture of margarine and shortenings, and for these purposes it is generally hydrogenated. Considerable quantities of the oil are used unhydrogenated as a salad oil and cooking oil, and it is also blended with olive oil for these purposes. Soyabean oil has a tendency to develop an off-flavour or odour when stored in contact with air, or when heated to a high temperature such as its used for deep fat frying. This property is referred to as "reversion", and is due mainly to the presence of linolenic acid in the oil, but it can be overcome by partially hydrogenating soyabean oil, when the linolenic acid content is reduced to 1 per cent or less, and the linoleic acid content to about 10 per cent.

535. In the United States it is estimated that only about 10 per cent of the total domestic production of the oil is used for industrial purposes, but it is expected that the non-food uses of the oil will increase. Soyabean oil is used in the paints, varnishes, linoleum, and printing ink industries, and fatty acids from soyabean foots and poor quality oil are being used for the manufacture of soap.

536. From the preceding discussion, it can be seen that with the aid of modern technology nearly all vegetable oils are substitutable to varying degrees, both for each other and for animal oils, marine oils, and synthetic products. The manufacturer of food and non-food materials based on vegetable oils has a wide choice when deciding on a suitable substitute oil for his particular end-product. Generally, he will select the cheapest and most readily available oil, depending on the nature of his end-product.

537. Although the degree of substitution that occurs in practice between vegetable oils is a function of relative prices, these prices are themselves determined by the interplay of supply and demand. In a situation where total demand for vegetable oils is growing at a faster rate than total supply, the scope for substitution to cheaper oils will be more limited than in the situation where supplies are growing faster than demand. Relative growth rates of demand and supply can therefore be considered the essential determinants of the type of substitution that takes place.

B. Potential food uses for vegetable oils

538. With the current tendency to use blends of various oils in the manufacture of any one product and/or to substitute one oil for another in a product depending on availability, patents, surveys of future demand and similar publications frequently name a variety of oils for a given purpose. One of the most important trends in the pattern of vegetable oil utilization has been the incorporation of various low-melting oils in polyunsaturated (soft) margarines.

539. There is the belief among many people that coronary disease in middle age may be linked to a high consumption of saturated fat, which has resulted in a considerable increase in the demand for fats and oils containing a high proportion of highly-unsaturated fatty acids ("polyunsaturated fatty acids", or PUFAs) mainly for incorporation in margarines. By careful choice of the constituent fats it is also possible to ensure that such margarines have the commercially desirable property that they can be spread when cold ("spread from the refrigerator"), due to the presence of the low-melting unsaturated oils therein, yet they retain a reasonably firm consistency at room temperature and can be tub-packed. Recently several patents have been filed in this area and it does seem likely that demand for such low-melting, highly-unsaturated oils will increase. For example, two patents filed recently by Unilever both stipulate the use of a high proportion of "a liquid oil containing at least 40 per cent polyunsaturated fatty acids" (soyabean, sunflower, sesame, safflower and cottonseed (but see also para. 547) oils would come in this category) blended with a few per cent of a saturated fat, derived from, say, palm or palm kernel oil, to give the desired consistency. Other recent patents for such products include one for a soft margarine made by blending palm oil (after randomizing its glyceride fatty-acid chains) with a liquid oil "such as groundnut, cottonseed, sesame, soyabean, sunflower or safflower"; and one for a similar product with the same list but added rapeseed oil - to be used alone or blended and treated with a sugar/fatty-acid derivative as an emulsifying agent. In the discussion of future food uses for individual oils, their suitability for inclusion in soft margarines is likely to be the dominant influence on the extent of future demand for them.

Palm oil

540. There has been of late an increasing tendency for palm oil, once refined, to be further processed by fractionation. This is a procedure whereby the refined oil, normally a soft solid at ambient (tropical) temperatures, is separated into

solid and liquid portion each with its own particular use; for example the former can be used in the manufacture of margarine, pastry shortening or cooking fat and the latter as cooking or salad oil. The methods used basically involve cooling the warm liquid oil, either neat or dissolved in a solvent such as hexane, and collecting the solid which separates out (the material left behind being the liquid fraction). By varying the temperature at which the crystallization process occurs and/or the amount of solvent, fractions of varying melting points can be obtained,; thus it is even possible to obtain a particular fraction melting just below body temperature and which therefore can be used as a cocoa-butter substitute, a product which is in considerable demand for use in chocolate-coated confectionery. In this way it becomes possible to make a whole range of different products, each with a specific use, all from palm oil feedstock. Until recently, this "secondary" processing of palm oil was confined to the refining plants in the developed countries. Recently, however, such plants have been constructed in Malaysia. This trend towards more sophisticated processing, often in the country of origin, is expected to continue as palm oil production, particularly in Malaysia and Indonesia, continues to increase. A chemical procedure known as transesterification, which allows the composition of the triglycerides making up the bulk of the oil to be changed, is also being used increasingly to change the properties, particularly the melting point, of the oil; again so that a variety of tailor-made products can be offered to the market. Undoubtedly, with the rapidly rising production of palm oil by the developing countries, it will become necessary to find new outlets - often by using palm oil in a food product in place of the oil traditionally used. For example, the high stability (to oxidation) and low foaming properties of the liquid ("olein") fraction from fractionated palm oil make it a particularly good frying oil and there are indications that it might therefore start to displace the "increasingly expensive" groundnut oil for this purpose. The provision of palm oil in a variety of formats as indicated above will help achieve the goal of finding new outlets.

541. Palm oil is a deep orange-red colour due to the carotenoids it contains, typically to the extent of 500 to 700 ppm but sometimes even greater (in particular in the oils from semi-wild West African palms and from the South American species, Elaeis oleifera). The major carotenoids present are the beta- and alpha-carotenes both of which are converted into vitamin A on ingestion and are therefore extremely valuable nutritionally. However, since the users of the oil and its derived products prefer these products to be near-white in colour, the carotenoids are currently bleached out during processing by heat and/or adsorbent-earth treatment, thereby wasting a nutritionally and commercially valuable constituent of the oil. In addition it seems likely that the market price of both synthetic carotene and of vitamin A (much of both being made from a crude-oil feedstock) will rise which would make it increasingly worthwhile to devise a refining process in which the carotene fraction is removed at the start for purification and use, rather than destroyed. This would also obviate the need for the bleaching step in the refining process. So far the only method devised to achieve this objective is a rather complex process which requires the splitting of the triglyceride mixture into glycerol plus mixed fatty acids and eventual reconstitution of the oil after extracting the carotenes, a procedure which additionally may run into legal (definition) problems. However, it should be possible to devise such a process without these drawbacks in which case the beta/alpha-carotene mixture could be sold as a concentrate, either as such or after purification/crystallization, for use in vitamin supplement preparations or as a food colourant. There is evidence of recent interest in isolating the carotene for use as a vitamin supplement and a Danish company is said to be operating a process whereby the carotene is retained during refining and the processed material used in small amounts as a colourant for margarine.

542. Palm oil also contains tocopherols, which are natural antioxidants, to the extent of 500-800 ppm. A proportion of these components is lost during current refining procedures but it seems likely that in the future the refining procedure will be modified, or a different one devised, which will allow a part of the tocopherol content to be isolated for use as an antioxidant in other foodstuffs (particularly now that legislation on synthetic food additives is tending to be tightened up).

Palm kernel oil and coconut oil (the "lauric oils")

543. Because of their similarity in composition, palm-kernel and coconut oils are considered together. Palm kernel oil contains little or no carotenoid, and it has a triglyceride composition which approximates that of coconut oil rather than palm; thus the lower molecular weight representatives, lauric and, to a less extent, myristic acids, predominate, with palmitic and oleic, the major palm-oil acids, accounting for only about 10 per cent of the oil's composition.

544. The chemical composition of the lauric oils results in good stability to oxidation and a melting point (20°-25°C) which is particularly appropriate for their incorporation in a wide variety of confectionery products as well as margarine and cooking fats. As already mentioned there is a continuing demand for cocoa-butter substitutes in the confectionery trade (for chocolate coatings and fillings), with genuine cocoa-butter becoming increasingly expensive. Fractionated and hydrogenated lauric oils are already used as constituents of certain proprietary cocoa-butter substitutes and this end-use is likely to become increasingly important. Thus a recent patent application by Unilever for a cocoa-butter substitute for use in hot climates specifies a blend of coconut oil with half its weight of a saturated fat consisting of palmitic/stearic triglycerides (from fractionated palm oil for example).

545. An established, but relatively small, outlet in the developed countries is the use of that fraction from fractionated coconut oil containing mainly those triglycerides carrying C_8 (caprylic) and to a less extent, C_{10} (capric) acids as an easily absorbed fat; for use in the diet of those infants, and occasionally adults, who have difficulty digesting triglyceride fats containing the longer fatty acid chains present in most well-known oils and fats. It is thought that as dietary control in the developing countries becomes more sophisticated, a demand for such medium-chain triglyceride products may well develop there also.

Groundnut oil

546. The most pressing problem facing groundnut oil is to maintain its traditional market outlets in cooking oils and other food products. No information could be obtained on possible new food uses, with the exception of the possibility of isolating the lecithins from the wash liquors obtained during refining, as is already done with soyabean oil. However, this would be worth considering only for large-scale refining plants with high throughputs of oil. In addition, recent patents suggest groundnut as one of the oils which could be used in various "soft" (poly-unsaturated-fat) margarine formulations.

