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COMMITTEE ON COMMODITY PROBLEMS

INTERGOVERNMENTAL GROUP ON OILSEEDS, OILS AND FATS

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BIOTECHNOLOGY DEVELOPMENTS IN THE OILSEEDS SECTOR

Table of Contents

The Group decision on this document as reflected in the Report of the 28th Session (Document CCP:99/5 - CCP:OF 97/8) is presented below

This item was reviewed with the help of document CCP:OF 97/4, prepared in response to a request by the Committee on Commodity Problems to undertake work on the impact of biotechnology developments on trade in commodities on a selective basis.

A number of delegates from major producing/exporting countries informed the meeting of the progress made in biotechnology research in their countries and/or of the rapid increase of the share of genetically-modified oilseeds in total domestic output. Concern was expressed regarding the attitude of consumers to Genetically Modified Organisms (GMOs) in some countries. In this connection one delegate noted the importance of appropriate labelling requirements to ensure consumers are adequately informed. Other delegations expressed concern about such measures as potential non-tariff barriers.

The Group recognized that biotechnology research to date had focused heavily on agronomic traits. It was pointed out that the impact of progress in biotechnology on increasing the interchangeability of oil crops and oils through the modification of their fatty acid characteristics had so far been rather little. Hence, possible changes in the respective competitive positions of oilcrops as a result of such research would only be felt at a later stage. For the future, attention was drawn to the importance of monitoring factors affecting the direction of biotechnology research.

INTRODUCTION

1. The Committee on Commodity Problems made a preliminary review of the present state of biotechnology developments and their possible impact on trade in agricultural products at its 61st session of February 1997 (Document CCP:97/17). There was widespread agreement in the Committee on the need for IGGs to undertake studies assessing the current and future impact of biotechnological developments on the commodities under their mandate.

2. This report therefore is concerned with the biotechnology developments in the oilseeds sector, their impact on the competitiveness of major oils and the analysis of factors affecting the future direction of biotechnology research and development. The focus of the study is on the main traded oil crops, i.e. soybean, sunflower, rapeseed, as well as palm and coconut oils.

BIOTECHNOLOGY DEVELOPMENTS IN THE SECTOR OF OILSEED-BASED PRODUCTS

3. Oil crops are the source of edible and industrial oils with a wide variety of uses[1], as well as of protein meals. Plant breeding and induced mutations [2] over the last century have been the key to the significant increase in the production of the three major annual crops (soybean, sunflower and rapeseed) and contributed significantly to the increase in the production of other oilcrops, as groundnut and oil palm. Some of the objectives of biotechnological improvements of oil crops, such as higher yields, the modification of plant architecture, improvement of biotic and abiotic stress[3] resistance, adaptation to new environments, earliness, etc., are common to other crops. However, for oil crops there are additional objectives concerning the bio-engineered modification of their fatty acid and protein composition, in order to adapt them to specific food, feed or industrial utilisations. Oil crops are also potential sources of renewable fuels and of raw materials for the chemical industry. It can be anticipated that within the next few years, the new developments in molecular genetics, induced mutations and plant breeding will make possible the development of genotypes that will provide “tailor made” vegetable oils to meet the needs of the edible and industrial markets.

4. The pace of the commercial application of biotechnology developments has accelerated in the nineties. The area planted with genetically modified soybeans in 1997/98 is estimated at 3 to 4 million hectares, or 11-14 percent of the plantings in the United States, and at about 1.5 million hectares, equivalent to one-fifth of the total plantings in Argentina. In 1998/99, the transgenic soybean production is expected to double in the United States and Argentina and to amount to a quarter of the total Canadian plantings. Moreover, transgenic, herbicide-resistant Canola covered already about a quarter of the Canadian plantings in 1997/98, while rapeseed with altered oil characteristics is reported to have been commercially produced in Canada since 1995. About 28,000 hectares of high-lauric(60 percent) rapeseed were also reported planted by US farmers in 1996. Moreover, following the induction of a gene mutation leading to a very high proportion of oleic acid in sunflower oil is on the verge of becoming a source of a raw material for the chemical industry. These significant biotechnological developments are likely to result in structural changes

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[1] Pharmaceutical products; soap and detergents; paints, coatings and resins; linoleum; cosmetics; lubricants; plastic coatings; chemicals; technical products and biofuels.