Cottonseed oil

547. Cottonseed oil is already used in certain of the developed countries as a constituent of certain brands of margarine, after extensive refining and deodorizing followed by partial hydrogenation to harden it. However, there are indications of new developments in this field, which might therefore lead to increased consumption of this oil for margarine and allied products. Thus an Egyptian author has suggested that locally produced, refined/deodorized cottonseed oil

could, after adding 5 to 9 per cent glycerol monostearate as an emulsifier and various antioxidants, be used to make a margarine-like product. Samples made on a small scale were reported to have a good appearance and to go firm on refrigeration. It would of course be important, if this process were to be scaled up, to ensure that the usual care be taken to refine out all the gossypol (a toxic constituent in the seed, removable by alkali washing during refining) from the crude oil before being used in the above process. A further constraint on the use of this oil alone in such products might be the occurrence of 1 to 2 per cent cyclopropene fatty acids in cottonseed oil triglycerides, as a limit on the amount present in the final margarine might be imposed by the authorities for health reasons. In addition, two of the patents mentioned in paragraph 539 suggest the use of this oil in the blend of various oils that could be used in the manufacture of "polyunsaturated" margarines for consumption in the developed countries.

Rapeseed oil

548. Despite the virtual doubling of world rapeseed production between 1973 and 1975, a major constraint exists on any further large-scale increase in the use of rapeseed oil in human foodstuffs, at least of the kind of oil generally being produced from the seed. This is the restriction imposed by some Governments, mainly so far those of the developed countries, on the large-scale use of this oil in such foods due to its high eurcic acid content. Erucic acid, a C_{22} (i.e. longer than usual chain-length) unsaturated acid, has been shown to have an adverse effect on the heart tissue of experimental animals and although its effect on man remains uncertain, it seemed wise to assume similar effects might be produced with a diet containing substantial quantities of this substance. Over recent years, plant breeders in Canada (and later in Western Europe) have succeeded in producing low-erucic strains of rape and it is possible that the cultivation of such strains will increase throughout the developed countries over the next few years. In similar vein, a recent forecast of trends in consumption of various vegetable oils in the United Kingdom suggested that by 1985 most or all of the rapeseed oil used in the United Kingdom food industry would be of the low erucic kind and that during the same period there would be a concommitant steep increase in rapeseed oil usage. It therefore seems likely that low erucic strains of rapeseed may similarly spread to some developing countries eventaully(providing any disease-resistance and similar problems do not arise when the new strains are used in lower latitudes). Such a development if achieved would overcome the present constraint of too high an erucic acid content on the use of rapeseed oil from the developing countries and could therefore lead to increases in domestic consumption and/or exports of the oil.

549. Major current uses of the traditional, high-eurcic oil are as a cooking oil and salad oil or, after hydrogenation, as one of the constituents of various cooking fats and margarines, but various other uses have been mooted, such as in the production of confectionery fat, cocoa-butter substitutes and in ice cream. In addition, there is a continuing interest in modifying the properties of rapeseed oils by, for example, mixing a high-erucic rapeseed oil with a lauric oil and transesterifying so that the erucic acid is "diluted out" in the final fat. Alternatively, by using low erucic oil, the oil's properties can be modified so as to make it a more acceptable constituent of, for example, margarine.

550. As with several other vegetable oils, one of the steps during the refining of crude rapeseed oil is degumming. This involves treating the oil with a few per cent by weight of hot water, sometimes with the addition of phosphoric acid, whereby the mixture of phosphatides (about 2 per cent by weight) present in the oil, known as lecithins, are precipitated as a gum and are removed from the oil

along with the water by centrifuging. The crude material contains mainly oleic and linoleic acids as the fatty acid components and only a little erucic acid even when obtained from a high-erucic oil; it also has a gross chemical composition very similar to that of soyabean lecithin which is used extensively in the food industry. However, rapeseed lecithin is darker in colour and inferior in flavour, taste and general appearance, to soyabean lecithin. Although there have been many attempts to devise a process which will bring rapeseed lecithin up to the quality of soyabean lecithin, in general it still runs the latter a poor second and as a consequence is little used in the developed countries. However, if the food-processing industry shortly becomes more widely established in the tropical developing countries it seems likely that there could be an upsurge in the demand for a "home-grown" lecithin - such as rapeseed lecithin.

551. A substantial proportion of the tocopherols naturally present in rapeseed oil, to the extent of 800 to 900 ppm, is lost during the alkali-wash, bleaching, and deodorization steps of the refining procedure generally used. Where rapeseed oil is processed on a large scale it might prove worthwhile to isolate the tocopherols at one or all of these steps (e.g. in vacuo deodorization step) and use them as antioxidants in other foodstuffs.

Sesame seed oil

552. Sesame oil has a particularly good fatty acid distribution being high in the relatively stable unsaturated acids, linoleic and oleic, but free of the rather oxidation-prone linolenic acid (which can cause problems with soyabean oil). It is therefore a good candidate for incorporation in the polyunsaturated fatty acid margarines, the demand for which is thought likely to increase. It is, however, currently rather more expensive than most of the other oils available as potential PUFA-margarine constituents.

Soyabean oil

553. As a cooking oil and as a salad oil the high linoleic acid content (typically 55 per cent) in this oil, which is usually considered a desirable constituent, is accompanied by a significant linolenic acid content, which leads to storage problems due to its greater proneness to oxidation resulting in off-flavours and rancidity in the products incorporating it. A recent method of selectively hydrogenating the linolenic acid while having little effect on the linoleic, means that it will become possible to make from soyabean oil an oil which is high in linoleic acid but virtually free of linolenic simply by incorporating this additional step in the refining procedure. This should facilitate the use of this oil in cooking oil, salad oil and other products which need to be stable during storage without off-flavour problems developing.

554. As a source of tocopherols, crude soyabean oil has one of the highest known concentrations of tocopherols, the natural anti-oxidants: typically between 850 and 1,450 ppm. The same can therefore be said of this oil as was previously said under palm oil.

555. The lecithins are a family of chemically related substances occuring naturally, to the extent of about 2 per cent, in soyabean oil and which can be isolated from the oil during normal processing (at the initial, water-wash stage). The mixture is used widely in the food industry as an emulsifier and dispersing agent (in convenience foods, ice cream, margarine etc.); current world consumption being around 100,000 tons a year, much of which is derived from soyabean oil. It seems likely that the demand for this product will increase in step with the expanding convenience food industry and with recent public preference for food additives to be naturally derived where possible. In addition, the market price has risen

steadily over the last few years which will tend to make the isolation of lecithins during soyabean oil processing even more worthwhile. The possibility of producing chemically modified lecithins in the future and using these for new applications in the food industry was pointed out at the 1976 Amsterdam Oils and Fats symposium.

Sunflower seed oil

556. Sunflower oil's high (though variable) linoleic/negligible linolenic fatty acid composition makes it very suitable for various food purposes. Perhaps more significant in the sense of increased demand is its increasing use as a constituent of poly-unsaturated margarines and modified dairy products. (Low-temperature spreadability and "anti-coronary" properties can be built into traditional dairy butter simply by blending in a proportion (up to 30 per cent) of refined sunflower oil, the increased susceptibility to oxidation being countered if necessary by the incorporation of synthetic antioxidants such as BHT.)

557. Although little quantitative information is available on the amount of lecithins present in the crude oil, and hence whether it would be worth trying to isolate these compounds during processing, the crude oil contains some phosphatides (which include lecithins), although in smaller quantity than in cottonseed oil; there is therefore the possibility that these could be isolated from the degumming liquor as is done with soyabean oil.

Safflower oil

558. Safflower oil is produced and traded on a much smaller scale than most of the other oils in the group under study, and, perhaps as a consequence, less information is immediately available as to by-products (such as lecithins or steroids) therein which might be separated from the oil during refining. However, because of its composition, high in the unsaturated fatty acids linoleic and oleic but free of the oxidation-prone linolenic acid, it has many food and non-food uses with every indication that demand for the oil in several of these established outlets will increase. In addition, several recent patents describing polyunsaturated margarine formulations have mentioned safflower oil as a possible constituent and its high-linoleic/no-linolenic fatty acid spectrum would make it ideal for such a purpose.

C. Potential non-food uses for vegetable oils

559. Although food uses are still likely to account for the major part of vegetable oil utilization in the future, a number of oils have particular properties which offer some prospect for inclusion in non-edible products.

Palm oil

560. Hydrolytic splitting of the triglycerides comprising palm oil yields glycerol and a mixture of fatty acids, with palmitic and oleic acids predominating. With the fatty acid fraction accounting for over 90 per cent of the weight of a typical palm oil, the latter is obviously capable of providing a rich source of the above two fatty acids (and smaller amounts of stearic acid and the nutritionally essential linoleic acid). Fatty acids are used widely in industry in making such products as soaps, detergents, emulsifiers for the food industry, cosmetics, and agricultural preparations. Although it was reported in 1975 that palm oil's non-food uses, such as the production of fatty acids, soap and candles, were showing little sign of growth, there is evidence of renewed interest in the foremost of these uses.

Palm kernel and coconut oils

561. The composition of these oils leads to the soaps made from them having particularly desirable properties (soft, creamy consistency; quick lathering; good solubility) and this results in the lauric oils being in considerable demand for the manufacture of high quality soaps. Of the various other allied uses the use of lauric esters in cosmetic products is prevalent and it is expected that its use in the production of biodegradable detergents and of chemical intermediates such as lauryl dimethylamine oxide and vinyl laurate will increase.

Groundnut oil

562. Groundnut oil has an established non-food use in the cosmetics industry, but no information could be obtained as to possible new uses, with the exception that it might be possible to isolate some steroids from the wash liquors obtained during refining. This would be likely to be economically feasible only if refining was on a large scale.

Cottonseed oil

563. The possible inclusion of cottonseed oil in non-food products seem unlikely in the near future, although research is being carried out in the United States.

Rapeseed oil

564. The possibility of isolating lecithins for edible uses has already been mentioned. Whether or not it proves possible to purify them sufficiently for such uses, it may still be possible to use their emulsifier and allied properties in the cosmetics industry, as indicated for soyabean lecithins, providing that there are no adverse skin reactions due to any of the impurities therein.

565. Rapeseed oil usually contains 0.5 to 1 per cent by weight of steroids, partly free and partly as esters or glycosides (as compounds with fatty acids or sugars). A proportion of these compounds is transferred into the lecithin fraction on degumming the crude oil and could presumably be isolated as outlined in the discussion on soyabean oil. The major steroid present, beta-sitosterol, could be used as a starting material for the synthesis of contraceptive steroids, again as noted under soyabean oil.

566. Although, as pointed out above, the presence in traditionally produced rapeseed oil of up to 50 per cent erucic acid (accompanied by small amounts of the analogous C_{20} acid) is a considerable disadvantage when considering its use in foodstuffs, various non-food uses have been devised for this acid and such oil provides a very convenient source. Thus alkaline hydrolysis, or saponification, of rapeseed oil yields a mixture of fatty acids from which the major constituent, erucic acid, could be isolated by, for example, vacuum distillation or fractional crystallization. On treatment with ozone the erucic acid molecule is cleaved to yield two relatively short-chain acids, pelargonic acid and brassylic acid, both of which are in considerable demand in industry; for example in the manufacture of plasticizers, alkyd resins (used in varnishes and other surface coatings) or lubricants. In addition, the brassylic acid could be used for the manufacture of nylon-type polymers. With several of these outlets tending to increase in importance, it seems likely that the demand for the above mentioned two acids, and hence for erucic acid as one of the more convenient sources thereof, could well increase.

Sesame seed oil

567. The use of the rather complex chemicals present in crude sesame oil known as sesamin and sesamolin as synergists for pyrethrum-based insecticides largely disappeared following the introduction of the semi-synthetic analogue, piperonyl butoxide. However, the recent resurgence in interest in the use of pyrethrum insecticides in the face of widespread concern over the persistence of the chlorinated pesticides such as DDT in the environment could lead to an increased usage of the sesame synergists particulary in theose developing countries with native sesame oil but which would have to import the synthetic analogue mentioned above. Since, as already intimated, the sesame synergists are largely removed from the oil during refining, it may prove possible to isolate a concentrate of these compounds from the refining liquors. In this way a use for an otherwise wasted liquor could be found and there would be no need to use any of the oil itself for this purpose.

568. Sesamol, which is obtained when sesamolin is treated with acid or hydrogenated, although not active as a synergist, is on the other hand a good antioxidant and one might forsee it being used in this manner in certain areas (e.g. where entirely synthetic antioxidants such as BHT are expensive) in the future. Sesame oil also contains ca. 0.2 per cent steroids, much less than in rapeseed oil, the major representative being beta-sitosterol. The same remarks therefore apply as in the case of rapeseed oil but with this source being much less likely to be worth exploiting owing to the small concentration (the same is true for lecithins, which are reported to be present in only trace amounts).

Soyabean oil

569. Steroids (sterols) naturally present in soyabean are largely washed out of the oil during refining at the initial, water-washing state - into the hydration sludge - and can be isolated from this sludge by precipitation with digitonin. With the increasing demand for steroids as medicinals (cortisone and anabolic drugs) and for use in the contraceptive pill, it seems quite conceivable that it may soon become worth while isolating these steroids from the hydration sludge for conversion into such pharmacologically useful derivatives. For the latter use, the beta-sitosterol and stigmasterol in the sludge would both be usable. It is already considered economic in the United States to isolate the steroids from the oil itself.

570. Hydrogen sulphide-olefin addition addition products of the kind which are used industrially as lubricants, synthetic rubber, feedstocks, ore-flotation collectors, fungicides and chemical intermediates can be prepared by treating soyabean oil with hydrogen sulphide/boron trifluoride at a low temperature, the oleate and the linoleate in the oil reacting as typical olefins in this reaction. It seems likely that if an imbalance in the demand for meal and oil arises in the future with the latter in excess, the surplus oil might be used as a feedstock for the preparation of such chemicals. In addition, the oil has already been used in the United States in large amounts in the plastics industry.

Sunflower seed oil

571. Like soyabean oil, sunflower oil contains some steroids which are partly washed out in the hydration sludge during refining and which could presumably be isolated if desired by digitonin precipitation. However, the concentration present (0.3 per cent) is less than for soyabean oil and relatively little sunflower oil is produced in the developing countries; so other oils might prove to be better sources.

572. The degree of overlap between the concept of substitutability and that of new end uses in the vegetable oils and fats industry is amply illustrated by the discussion above and it can be seen that none of the end uses mentioned in this chapter is likely to constitute a major new market for vegetable oils. Many, such as the production of lecithins and steroids, are really an extension of existing practices and could be expanded comparatively easily given the required growth in the markets for these products. Other aspects, such as the increasing use of oils high in polyunsaturated fatty acids, undoubtedly imply changes in the relative demand for different oils but the process is essentially one of substitution rather than absolute expansion of vegetable oils uses. Consequently, nothing in the foreseeable future leads one to conclude that the overall demand for vegetable oils could change markedly, although marginal changes in the relative proportion of demand met by the individual oils could take place. The implications of the trends in vegetable oil consumption in the developed economies tends to reinforce the view that, with the exception of palm oil (and palm kernel oil), the developing countries are likely to find world markets for the oilseeds they produce increasingly competitive. Nevertheless, meeting their own needs could provide the required impetus to the developing countries as a group to expand their own oilseed industries.

III. STATISTICAL TABLES

Table 19. Production of oilseeds 1965-1975 by
main producing countries

19.1. Production of soyabean

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
U S A	23014	63.0	30675	66.0	41406	60.6
China	11036	30.4	11645	25.0	12062	17.6
Brazil	523	1.4	1509	3.2	10200	14.9
U S S R	421	1.2	595	1.2	600	0.9
Indonesia	410	1.1	498	1.1	560	0.8
Japan	230	0.6	126	0.3	126	0.2
Canada	219	0.6	283	0.6	367	0.5
Korea D.P.R.	200	0.6	228	0.5	263	0.4
Korea Rep.	174	0.5	232	0.5	320	0.5
Mexico	58	0.1	215	0.5	545	0.8
Colombia	50	0.1	96	0.2	168	0.2
Others	170	0.4	372	0.9	1739	2.5
World	36505	100.0	46474	100.0	68356	100.0

19.2. Production of coconuts

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Philippines	7089	26.9	6484	24.7	9069	30.6
Indonesia	5588	21.2	5413	20.6	6500	21.9
India	3741	14.2	4514	17.2	4589	15.5
Sri Lanka	2017	7.6	1882	7.2	1650	5.6
Thailand	1217	4.6	967	3.7	820	2.8
Mexico	1115	4.2	992	3.8	960	3.2
Malaysia	945	3.6	1071	4.1	794	2.7
Papua New Guinea	710	2.7	776	3.0	795	2.7
Brazil	265	1.0	328	1.2	236	0.8
Fiji	260	1.0	249	0.9	281	0.9
New Hebrides	209	0.8	227	0.9	260	0.9
Ghana	229	0.9	201	0.8	300	1.0
Mozambique	275	1.0	407	1.5	400	1.3
Tanzania	274	1.0	321	1.2	300	1.0
Others	2439	9.2	2443	9.3	2676	9.0
World	26373	100.0	26275	100.0	29630	100.0

19.3. **Production of cottonseed**

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
U S A	5522	25.0	3690	16.7	3175	13.8
U S S R	3725	16.9	4416	19.9	5130	22.3
China	3298	14.9	3992	18.0	4337	18.9
India	1994	9.0	1908	8.6	2450	10.7
Brazil	855	3.9	1277	5.8	1015	4.4
Mexico	998	4.5	550	2.5	335	1.5
Egypt	961	4.4	884	4.0	730	3.2
Pakistan	834	3.8	1114	5.0	1020	4.4
Turkey	527	2.4	640	2.9	745	3.2
Syria	296	1.3	234	1.1	240	1.0
Sudan	289	1.3	467	2.1	432	1.9
Iran	273	1.2	288	1.3	328	1.4
Argentina	268	1.2	249	1.1	270	1.2
Peru	218	1.0	153	0.7	141	0.6
Nicaragua	207	0.9	112	0.5	200	0.9
Others	1797	8.1	2181	9.8	2416	10.5
World	22062	100.0	22155	100.0	22964	100.0