[2] Gamma-irradiation and chemically-induced mutations.

[3] Biotic stress resistance concerns resistance to pests and diseases, while abiotic stress resistance covers the resistance to drought, frost, saline soil, etc.

in the vegetable oil sector. In order to ground a better understanding of these potential changes, this chapter describes the current status of the applications of biotechnology in the breeding and processing of the major oil crops.

GENETIC MODIFICATIONS AND OIL CROP BREEDING

5. The introduction of biotechnological applications in the oilseeds sector is currently most advanced in crop breeding. Different biotechnology techniques are directed towards the following four goals.

6. Acceleration of the plant breeding process and extension of breeding possibilities. Modern biotechnology enables the transfer of genes between non-related species, the precise regulation of gene expression, the regeneration of genetically modified plants and the early selection and reproduction of new plants. These techniques decrease the time needed to develop new plant varieties and open the possibility to use mutations (induced by gamma-rays or chemicals), or genetic material of bacteria and other related species in the breeding of new oil crop varieties. Some of the biotechnology techniques in this category are highly plant specific, e.g. tissue culture techniques for regeneration and reproduction, but most of them are similar to general techniques applied in other crops.

7. Genetic modification of the agronomic characteristics of oil crop. All the major oil crops have been genetically modified during the past fifty years by addition of alien genes, conferring to plants increased resistance to certain herbicides, pests, diseases, lodging, or tolerance to abiotic stress conditions (drought, frost, etc). Several of these genetically modified oil crops which have already entered the market are listed in Table 1. Other recent examples include the mutation breeding of high-yielding rapeseed varieties with an early maturation and tolerance to salinity, commercialized in Bangladesh; the high-yielding, high-oil content, lodging-resistant rapeseed varieties introduced in China; the mutation breeding and hybridisation of

Table 1: Transgenic oil crops with altered agronomic characteristics in the market, as of November 1996

Crop	**Purpose**	**Trait**	**Approved for sale**
Cotton	Herbicide resistance	Bromoxynill resistant gene	USA: 1995
Cotton	Herbicide resistance	Glyphosate resistant gene	USA: 1996
Cotton	Insect resistance	Toxin gene of Bacillus thuringiensis	USA: 1995
Cotton	Herbicide resistance	Sulfonylurea resistant gene	Under way
Soy bean	Herbicide resistance	Glyphosate resistant gene	USA: 1995
Soybean	Herbicide resistance	Glufosinate resistant gene	Under way
Canola	Herbicide resistance	Glufosinate resistant gene	Japan: 1996
Canola	Herbicide resistance	Glyphosate resistant gene	Japan: 1996

Sources: The Gene Exchange 1996, p.8; Green Gene Gazette 1997, p.20.

stress resistant rapeseed varieties introduced in Pakistan and the semi-arid regions of Turkey; the mutation and cross-breeding of high-yielding sesame seed varieties with high lodging resistance for the Republic of Korea, Israel and Pakistan; or the mutation breeding of disease-resistant cotton, adapted for short growing periods of Greece.

8. The development of these genetically-modified varieties of oil crops with new agronomic characteristics has expanded the geographic boundaries of the production areas of oil crops. At present though, biotechnology applications are directed to only a very small number of annual oil crops: rapeseed, soybean, sunflower and cotton. The greater breeding advancement in these crops might present the danger of genetic vulnerability: larger areas planted to fewer crops and fewer genotypes of each of these crops could be damaged by outbreaks of epidemics caused by new pathogenic races, or by climatic disasters like drought, frosts, etc.