19.4. **Production of groundnuts**

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
India	4263	26.6	6111	33.2	6600	34.5
China	2426	15.1	2772	15.0	2800	14.6
Nigeria	1978	12.3	1581	8.6	280	1.5
Senegal	1121	7.0	583	3.2	1300	6.8
U S A.	1084	6.8	1351	7.3	1750	9.1
Brazil	743	4.6	928	5.0	441	2.3
Indonesia	405	2.5	468	2.5	541	2.8
Argentina	439	2.7	235	1.3	375	2.0
South Africa	197	1.2	318	1.7	288	1.5
Cameroon	141	0.9	178	1.0	165	0.9
Burma	288	1.8	529	2.9	500	2.6
Niger	277	1.7	220	1.2	100	0.5
Thailand	131	0.8	190	1.0	260	1.4
Malawi	157	1.0	190	1.0	165	0.9
Mali	153	1.0	158	0.9	120	0.6
Others	2235	13.9	2616	14.2	432	17.9
World	16038	100.0	18428	100.0	19117	100.0

19.5. Production of sunflower seed

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
U S S R	5449	68.5	6144	62.0	5000	51.9
Argentina	757	9.5	1140	11.5	732	7.6
Turkey	160	2.0	375	3.8	488	5.1
South Africa	73	0.9	96	1.0	214	2.2
Bulgaria	357	4.5	407	4.1	420	4.4
Romania	564	7.1	770	7.8	724	7.5
Yugoslavia	265	3.3	264	2.7	273	2.8
Spain	9	0.1	159	1.6	338	3.5
U S A	20	0.3	86	0.9	625	6.5
Others	303	3.8	476	4.8	826	8.6
World	7959	100.0	9917	100.0	9640	100.0

19.6. Production of palm oil

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Nigeria	574	42.4	488	26.5	470	16.1
Indonesia	157	11.6	217	11.8	370	12.7
Malaysia	150	11.1	431	23.4	1265	43.3
Zaire	120	8.9	180	9.8	165	5.6
Ivory Coast	18	1.3	50	2.7	140	4.8
Cameroon	44	3.2	54	2.9	60	2.1
Ghana	37	2.8	60	3.3	24	0.8
Angola	32	2.4	80	4.3	40	1.4
Colombia	2	0.1	27	1.5	57	2.0
Sierra Leone	39	2.9	48	2.6	55	1.9
Benin	27	2.0	36	2.0	47	1.6
Others	155	11.4	173	9.4	230	7.9
World	1355	100.0	1844	100.0	2923	100.0

19.7. Production of palm kernels

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Nigeria	462	40.5	295	24.1	295	21.1
Brazil	186	16.3	235	19.2	245	17.5
Zaire	75	6.6	132	10.8	74	5.3
Sierra Leone	54	4.7	65	5.3	52	3.7
Benin	50	4.4	57	4.6	70	5.0
Cameroon	48	4.2	56	4.6	60	4.3
Malaysia	35	3.1	92	7.5	248	17.7
Indonesia	33	2.9	49	4.0	82	5.9
Ivory Coast	17	1.5	20	1.6	36	2.6
Mexico	25	2.2	28	2.3	30	2.1
Others	156	13.7	197	16.1	205	14.7
World	1141	100.0	1226	100.0	1397	100.0

19.8. Production of rapeseed

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
India	1474	28.1	1564	23.4	2211	27.2
China	1143	21.8	992	14.8	1254	15.4
Canada	513	9.8	1637	24.5	1635	20.1
Poland	504	9.6	566	8.5	700	8.6
France	334	6.4	592	8.9	532	6.6
Sweden	216	4.1	192	2.9	332	4.1
Pakistan	215	4.1	250	3.7	248	3.1
German Democratic Republic	214	4.1	180	2.7	270	3.3
Federal Republic of Germany	107	2.0	185	2.8	199	2.4
Others	533	10.1	531	7.9	740	9.1
World	5253	100.0	6689	100.0	8121	100.0

19.9. Production of sesame seed

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
India	424	25.0	562	25.7	420	21.1
China	368	21.7	367	16.8	372	18.7
Sudan	160	9.4	297	13.6	271	13.6
Mexico	154	9.1	179	8.2	140	7.0
Burma	62	3.7	132	6.0	130	6.5
Nigeria	61	3.6	60	2.7	66	3.3
Colombia	58	3.4	28	1.3	30	1.5
Venezuela	54	3.2	125	5.7	60	3.0
Turkey	34	2.0	36	1.6	35	1.8
Ethopia	33	1.9	81	3.7	100	5.0
Uganda	30	1.8	17	0.8	17	0.8
Afghanistan	34	2.0	30	1.5	40	2.0
Egypt	22	1.3	20	0.9	18	0.9
Bangladesh	24	1.4	27	1.2	29	1.5
Saudi Arabia	18	1.1	17	0.8	18	0.9
Thailand	18	1.1	20	0.9	33	1.7
Others	140	8.3	190	8.7	211	10.6
World	1694	100.0	2188	100.0	1990	100.0

19.10. Production of safflower seed

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
U S A	271	57.8	170	25.6	180	18.3
Mexico	80	17.1	288	43.4	31	54.1
India	75	16.0	142	21.4	196	20.0
Ethiopia	28	6.0	36	5.4	25	2.5
Australia	10	2.0	9	1.4	18	1.8
U S S R	3	0.6	7	1.1	3	0.3
Israel	1	0.2	-	-	2	0.2
Turkey	1	0.2	1	0.2	1	0.1
Spain	-	-	8	1.2	17	1.7
Others	-	-	2	0.3	9	0.9
World	469	100.0	663	100.0	982	100.0

Table 20. Trade in oilseeds 1965-1975 by major trading countries

20.1 (a). Soyabeans - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
U S A	6196.0	88.8	11839.1	93.8	12496.0	75.9
China	576.6	8.3	410.0	3.2	360.0	2.2
Canada	82.6	1.2	28.6	0.2	9.0	0.1
Brazil	75.3	1.1	289.6	2.3	3334.0	20.3
Paraguay	1.3	-	0.9	-	102.0	0.6
Romania	-	-	-	-	-	-
Others	43.4	0.6	53.3	0.4	158.0	1.0
World	6975.2	100.0	12621.5	100.0	16459.0	100.0

20.1(b). Soyabeans - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Japan	1847.5	27.8	3244.8	26.5	3334.0	21.3
Federal Republic of Germany	1292.9	19.5	2074.6	16.9	3464.0	22.1
Italy	449.5	6.8	845.3	6.9	1217.0	7.8
Denmark	404.2	6.1	535.4	4.4	402.0	2.6
Netherlands	392.0	5.9	1105.6	9.0	1282.0	8.2
Spain	340.9	5.1	1230.7	10.1	1737.0	11.1
United Kingdom	287.0	4.3	365.7	3.0	754.0	4.8
Belgium	139.9	2.1	324.5	2.7	698.0	4.5
France	109.5	1.6	442.6	3.6	416.0	2.7
Others	1370.8	20.6	2072.0	17.0	2373.0	15.1
World	6634.2	100.0	12241.2	100.0	15677.0	100.0

20.2(a). Groundnuts - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Nigeria	520.0	38.2	291.2	29.4	2.0	0.2
Senegal	216.8	15.9	51.4	5.2	17.4	2.0
Sudan	152.2	11.2	63.9	6.4	203.0	22.9
Niger	86.4	6.3	131.9	13.3	-	-
U S A	78.4	5.8	51.2	5.2	237.4	26.8
China	46.3	3.4	16.2	1.6	22.7	2.6
Gambia	33.8	2.5	38.1	3.8	51.0	5.7
Mali	22.2	1.6	17.6	1.8	13.0	1.5
Malawi	18.9	1.4	22.5	2.3	26.0	2.9
South Africa	18.8	1.4	70.3	7.1	70.0	7.9
Brazil	18.4	1.3	53.5	5.4	54.0	6.1
Cameroon	10.6	0.8	13.4	1.4	18.0	2.0
India	0.2	-	25.8	2.6	70.0	7.9
Others	140.0	10.3	144.1	14.5	101.9	11.5
World	1363.0	100.0	991.1	100.0	886.4	100.0

20.2(b). Groundnuts - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
France	504.2	38.4	314.3	30.0	198.6	22.5
Italy	103.0	7.8	116.1	11.1	75.6	8.6
Portugal	92.0	7.0	48.0	4.6	59.1	6.7
United Kingdom	91.8	7.0	61.6	5.9	71.5	8.1
Switzerland	70.6	5.4	80.9	7.7	50.1	5.7
Federal Republic of Germany	56.3	4.3	89.2	8.5	53.2	6.0
Canada	49.1	3.7	49.0	4.7	90.9	10.2
Netherlands	42.2	3.2	42.4	4.0	55.5	6.3
Spain	28.6	2.2	26.7	2.5	20.0	2.3
Japan	25.1	1.9	58.9	5.6	51.0	5.8
Others	250.9	19.1	161.2	15.4	157.8	17.9
World	1313.8	100.0	1048.3	100.0	883.3	100.0

20.3(a). Copra - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Philippines	866.2	63.6	425.2	46.3	761.0	70.1
Indonesia	126.0	9.2	185.1	20.1	30.0	2.8
Papua N.Guinea	74.7	5.5	85.6	9.3	96.0	8.8
Sri Lanka	41.6	3.1	15.5	1.7	1.0	0.1
New Hebrides	28.7	2.1	31.2	3.4	27.0	2.5
Mozambique	28.6	2.1	45.1	4.9	27.0	2.5
Malaysia(Sabah)	24.9	1.8	15.0	1.6	31.0	2.9
British Solomons	24.9	1.8	21.4	2.3	25.0	2.3
Pacific Is.	12.7	0.9	14.2	1.5	7.0	0.6
West Samoa	12.6	0.9	9.8	1.1	20.0	1.8
Gilbert Is.	9.2	0.7	5.8	0.6	6.0	0.5
Tonga	7.0	0.5	8.0	0.9	19.0	1.7
Others	105.6	7.7	56.8	6.2	35.0	3.2
World	1362.7	100.0	918.7	100.0	1085.0	100.0

20.3(b). Copra - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
U.S.A.	278.9	20.6	197.6	22.4	-	-
Federal Republic of Germany	242.5	17.9	150.6	17.1	413.0	40.6
Netherlands	136.0	10.0	77.9	8.8	167.0	16.4
France	95.6	7.1	54.5	6.2	64.0	6.3
Japan	94.2	7.0	126.9	14.4	90.0	8.9
Sweden	69.4	5.1	55.4	6.3	39.0	3.8
United Kingdom	56.5	4.2	32.0	3.6	29.0	2.8
Australia	33.0	2.4	28.3	3.2	7.0	0.7
Singapore	26.7	2.0	17.2	1.9	27.0	2.7
Norway	22.1	1.6	19.0	2.2	11.0	1.1
Others	299.5	22.1	123.8	14.0	169.0	16.6
World	1354.4	100.0	883.2	100.0	1016.0	100.0

20.4(a). Rapeseed - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Canada	275.0	40.2	705.8	57.3	676.0	69.5
France	126.4	18.5	200.4	16.3	47.0	4.8
Sweden	73.5	10.8	53 .5	4.3	118.0	12.1
Denmark	45.2	6.6	28. 0	2.3	56.0	5.8
Federal Republic of Germany	4.8	0.7	36.9	3.0	10.0	1.0
Others	158.8	23.2	207.1	16.8	66.0	6.8
World	683.7	100.0	1231.7	100.0	973.0	100.0

20.4(b). Rapeseed - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Italy	132.5	20.7	216.8	19.9	12.0	1.1
Federal Republic of Germany	109.8	17.2	75.1	6.9	117.0	10.8
Japan	108.2	16.9	344.9	31.6	659.0	61.2
Bangladesh	73.2	11.5	89.0	8.2	43.0	4.0
Algeria	59.4	9.3	58.5	5.4	40.0	3.7
United Kingdom	32.7	5.1	51.3	4.7	45.0	4.2
Netherlands	20.5	3.2	35.7	3.3	48.0	4.4
U S A	14.4	2.3	38.2	3.5	32.0	3.0
France	4.5	0.7	62.3	5.7	40.0	3.7
Mexico	0.1	-	12.9	1.2	-	..
Others	83.6	13.1	105.8	9.7	41.0	3.8
World	638.9	100.0	1090.5	100.0	1077.0	100.0

20.5(a). Palm kernels - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Nigeria	422.2	63.5	185.3	40.5	173.0	51.0
Sierra Leone	50.1	7.5	59.9	13.1	29.0	8.6
Indonesia	32.9	4.9	42.4	9.3	32.0	9.4
Cameroon	21.5	3.2	22.7	5.0	12.0	3.5
Togo	15.3	2.3	17.1	3.7	6.0	1.8
Ivory Coast	14.3	2.2	18.1	4.0	29.0	8.6
Angola	14.3	2.2	12.5	2.7	5.0	1.5
Guinea	12.0	1.8	13.0	2.8	9.0	2.6
Malaysia	0.1	-	5.2	1.1	25.0	7.4
Others	82.0	12.3	80.9	17.7	19.0	5.6
World	664.7	100.0	457.1	100.0	339.0	100.0

20.5(b). Palm kernels - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
United Kingdom	207.0	31.1	38.0	8.8	75.0	25.6
Federal Republic of Germany	126.0	18.9	76.0	17.7	42.0	14.3
Netherlands	113.0	17.0	146.0	34.0	98.0	33.4
France	66.0	9.9	60.0	14.0	12.0	4.1
Poland	26.0	3.9	13.0	3.0	-	-
Japan	22.0	3.3	33.0	7.7	7.0	2.4
Portugal	17.0	2.6	12.0	2.8	7.0	2.4
Malaysia	-	-	-	-	20.0	6.8
Denmark	14.0	2.1	18.0	4.2	17.0	5.8
Switzerland	7.0	1.1	4.0	0.9	9.0	3.1
Others	67.0	10.1	30.0	7.0	6.0	2.0
World	665.0	100.0	430.0	100.0	293.0	100.0

20.6(a). Cottonseed - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Nicaragua	138.5	30.3	17.2	3.6	23.0	11.4
Nigeria	71.3	15.6	96.0	19.9	5.0	2.5
Sudan	65.3	14.3	69.2	14.3	11.0	5.5
Thailand	8.9	1.9	23.7	4.9	10.0	5.0
Uganda	-	-	8.1	1.7	15.0	7.4
Ivory Coast	4.9	1.1	15.6	3.2	29.0	14.3
U S A	4.8	1.0	22.1	4.6	7.0	3.5
Afghanistan	4.3	0.9	5.2	1.1	10.0	5.0
Benin	1.0	0.2	8.2	1.7	-	-
Israel	2.1	0.5	19.1	4.0	5.0	2.5
USSR	-	-	39.5	8.2	30.0	14.9
Others	156.5	34.2	156.9	32.5	57.0	28.2
World	457.6	100.0	482.6	100.0	202.0	100.0

20.6(b). Cottonseed - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Japan	217.1	47.4	296.6	60.1	116.0	65.1
Lebanon	49.8	10.9	49.3	10.0	20.0	11.2
Greece	28.4	6.2	48.5	9.8	25.0	14.0
Czechoslovakia	24.5	5.3	12.0	2.4	-	-
Portugal	7.7	1.7	21.7	4.4	4.0	2.2
Honduras	2.1	0.5	0.3	0.1	-	-
Kenya	1.9	0.4	8.4	1.7	1.0	0.5
Spain	1.6	0.3	1.5	0.3	1.0	0.5
Mexico	1.0	0.2	32.4	6.6	3.0	1.7
Costa Rica	-	-	4.1	0.8	7.0	4.0
Others	124.3	27.1	18.4	3.7	1.0	0.5
World	458.4	100.0	493.2	100.0	178.0	100.0

20.7(a). Sunflower seed - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Bulgaria	91.5	38.3	97.3	20.4	4.0	1.1
USSR	83.7	35.1	142.7	29.9	61.0	17.4
Romania	18.7	7.8	44.3	9.3	1.0	0.3
Hungary	10.4	4.4	24.1	5.0	27.0	7.7
Yugoslavia	9.0	3.8	118.4	24.8	1.0	0.3
Tanzania	6.9	2.9	10.0	2.1	3.0	0.8
Canada	6.2	2.6	2.6	0.5	8.0	2.3
China	4.7	2.0	2.3	0.5	3.0	0.8
U S A	-	-	1.8	0.4	210.0	59.8
German Democratic Republic	0.5	0.2	0.2	-	-	-
France	0.4	0.2	22.2	4.6	8.0	2.3
Australia	-	-	-	-	15.0	4.3
Others	6.6	2.8	11.8	2.5	10.0	2.8
World	238.6	100.0	477.7	100.0	351.0	100.0

20.7(b). Sunflower seed - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
German Democratic Repbulic	65.0	33.0	92.5	17.9	40.00	12.4
Italy	63.0	32.0	179.7	34.7	4.0	1.2
Federal Republic of Germany	32.6	16.5	79.0	15.3	126.0	39.2
Czechoslovakia	16.6	8.4	65.0	12.6	60.0	18.7
Australia	5.0	2.5	6.3	1.2	-	-
Japan	3.9	2.0	45.4	8.8	2.0	0.6
Belgium	2.6	1.3	1.5	0.3	4.0	1.2
France	0.4	0.2	1.9	0.4	22.0	6.8
Netherlands	1.0	0.5	17.2	3.3	3.0	0.9
Portugal	-	-	4.1	0.8	24.0	7.5
Others	6.9	3.5	25.3	4.9	36.0	11.2
World	197.0	100.0	517.9	100.0	321.0	100.0

20.8(a). Sesame seed - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Sudan	70.6	39.6	81.9	36.9	57.0	26.6
Ethiopia	21.5	12.1	39.7	17.9	60.0	28.0
Nigeria	20.5	11.5	12.1	5.5	4.0	1.9
Tanzania	9.8	5.5	5.3	2.4	3.0	1.4
Democratic Kampuchea	8.9	5.0	9.3	4.2	-	-
Hong Kong	7.5	4.2	5.4	2.4	1.0	0.5
Nicaragua	5.5	3.1	5.9	2.7	3.0	1.4
Thailand	3.7	2.1	3.7	1.7	7.0	3.3
Mexico	0.4	0.2	3.6	1.6	12.0	5.6
Others	30.0	16.8	55.1	24.8	67.0	31.3
World	178.4	100.0	222.0	100.0	214.0	100.0