9. Genetic modification of the fatty acid composition of oil crops and oils. Among other techniques, biotechnological methods have resulted in the alteration of the type and the proportion of fatty acids specific to individual oil crop varieties. Achievements in this field include the development of enhanced germplasm of rapeseed, soybean, sunflower, flax and cotton and of new industrial oil crops for traditional and non-traditional industrial uses. Particularly significant commercial results were obtained in the bioengineering of rapeseed, in order to secure and increase the food and non-food consumption of rapeseed oil. The oil is now commonly used in human consumption for cooking, baking and frying purposes, as well as in products such as margarine and salad oils, and tends to deteriorate during storage because of the oxidation of the unsaturated fatty acids it contains. Efforts, therefore, are mainly directed towards the decrease of its levels unsaturated, fatty acids in particular of linolenic acid (traditional varieties contain about 10 percent). Mutation of Canola resulted in high-yielding winter rapeseed varieties with very low linolenic acid content (below 4 percent), providing oil with a remarkably improved stability and quality. Moreover, vegetable oils with one major, long chain fatty acid component are typical industrial feedstocks with a wide range of applications in oleochemistry. Most of the traditional and newly bred cultivars of rapeseed do not exceed an average of 60 percent of the long chained erucic acid, and the high erucic acid rapeseed (HEAR) oil extracted is processed into an intermediate product used in the manufacture of polyolefine films. It has been predicted that an increase of HEAR oil up to 90 percent would enlarge appreciably its market prospects and use in oleochemical applications. Several other fatty acids are targeted through the genetical modification of rapeseed (see table 2).

10. Likewise, the genetic engineering of sunflower with an increased content of oleic acid (over 85 percent, compared to about 30 percent content of conventional varieties) points to the use of this new high-oleic acid sunflower oil as a renewable fuel. A last example concerns the genetical modification of one of the oldest oilcrops, the linseed. Despite its high dietary value, linseed covers only a small share of the world market for edible oils because of the high percentage of the unsaturated linolenic acid of the seed oil, which causes oxidation (rancidity). As in the case of rapeseed, mutant linseed with a linolenic acid content lower than 2 percent may gain consumer acceptance. Moreover, interest for using linseed oil as ‘natural” oleochemical raw material has become stronger during the last five years, with the development of mutant, high yielding, high-linolenic acid linseed. The linseed oil extracted from this mutant crop is used in the manufacture of varnishes and coatings, and is one factor behind the rise of area under linseed in the EU from an average of 70 000 hectares in the eighties to 200,000 hectares in the nineties

11. Genetic modification of oil crops to affect their meal quality. Changing the characteristics of the meal component of oil crops can influence substantially their market value. A main example of an achievement of biotechnology application in this field is the elimination from rapeseed of glucosinolates, which lower considerably the value of rapeseed meal as a feed ingredient. Genetic engineering is likely to create new and faster routes to improve meal quality and to extend the application of protein in human food (e.g. the use of soybean proteins in soy milk, tofu, or meat substitutes).

Table 2: Transgenic rapeseed with altered oil characteristics under development, as of November 1996

Crop	Purpose of genetic modific.	Trait	Development status	Market
Rapeseed	40% lauric acid production	Gene of California Bay plant	Commercial production since 1995	Detergents, soaps
Rapeseed	60% lauric acid production	Genes of California Bay plant and coconut palm	Field trials since 1996	Detergents
Rapeseed	40% stearic acid production	Antisense of Brassica gene	Field trials since 1994	Margarine, cocoa butter substitutes
Rapeseed	80% oleic acid production	n.a.	Field trials since 1995	Food, lubricants, inks
Rapeseed	Petroselinic	n.a.	Probably field trials in 1998	Polymers, detergents
Rapeseed	"Jojoba" wax production	n.a.	Field trials expected in 1996	Cosmetics, lubricants
Rapeseed	40% myristate acid production	n.a.	Field trials since 1996	Detergents, soaps, personal care
Rapeseed	90% erucic acid production	n.a.	Probably field trials in 1998	Polymers, cosmetics, inks, pharmaceuticals
Rapeseed	Ricinoleic acid production	n.a.	Probably field trials in 1997	Lubricants, plasticisers, cosmetics, pharmaceuticals

n.a.: not avilable

Sources: The Gene Exchange 1996; Murphy 1996.