20.8(b). Sesame seed - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Japan	33.4	21.5	52.7	28.2	39.0	20.0
Italy	31.2	20.1	40.3	21.6	25.0	12.8
USA	12.6	8.1	19.4	10.4	20.0	10.2
China	7.4	4.8	5.4	2.9	11.0	5.6
Portugal	6.5	4.2	1.9	1.0	2.0	1.0
Egypt	5.0	3.2	19.0	10.2	30.0	15.4
Lebanon	4.4	2.8	5.4	2.9	6.0	3.1
USSR	4.0	2.6	8.7	4.7	8.0	4.1
Israel	2.0	1.3	3.3	1.8	6.0	3.1
Greece	0.2	0.1	4.5	2.4	13.0	6.6
Others	48.4	31.2	26.3	14.1	35.0	17.9
World	155.1	100.0	186.9	100.0	195.0	100.0

20.9. **Safflower seed - major exporters**

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
U S A	171.7	96.5	59.9	76.8	73.8	100.0
Others	6.3	3.5	18.1	23.2	-	100.0
World	178.0	100.0	78.0	100.0	73.8	100.0

Table 21. Trade in vegetable oils 1965-1975
by major trading countries

21.1(a). Soyabean oil - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
USA	545.1	78.8	674.5	59.9	353.0	25.9
Denmark	41.3	6.0	56.4	5.0	34.0	2.5
Netherlands	17.5	2.5	86.5	7.7	162.0	11.9
Canada	15.8	2.3	21.4	1.9	2.0	0.1
Federal Republic of Germany	15.5	2.2	69.0	6.1	294.0	21.6
Belgium	6.0	0.9	27.4	2.4	85.0	6.2
Japan	5.6	0.8	13.2	1.2	-	-
France	4.0	0.6	29.3	2.6	80.0	5.9
Spain	0.1	-	85.6	7.6	41.0	3.0
Romania	-	-	5.3	0.5	-	-
Others	40.5	5.9	57.3	5.1	-	-
World	691.4	100.0	1125.9	100.0	1364.0	100.0

21.1(b). Soyabean oil - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Pakistan	50.5	7.6	88.5	8.9	63.0	4.6
Morocco	44.5	6.7	38.5	3.9	77.0	5.6
India	40.5	6.1	78.5	7.9	4.0	0.3
Iran	27.6	4.1	96.8	9.8	153.0	11.2
Netherlands	22.9	3.4	35.9	3.6	74.0	5.4
Tunisia	22.2	3.3	28.2	2.9	54.0	4.0
Peru	14.0	2.1	21.3	2.2	54.0	4.0
Sweden	8.1	1.2	37.6	3.8	42.0	3.1
Italy	1.8	0.3	37.1	3.7	107.0	7.8
France	1.2	0.2	37.2	3.8	90.0	6.6
Others	434.1	65.0	489.8	49.5	242.4	34.0
World	667.4	100.0	989.4	100.0	713.8	100.0

21.2(a). Groundnut oil - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Senegal	142.5	34.3	146.1	34.0	209.0	51.6
Nigeria	92.2	22.2	90.3	21.0	-	-
Argentina	79.2	19.1	42.6	9.9	-	-
USA	27.7	6.7	14.5	3.4	12.0	3.0
Gambia	16.3	3.9	16.0	3.7	14.0	3.4
France	11.5	2.8	20.4	4.7	44.0	10.8
China	5.0	1.2	7.0	1.6	11.0	2.7
Netherlands	4.2	1.0	3.0	0.7	6.0	1.5
Federal Republic of Germany	3.8	0.9	3.4	0.8	10.0	2.5
Brazil	-	-	31.9	7.4	38.0	9.4
Others	33.0	7.9	54.5	12.7	61.0	15.1
World	415.4	100.0	429.0	100.0	405.0	100.0

21.2(b). Groundnut oil - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
France	155.6	36.7	142.6	33.1	180.0	44.0
United Kingdom	69.5	16.4	95.8	22.2	29.0	7.0
Federal Republic of Germany	49.1	11.6	52.3	12.1	38.0	9.2
Dominican Rep.	15.1	3.6	5.5	1.3	6.0	1.4
Hong Kong	10.4	2.5	12.3	2.9	14.0	3.4
Netherlands	10.1	2.4	9.4	2.2	9.0	2.2
Belgium	9.0	2.1	21.4	5.0	21.0	5.1
Switzerland	5.3	1.3	3.8	0.9	8.0	2.0
Singapore	5.0	1.2	6.0	1.4	1.0	0.2
Italy	0.2	-	8.2	1.9	24.0	5.9
Others	94.4	22.3	73 .4	17.0	23.8	7.0
World	423.7	100.0	430.7	100.0	341.0	100.0

21.3(a). Coconut oil - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Philippines	241.4	50.8	338.0	54.9	614.0	59.6
Sri Lanka	88.3	18.6	57.9	9.4	50.0	4.8
Netherlands	35.9	7.6	31.9	5.2	67.0	6.5
Papua N.Guinea	25.9	5.5	21.7	3.5	27.0	2.6
Malaysia	18.3	3.9	42.5	6.9	36.0	3.5
Singapore	17.1	3.6	38.1	6.2	26.0	2.5
Fiji	15.0	3.2	19.0	3.1	16.0	1.6
Mozambique	6.5	1.4	7.3	1.2	4.0	0.4
Federal Republic of Germany	1.3	0.3	12.4	2.0	115.0	11.1
Fr.Polynesia	0.3	0.1	10.8	1.8	11.0	1.1
Others	24.8	5.2	36.2	5.9	65.0	6.3
World	474.8	100.0	615.6	100.0	1031.0	100.0

21.3(b). Coconut oil - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
U S A	174.7	38.1	260.5	43.7	409.0	42.7
Federal Republic of Germany	55.3	12.1	31.6	5.3	36.0	3.8
United Kingdom	42.7	9.3	48.1	8.1	38.0	4.0
Canada	18.0	3.9	21.5	3.6	26.0	2.7
Italy	15.8	3.4	19.8	3.3	32.0	3.3
China	10.8	2.4	20.9	3.5	44.0	4.6
Singapore	10.0	2.2	14.1	2.4	15.0	1.5
South Africa	6.8	1.5	10.1	1.7	12.0	1.2
Poland	6.0	1.3	6.3	1.1	12.0	1.2
France	3.9	0.9	18.7	3.1	47.0	4.9
Others	114.1	24.9	144.8	24.3	287.0	30.0
World	458.1	100.0	596.4	100.0	958 .0	100.0

21.4(a). Cottonseed oil - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
U S A	255.6	72.4	154.8	63.2	297.0	79.2
China	22.2	6.3	7.7	3.1	4.0	1.0
USSR	20.8	5.9	26.2	10.7	28.0	7.5
Syrian Arab Republic	15.8	4.5	8.4	3.4	-	-
Sudan	9.8	2.8	9.1	3.7	11.0	2.9
Uganda	8.7	2.5	9.0	3.7	-	-
Israel	2.0	0.6	5.0	2.0	11.0	2.9
Guatemala	1.9	0.5	1.4	0.6	4.0	1.0
Nicaragua	1.3	0.4	9.3	3.8	11.0	2.9
Argentina	1.1	0.3	1.0	0.4	-	-
Others	13.6	3.9	13.2	5.4	-	-
World	352.8	100.0	245.1	100.0	375.0	100.0

21.4(b). Cottonseed oil - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Federal Republic of Germany	79.1	21.0	31.6	11.6	13.0	2.9
United Kingdom	33.1	8.8	41.1	15.1	8.0	1.7
Egypt	28.8	7.7	56.2	20.6	280.0	61.4
Iran	26.7	7.1	1.3	0.5	19.0	4.1
Canada	21.6	5.7	14.0	5.1	11.0	2.4
German Democratic Republic	20.8	5.5	26.2	9.6	29.0	6.4
Venezuela	15.4	4.1	15.8	5.8	38.0	8.3
Sweden	7.0	1.9	4.7	1.7	10.0	2.2
Japan	2.1	0.6	3.8	1.4	10.0	2.2
El Salvador	1.4	0.4	1.6	0.6	2.0	0.4
Others	139.9	37.2	76.6	28.1	36.0	7.9
World	375.9	100.0	272.9	100.0	456.0	100.0

21.5(a). Palm oil - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Nigeria	152.4	24.7	7.6	0.8	31.0	1.5
Malaysia	143.2	23.2	402.0	44.4	1035.0	50.6
Indonesia	125.9	20.4	159.1	17.6	386.0	18.9
Zaire	79.0	12.8	118.9	13.1	55.0	2.7
Singapore	47.7	7.7	133.3	14.7	140.0	6.8
Benin	13.3	2.2	15.0	1.7	14.0	0.7
Cameroon	12.9	2.1	8.4	0.9	9.0	0.4
Netherlands	5.7	0.9	19.3	2.1	57.0	2.8
Ivory Coast	1.2	0.2	12.5	1.4	114.0	5.6
Papua N.Guinea	-	-	-	-	18.0	0.9
Others	36.7	5.9	30.1	3.3	187.0	9.1
World	618.0	100.0	906.2	100.0	2046.0	100.0