12. The timing of the commercial application of biotechnology in breeding will differ between individual oil crops. At present, the genetic engineering of rapeseed is routine, and genetically modified soybeans are broadly used. Since the manipulation of genes responsible for fatty acid composition and yields appear to give rise to the same type of modifications in other oilseeds, it can be expected that in the next five years other annual oil crops could be genetically modified. The bioengineering of tree crops, such as oil palm and coconut palm is, however, more difficult, because the existing technology for modifying annual oilseeds cannot be readily applied to the perennial crops. In addition, regeneration of tree crops takes much more time : it has been estimated that it will take two decades before modified palm oil could appear on the market. The differences in the time expected to commercially apply biotechnological breakthroughs to different oil crops has repercussions on their geographical production: given that rapeseed is the most "temperate" commercial oil crop, and soybean and the other major oil crops are largely sub-tropical,

commercial cultivation of transgenic oil crops in North America and Europe will probably remain ahead of other regions for some two decades.

13. The critical factor influencing the timely commercial cultivation the genetically- engineered oil crops and their relative importance in world output is their consumer acceptance. The first shipments of soybeans containing a small percentage of herbicide-resistant, genetically- modified varieties into the European Union provoked protest from environmental and consumer groups. A mixture of concerns was expressed, including the fear that herbicide resistance could be transferred from the modified oil crop to weeds; that the herbicide glyphosate and the modified crop entailed a risk for the consumers and that the choice between genetically engineered products and conventional alternatives was no longer there. Although many of these claims were disputed, several soybean processors reacted by claiming that they would not use transgenic soybeans, or at least not in certain applications, such as infant products. A ban on imports of bio-engineered soybeans was rejected by the EU Commission; the requirement to label products containing genetically modified crops, however, is still under discussion.

BIOTECHNOLOGY APPLICATIONS IN VEGETABLE OILS PROCESSING AND THE PRODUCTION OF FATTY ACIDS

14. Although bioengineering is more advanced in plant breeding, several possibilities exist to apply biotechnology in the extraction of oil from crops and the processing of vegetable oils. Enzyme technologies are the most important here, whereby enzymes act as catalysts of chemical reactions including the break down and the recomposition of fatty acids.

- Application of enzyme technology to extraction of oil from oilseeds : enzymes could be used to breakdown oil plant cells to release their oil content, theoretically providing higher oil outputs and quality. Some companies have already commercialized enzymes to improve the yield of oil extraction from olives. However, problems have still to be overcome before enzymes are commercially applied in the bulk extraction of oils, including the high costs of the enzymes, the necessity to use a specific cocktail of enzymes for each oilseed, a longer, non-continuous crushing operation and the negative impact of the process on the quality of the meal.
- Application of enzyme technology to processing of vegetable oils: most crude vegetable oils undergo refining, including de-gumming, bleaching, deodorization, hydrogenation, inter- and trans-esterification processes. An enzyme technology that accelerates the de-gumming process, improves the quality of the oil and reduces the environmental impact of effluent disposal is currently available. Enzymatic trans-esterification is currently applied only on a reduced scale, in the production of high-value, oilseed-derived products, such as infant food, cocoa butter substitutes and essential fatty acids. However, the large- scale application of enzymatic trans-esterification is not expected within the next five years, due to the high costs of enzymes and the technological complexity of the biochemical processes they should control.
- Industrial production of fatty acids: biotechnology can also be applied in the production of fatty acids by using micro-organisms and cell culture. Micro-organisms producing fatty acids can be grown on cheap substrates, such as waste products from agriculture or the food processing industry. Several existing patents are related to the biotechnological production of oils and fatty acids in general, and to the industrial production of specific fatty acids, such as linoleic acid, in particular. However, the overall production costs involved are still prohibitive, and it is doubtful whether these processes will reach the commercial level of production in the next decade. Nevertheless, certain high-value fatty acids, finding applications in niche markets, can be industrially produced through biotechnology processes; the enzymatic production of fat substitutes (products having characteristics similar to fatty acids, but with much lower caloric values) is an example.

Table 3: Classification of vegetable oils (traditional types) according to fatty acid composition (between brackets, ranking number according to relative importance within group)

FATS OR OILS	CONSTITUENT FATTY ACIDS (g/100 g total fatty acids)								
	UNSATURATED				SATURATED				
	GROUP 1	GROUP 2	GROUP 3		GROUP 4				
	Tri-unsaturated linoleic	Di-unsaturated linoleic	Mono-unsaturated oleic	Other	Lauric	Myristic	Palmistic	Stearic	Other
Babassu	-	1 - 2	16 - 17 (9)	-	45 - 46 (3)	15 - 16 (2)	9 - 10 (3)	3 - 4 (2)	5 - 11 Caproic caprylic capric
Castor	-	3	7 - 8 (10)	86 - 90 (1) (ricinoleic)	0 - 1	0 - 1	-	0 - 1	-
Coconut	-	Trade	8 - 9 (10)	-	52 - 58 (1)	18 (1)	7 - 10 (3)	2 - 3 (3)	7 - 8 arachic caproic caprylic capric
Cottonseed	-	47 - 49 (3)	22 - 24 (7)	0 - 5	-	1	23 - 24 (2)	1	1
Linseed	47 - 49 (1)	24 (5)	19 (8)		-	-	6 - 7 (4)	2 - 3 (3)	-
Olive	-	4 - 5	85 - 86 (1)	-	-	Trace	7 (4)	2 (3)	1
Palm	-	10 (7)	42 (4)	-	-	2	40 (1)	6 (1)	-
Palm kernel	-	0 - 1	18 - 20 (8)	-	46 - 48 (2)	14 - 15 (3)	8 - 9 (3)	1 - 2	5 - 13 caprylic capric
Groundnut	-	26 - 28 (4)	53 - 58 (2)	3 - 4 (3)	-	-	8 - 9 (3)	3 (3)	2 - 3 arachic
Rapeseed	5 - 13 (2)	14 - 16 (6)	24 - 28 (6)	48 - 50 (2) (erucic)	-	-	1	-	-
Sesame	-	40 - 41 (3)	45 - 46 (3)	-	-	-	9	4 (2)	1
Soybean	6 - 7 (3)	50 - 51 (2)	28 - 29 (5)	0 - 4	Trace	Trace	9 - 10 (3)	2 - 3 (3)	0 - 5
Sunflowerseed	-	64 - 67 (1)	25 - 26 (6)	-	-	-	5 - 6 (5)	2 - 3 (3)	1

Source: FAO compilation

IMPACT OF BIOTECHNOLOGY ON THE COMPETITIVE POSITION OF OIL CROPS

15. Biotechnology application affects the competitiveness of the different oil crops and derived oils through the bio-engineered changes of their fatty acid composition, which directly affects the interchangeability among oils. Vegetable oils can be divided broadly into four overlapping groups (see table 3), based on their fatty acid composition, i.e tri-, di-, mono-unsaturated and saturated. The tri-unsaturated oils contain significant amounts of linolenic acid (used as drying oil in varnishes and coatings); the di-unsaturated oils are characterized by the presence of linoleic acid (used as semi-drying oil in the manufacture of paints, coatings, emulsifiers and vitamins), while the mono-unsaturated oils contain relatively large amounts of oleic acid (used in the manufacture of soft soaps, oleates, water proofing, polishing and thickening compounds). Palm and coconut oils are the major saturated oils.

16. Any oil competes for specific end-uses with oils of its own and of different groups too, depending on its fatty acid composition. Soybean oil, for instance, competes for some end-uses with sunflower and groundnut oils because of its linoleum acid content, but also with palm oil and other oils because of its oleic acid content. By increasing oils interchangeability, biotechnology changes the possible utilisation and market shares of the different vegetable oils in the four fatty-acid groups.

17. The following types of changes in the competitiveness of oils can result from biotechnological advances:

- Intensified competition between oils due to changes in the agronomic characteristics of oil crops. Changes in agronomic characteristics of varieties can lead to a more intense competition between oil crops. For example, the development of genetically-modified, herbicide resistant soybeans and rapeseed varieties led to a reduction in their production costs and the improvement of their competitive position as linoleum and oleic acid sources, the fatty acids in which they are particularly rich. Other oil crops, having received less biotechnological research attention, and hence fewer agronomic breakthrough, could encounter increased competition pressures.