21.5(b). Palm oil - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
United Kingdom	117.2	20.1	162.7	18.2	206.0	10.8
Federal Republic of Germany	102.6	17.6	115.9	13.0	210.0	11.0
Netherlands	64.5	11.0	89.3	10.0	186.0	9.8
Iraq	50.1	8.6	66.0	7.4	116.0	6.1
Singapore	48.8	8.3	140.8	15.8	128.0	6.7
France	36.7	6.3	41.1	4.6	50.0	2.6
Italy	32.0	5.5	42.9	4.8	51.0	2.7
Belgium	27.7	4.7	25.5	2.9	30.0	1.6
Japan	16.4	2.8	40.3	4.5	108.0	5.7
U S A	3.0	0.5	63.9	7.2	442.0	23.2
Others	85.4	14.6	103.4	11.6	68.1	4.3
World	584.4	100.0	891.8	100.0	1593.8	100.0

21.6(a). Sunflower seed oil - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
USSR	221.2	70.1	351.0	48.0	388.0	62.2
Argentina	35.5	11.2	101.2	13.8	-	-
Romania	33.0	10.5	119.1	16.3	110.0	17.6
Hungary	15.0	4.8	18.9	2.6	29.0	4.6
Federal Republic of Germany	6.1	1.9	11.6	1.5	19.0	3.0
Bulgaria	1.0	0.3	46.9	6.4	20.0	3.2
Netherlands	0.2	0.1	38.6	5.3	7.0	1.1
Belgium	-	-	20.2	2.8	13.0	2.1
France	-	-	7.3	1.0	20.0	3.2
Yugoslavia	-	-	3.4	0.5	-	-
Others	3.8	1.2	13.3	1.8	18.0	2.9
World	315.7	100.0	731.2	100.0	624.0	100.0

21.6(b). Sunflower seed oil - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentag of tota
Federal Republic of Germany	69.1	20.2	130.4	18.7	105.0	15.1
Cuba	49.9	14.6	54.7	7.8	70.0	10.1
German Democratic Republic	42.8	12.5	50.8	7.3	50.0	7.2
Czechoslovakia	25.2	7.4	45.2	6.5	35.0	5.0
Iran	20.0	5.8	15.5	2.2	46.0	6.6
Algeria	16.0	4.7	23.1	3.3	30.0	4.3
Switzerland	10.7	3.1	28.3	4.0	27.0	3.9
Belgium	9.2	2.7	36.3	5.2	23.0	3.3
Netherlands	8.3	2.4	51.8	7.4	21.0	3.0
France	1.3	0.4	58.1	8.3	91.0	13.1
Spain	-	-	-	-	76.0	10.9
Austria	-	-	-	-	19.0	2.7
Others	89.6	26.2	204.7	29.3	101.0	14.5
World	342.1	100.0	698.9	100.0	694.0	100.0

21.7(a). Palm kernel oil - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Zaire	32.9	30.2	50.3	29.6	28.0	10.8
Netherlands	19.7	18.1	31.5	18.5	30.0	11.6
Benin	17.0	15.6	18.6	10.9	16.0	6.2
Brazil	12.0	11.0	14.4	8.5	1.0	0.4
Federal Republic of Germany	7.2	6.6	3.2	1.9	7.0	2.7
United Kingdom	4.6	4.2	0.2	0.1	1.0	0.4
Paraguay	3.1	2.8	6.6	3.9	4.0	1.5
Nigeria	1.0	0.9	32.8	19.3	19.0	7.3
Switzerland	0.8	0.7	0.6	0.4	1.0	0.4
Malaysia	-	-	2.3	1.4	109 .0	42.1
Others	10.5	9.7	9.6	5.6	43.0	16.6
World	108.8	100.0	170.1	100.0	259.0	100.0

21.7(b). Palm kernel oil - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
U S A	37.9	40.6	37.4	23.5	72.0	26.0
Federal Republic of Germany	14.5	15.5	22.6	14.2	17.0	6.2
Italy	10.1	10.8	9.9	6.2	12.0	4.3
France	6.1	6.5	9.9	6.2	22.0	8.0
Canada	4.5	4.8	5.2	3.3	5.0	1.8
South Africa	2.9	3.1	2.0	1.3	4.0	1.4
Netherlands	1.6	1.7	19.5	12.2	41.0	14.8
Argentina	1.6	1.7	1.9	1.2	4.0	1.4
Belgium	1.5	1.6	9.0	5.7	4.0	1.4
United Kingdom	0.9	1.0	33.4	21.0	64.0	23.2
Others	11.8	12.6	8.4	5.3	31.0	11.2
World	93.4	100.0	159.2	100.0	276.0	100.0

21.8(a) Rapeseed oil - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
France	32.3	34.1	39.4	22.0	118.0	33.4
Federal Republic of Germany	24.5	25.9	33.0	18.1	64.0	18.1
Sweden	16.4	17.3	20.0	11.2	39.0	11.0
Poland	7.8	8.2	37.6	21.0	52.0	14.7
China	3.8	4.0	16.7	9.3	12.0	3.4
Japan	3.6	3.8	6.9	3.9	2.0	0.6
Netherlands	1.2	1.3	7.4	4.1	33.0	9.3
Canada	-	-	-	-	20.0	5.7
Hungary	-	-	8.0	4.5	7.0	2.0
Hong Kong	-	-	1.2	0.7	1.0	0.3
Others	5.1	5.4	8.7	4.9	5.0	1.4
World	94.7	100.0	178.9	100.0	353.0	100.0

21.8(b). Rapeseed oil - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Algeria	12.7	18.0	16.3	9.9	25.0	9.0
Netherlands	11.2	15.9	6.1	3.7	9.0	3.2
Federal Republic of Germany	7.7	10.9	15.0	9.1	19.0	6.8
Hong Kong	3.7	5.2	21.6	13.1	24.0	8.6
Czechoslovakia	3.0	4.2	20.0	12.2	1.0	0.4
Italy	0.6	0.8	22.1	13.5	14.0	5.0
India	0.3	0.4	0.1	0.1	6.0	2.2
United Kingdom	0.3	0.4	14.7	8.9	7.0	2.5
Morocco	-	-	1.3	0.8	84.0	30.2
Chile	-	-	2.5	1.5	21.0	7.5
Others	31.1	44.1	44.6	27.1	68.0	24.4
World	70.6	100.0	164.3	100.0	278.0	100.0

Table 22. Trade in oilmeals 1965-1975 by major trading countries

22.1(a). Soyabean meal - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
USA	1968.9	70.3	3660.4	68.2	3783.0	43.3
Canada	232.0	8.3	150.8	2.8	59.0	0.7
Federal Republic of Germany	202.3	7.2	264.9	4.9	569.0	6.5
Netherlands	116.3	4.2	365.3	6.8	229.0	6.4
Denmark	116.2	4.1	130.0	2.4	71.0	0.8
Brazil	105.1	3.8	525.4	9.8	3128.0	35.8
Belgium	26.6	0.9	131.3	2.4	212.0	2.4
Italy	7.1	0.3	10.1	0.2	29.0	0.3
Norway	4.3	0.1	57.9	1.1	134.0	1.5
Paraguay	3.5	0.1	23.4	0.4	31.0	0.4
Others	19.1	0.7	51.4	1.0	170.0	1.9
World	2801.4	100.0	5370.9	100.0	8745.0	100.0

22.1(b). Soyabean meal - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
France	485.8	19.9	843.3	17.5	1496.0	17.7
Federal Republic of Germany	470.2	19.2	997.6	20.7	766.0	9.0
United Kingdom	247.7	10.1	248.3	5.1	250.0	3.0
Denmark	223.3	9.1	242.9	5.0	443.0	5.2
Netherlands	162.5	6.6	530.9	11.0	850.0	10.0
Belgium	113.7	4.6	346.0	7.2	383.0	4.5
Italy	109.0	4.5	264.9	5.5	448.0	5.3
Hungary	40.4	1.6	228.0	4.7	390.0	4.6
Czechoslovakia	9.0	0.4	34.0	0.7	310.0	3.7
Poland	-	-	103.0	2.1	539.0	6.4
Others	584.8	24.0	990.6	20.5	2592.0	30.6
World	2446.4	100.0	4829.5	100.0	8467.0	100.0

22.2(a). Groundnut meal - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
India	735.2	49.1	655.1	43.9	536.0	46.3
Senegal	196.4	13.1	199.7	13.4	301.0	26.0
Argentina	131.7	8.8	64.6	4.3	29.0	2.5
Brazil	121.8	8.1	201.2	13.5	37.0	3.2
Nigeria	114.5	7.6	162.1	10.9	8.0	0.7
Burma	67.1	4.5	40.0	2.7	10.0	0.9
Sudan	18.1	1.2	36.5	2.4	32.0	2.8
Gambia	16.3	1.1	18.5	1.2	30.0	2.6
France	14.4	1.0	16.4	1.1	14.0	1.2
Niger	6.7	0.4	11.1	0.7	17.0	1.5
Others	75.4	5.1	87.1	5.9	144.0	12.4
World	1497.6	100.0	1492.3	100.0	1158.0	100.0