- Intensified competition between oils in different fatty acid groups. The increased possibilities to modify the fatty acid composition of oil crops and to change the characteristics of oils through the application of enzyme technologies imply that oils from one of the four above-mentioned groups will also face competition from oils in the other groups. A forerunner is the genetically engineered Canola with a high-lauric oil content, which became a new competitor for coconut and palm kernel oils on the market of lauric oils. The possibilities of obtaining a particular fatty acid from a broader spectrum of sources by plant breeding and enzyme technology reduces the differences between the different groups of oils as raw materials for the oleochemical industries.

- Intensified competition between oil crops and other agricultural raw materials in the manufacture of fatty acids and fatty acid substitutes. The application of biotechnology in the industrial production of fatty acids and fatty acid substitutes allows the use of raw materials other than oil crops, including starch sources such as cassava, potato, and maize. Another example of fading boundaries between oil crops and other agricultural raw materials is in cocoa butter production, which faces competition from cocoa butter substitutes obtained from vegetable oils.

18. However, the bio-engineering of new oil crop varieties with modified fatty acid compositions still has to prove its economic feasibility; an obstacle to the wider cultivation of genetically-modified oilcrops is the cost of their ‘identity preservation’ in the case of non-hybrid

seeds. Since their characteristics are different from these of the traditional oilcrops, high costs may be involved in seed segregation during cultivation, harvesting and processing, in order to prevent cross-contamination of the seeds. It is possible that fatty-acid modified oilcrops will need to be produced under contract and segregated geographically, in order to ensure that growers in a given area produce only one specific variety. Contract production would imply the change in the relations between breeders, farmers and the processing industry. This development, however, might not correspond to the interest of oil processors to have interchangeable raw material supplies; they might be reluctant to make their production too dependent on the activities of seed companies. It is therefore not at all clear at this time whether the new, fatty acid- modified oilcrops will play a significant role as raw materials in the vegetable oil sector in the medium-term future.

19. Unfortunately due to the widespread of data available it was not possible to undertake a quantitative assessment of the impact of biotechnology developments on the cost of cultivation and processing of the oil crops covered.

FACTORS AFFECTING THE FUTURE DIRECTION OF BIOTECHNOLOGY RESEARCH AND DEVELOPMENT

20. There are a number of factors bearing on the future of biotechnology research and development in the oilseeds sector, including the evolution of demand for different products and national and international policies. The two main developments of significance for the sector are the general move towards greater trade liberalisation and the move towards more sustainable production and processing systems.

21. The current trend towards trade liberalisation, reflected in the reduction in trade barriers and production subsidies, would probably affect the trade in grains more than the vegetable oil market, as the trade regime for oilseed-based products is already relatively liberal. However, since grains and oil meals are both major components of animal feeds and are to a large extent interchangeable, further liberalization in the world grain market is expected to have an effect on the market of oil meals. The use of oil meals in feed rations in North America and the Far East could increase if, as expected, grain prices strengthened on further liberalization, outweighing probably their lower use in the EU (where further liberalization could well result in lower internal grain prices. The growing overall demand for oil meals is expected to have a positive effect on their international prices. Soybean production in particular will be stimulated, biotechnology research and applications will focus on this major oil crop, and the competitiveness of soybean oil might be consequently improved.

22. A generalized reduction in the direct support to oil crops would result in a stimulus to world import demand, trade and possibly the prices of vegetable oils. This type of development would benefit in particular Latin American soybean growers.

23. Moreover, as a result of the removal of import levies on oils, crushing would tend to move from consuming to producing countries, and trade in oilseeds would increasingly shift to trade in vegetable oils and meals. Palm oil might gain improved access to certain import markets, but the increase in palm oil exports would only occur after several years, since crop tree production response to price changes is slower.

24. In a more liberalized market, therefore biotechnology developments could be focused more on soybean and oil palm, with perhaps less emphasis on rapeseed and sunflower as the production of these crops could be relatively discouraged. Exporters, in particular soybean producing countries in Latin America and palm oil exporting countries in South East Asia could gain from higher prices and increases in volumes traded world-wide, while net importers could face higher world market prices.