22.2(b). Groundnut meal - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
United Kingdom	488.5	37.5	374.0	22.4	211.0	17.8
France	190.7	14.6	243.3	14.6	254.0	21.5
Federal Republic of Germany	111.6	8.6	114.7	6.9	82.0	6.9
Hungary	99.1	7.6	64.4	3.9	44.0	3.7
Czechoslovakia	82.1	6.3	190.0	11.4	70.0	5.9
Japan	37.1	2.9	141.9	8.5	26.0	2.2
Belgium	34.1	2.6	52.5	3.2	32.0	2.7
Netherlands	19.2	1.5	12.3	0.7	9.0	0.8
Poland	-	-	200.0	12.0	205.0	17.3
USSR	-	-	99.4	6.0	70.0	5.9
Others	239.4	18.4	174.7	10.4	180.0	15.2
World	1301.8	100.0	1667.2	100.0	1183.0	100.0

22.3(a). Cottonseed meal - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Turkey	163.7	14.0	176.0	13.8	218.0	19.5
Syria	127.9	10.9	80.8	6.3	9.0	0.8
Sudan	123.4	10.6	183.5	14.4	94.0	8.4
India	104.6	8.9	105.7	8.3	192.0	17.2
Argentina	88.3	7.6	88.8	7.0	42.0	3.8
Uganda	69.8	6.0	77.4	6.1	16.0	1.4
Tanzania	42.5	3.6	34.5	2.7	43.0	3.9
Nicaragua	12.6	1.1	38.0	3.0	60.0	5.4
Brazil	0.9	0.1	161.5	12.7	20.0	1.8
Colombia	-	-	55.8	4.4	43.0	3.9
Others	433.9	37.2	273.2	21.3	378.0	33.9
World	1167.6	100.0	1275.2	100.0	1115.0	100.0

22.3(b). Cottonseed meal - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Denmark	392.2	29.9	251.8	27.2	499.0	45.9
United Kingdom	239.1	18.3	197.2	15.2	35.0	3.2
Federal Republic of Germany	167.6	14.3	268.6	20.8	179.0	16.5
Sweden	110.7	8.5	96.5	7.4	71.0	6.5
Czechoslovakia	73.0	5.6	85.0	6.6	40.0	3.7
Belgium	47.5	3.6	56.1	4.3	17.0	1.6
Norway	38.1	2.9	68.2	5.3	21.0	1.9
Hungary	23.6	1.8	14.7	1.1	27.0	2.5
Lebanon	-	-	29.3	2.3	28.0	2.6
Poland	-	-	9.7	0.8	70.0	6.4
Others	197.5	15.1	116.5	9.0	100.0	9.2
World	1309.3	100.0	1293.6	100.0	1087.0	100.0

22.4(a). Copra meal - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Philippines	184.9	39.8	243.9	42.8	303.0	43.5
Indonesia	125.8	27.0	207.9	36.5	296.0	42.5
Netherlands	41.0	8.8	17.5	3.1	9.0	1.3
Papua New Guinea	13.9	3.0	11.2	2.0	15.0	2.1
Sri Lanka	9.5	2.0	11.3	2.0	4.0	0.6
Thailand	8.9	1.9	8.1	1.4	2.0	0.3
Fiji	5.4	1.2	7.2	1.3	4.0	0.6
Tanzania	4.4	1.0	6.1	1.1	6.0	0.9
Singapore	4.3	0.9	15.7	2.7	11.0	1.6
Mozambique	4.3	0.9	5.2	0.9	4.0	0.6
Others	62.8	13.5	35.6	6.2	43.0	6.2
World	465.2	100.0	569.7	100.0	697.0	100.0

22.4(b). Copra meal - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Federal Republic of Germany	320.5	64.6	386.0	69.6	374.0	57.1
Denmark	65.7	13.2	28.5	5.1	30.0	4.6
Sweden	39.1	7.9	11.7	2.1	32.0	4.9
Netherlands	22.8	4.6	90.5	16.3	181.0	27.6
Malaysia	12.9	2.6	14.6	2.6	14.0	2.1
Belgium	11.2	2.3	12.5	2.3	13.0	2.0
Singapore	8.9	1.8	2.9	0.5	2.0	0.3
France	2.5	0.5	2.7	0.5	1.0	0.2
Sarawak	-	-	1.0	0.2	1.0	0.2
Others	12.4	2.5	4.1	0.8	7.0	1.0
World	496.0	100.0	554.5	100.0	655.0	100.0

22.5(a). Sunflower seed meal - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Argentina	275.9	78.2	403.8	72.2	188.0	52.5
Turkey	56.0	15.9	92.7	16.6	26.0	7.3
Italy	14.6	4.1	7.1	1.3	-	-
Uruguay	4.4	1.2	19.0	3.4	6.0	1.7
Netherlands	1.3	0.4	5.2	0.9	4.0	1.1
France	0.5	0.1	0.2	-	6.0	1.7
Federal Republic of Germany	0.2	0.1	6.3	1.1	16.0	4.5
Denmark	0.1	-	0.1	-	-	-
USSR	-	-	24.0	4.3	1.0	0.3
Others	-	-	0.5	0.2	111.0	31.0
World	353.0	100.0	558.9	100.0	358.0	100.0

22.5(b). Sunflower seed meal - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
United Kingdom	69.4	19.7	77.3	13.3	11.0	3.1
Netherlands	69.4	19.7	90.8	15.6	16.0	4.5
Federal Republic of Germany	51.1	14.5	134.5	23.2	157.0	43.8
Denmark	50.4	14.3	117.0	20.2	53.0	14.8
France	27.5	7.8	58.8	10.1	14.0	3.9
Belgium	27.4	7.8	58.9	10.1	25.0	7.0
Hungary	12.4	3.5	20.7	3.6	44.0	12.3
Bulgaria	12.0	3.4	10.0	1.7	20.0	5.6
Czechoslovakia	2.0	0.6	8.0	1.4	13.0	3.6
Poland	-	-	-	-	-	-
Others	30.4	8.7	4.3	0.8	5.0	1.4
World	352.0	100.0	580.3	100.0	358.0	100.0

22.6(a). Rapeseed meal - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Italy	52.3	30.1	68.8	29.9	3.0	1.1
Federal Republic of Germany	37.8	21.6	40.5	17.6	80.0	29.4
France	30.8	17.6	65.2	28.3	65.0	23.9
Algeria	28.5	16.3	27.1	11.8	28.0	10.3
Pakistan	17.0	9.7	0.1	-	38.0	14.0
Ethiopia	4.6	2.6	2.2	1.0	3.0	1.1
Netherlands	0.4	0.2	3.4	1.5	20.0	7.3
Morocco	-	-	5.0	2.2	7.0	2.6
Denmark	-	-	1.7	0.7	5.0	1.8
Chile	-	-	15.0	6.5	-	-
Others	3.2	1.9	1.4	0.5	23.0	8.5
World	174. 6	100.0	230.4	100.0	272 .0	100.0

22.6(b). Rapeseed meal - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
United Kingdom	55.4	32.0	63.4	23.7	49.0	15.6
Federal Republic of Germany	43.4	25.0	65.8	24.6	41.0	13.1
Netherlands	26.4	15.2	35.7	13.4	85.0	27.1
Belgium	24.9	14.4	35.1	13.1	48.0	15.3
Denmark	10.1	5.8	16.8	6.3	44.0	14.0
France	5.6	3.2	5.7	2.1	7.0	2.2
Austria	5.1	2.9	8.0	3.0	1.0	0.3
Japan	-	-	0.5	0.2	-	-
Norway	-	-	36.0	13.5	35.0	11.2
Italy	-	-	0.4	0.1	2.0	0.6
Others	2.5	1.5	-	-	2.0	0.6
World	173.4	100.0	267.4	100.0	314.0	100.0

22.7(a). Palm kernel meal - major exporters

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Netherlands	66.2	44.3	73.6	30.0	44.0	11.8
Benin	16.1	10.8	18.1	7.4	19.0	5.1
Denmark	7.9	5.3	11.6	4.7	7.0	1.9
Nigeria	3.9	2.6	33.3	13.6	20.0	5.3
Paraguay	1.9	1.3	1.9	0.8	-	-
Cameroon	1.3	0.9	2.0	0.8	5.0	1.3
Malaysia	-	-	0.6	0.2	145.0	38.8
China	-	-	-	-	10.0	2.7
Zaire	-	-	50.7	20.7	40.0	10.7
Brazil	-	-	48.3	19.7	45.0	12.0
Others	52.3	34.8	4.9	2.1	39.0	10.4
World	149.6	100.0	245.0	100.0	374.0	100.0

22.7(b). Palm kernel meal - major importers

Countries	1965		1970		1975	
	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total	Quantity '000 tons	Percentage of total
Federal Republic of Germany	217.9	96.2	227.3	94.2	299.0	89.0
France	8.4	3.7	8.1	3.4	6.0	1.8
Belgium	0.3	0.1	1.8	0.7	5.0	1.5
Netherlands	-	-	0.4	0.2	21.0	6.2
Sweden	-	-	3.5	1.5	3.0	0.9
Others	-	-	0.2	-	2.0	0.6
World	226.6	100.0	241.3	100.0	336.0	100.0

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