25. The other possible development of significance for the sector is the move towards a more sustainable production and processing, based on the assumption that environmental problems may accumulate to such an extent that environment-friendly ways of production and consumption of oilseed-based products would receive a much higher importance than at present. Sustainable development envisages a decreased use of agro-chemicals, which might increase the tree crops competitiveness over annual crops; a decline in intensive animal production, which would result in a decrease of the demand for soybean meal; increased demand for “health foods”, which will favour the use of unsaturated vegetable oils over saturated oils of animal or vegetal origin; and the diversification of the vegetable oil sector. This diversification could include a replacement of monocultures by multicropping farming systems, as well as an increased consideration given to the intrinsic value of specific vegetable oils in food processing, rather than to the formulation of food products out of the cheapest mixture of ingredients. In this case, biotechnology might be focused towards increased breeding of pest- and disease-resistant oil crops and the research and development programmes might shift their coverage to perennial oil crops (oil and coconut palms), which are easier to integrate into multicropping systems. The differentiation of production and use of vegetable oils would become pivotal for a more sustainable development and less importance might be given to achieving an increased interchangeability of oils. Soybean, which derives to a large extent its dominant position on the world market from its highly-valued meal component, would be the main loser from this development, as its demand would tend to decrease with increases in the use of waste and by-products of processing industries in animal feeding.

26. It is still very unclear at present whether enzymatic production of oils would become an alternative to the present bulk production. More likely, this technology will be limited to the production of special fatty acids. Palm oil exporting countries might gain in this scenario, especially by creating and exploiting the 'green' image of perennial oil crops, while the Latin American soybean exporters could be negatively affected by the possible decrease of demand for meal in the European Union, their major export market.

CONCLUSIONS AND RECOMMENDATIONS

27. The development and application of biotechnology is only one of the factors that will shape the future of the sector of oilseed-based products. Other factors, such as the trade policies of major countries and trading blocs are as important; in fact they could even determine the future direction of research and development in biotechnologies. Therefore, a meaningful assessment of the impact of biotechnology on the world market of vegetable oils can only take place in relation to other major policy developments in the sector.

28. This document presents a first assessment of the possible impact of biotechnology developments on the sector of oilseed-based products and the competitive position of oilcrops. The sector is exceptionally diverse, consisting of a large number of different crops and derived products, a globalized seed and agro-processing industry serving food and non-food consumer markets, and rapid developments and applications of biotechnology.

29. The main impact of biotechnology on the vegetable oil sector is related to the significant increase of the interchangeability of different oil crops and oils and the consequent increased competition between products.

30. Biotechnology applications in breeding of new oil crop varieties with increased herbicides and pesticides resistance and /or modified fatty acid contents have already found commercial application in the sector. In the longer term, applications of biotechnologies in the processing of oils and the industrial production of fatty acids might, however, outweigh the impact of current applications in breeding .

31. The role and possible impact of biotechnologies on the sector of oilseed-based products was analysed taking into account two major developments in agricultural policies, i.e. the trend towards trade liberalization and that towards the incorporation of sustainability concerns. The political and economic developments specific to each of these possible developments will have a decisive impact on the type of research and development programmes in biotechnology and their applications in order to modify individual oil crops for reaching specific economic targets. For example, in a more liberalized world economy, soybean may remain the most important oilcrop and biotechnologies could be predominantly focused to its modifications and processing. On the contrary, the crop may lose some of its market importance if a sustainable development is factored into oilseed policies.

32. The Group may wish to consider recommending the further monitoring of developments in the application of biotechnology developments in the sector and the following studies to be taken by the Secretariat, within the limits of the resources available:

i) Monitoring and regular reporting to the Group on developments in application of biotechnologies in breeding and processing of oilseed-based products**;**

ii) comparative cost analysis of cultivation and processing of genetically modified and traditional varieties of soybeans and rapeseed;

iii) a study on the impact of biotechnology developments on the horizontal and vertical integration in the sector of oilseeds and derived products.

iv) a study on the impact of biotechnology on future use of speciality oils, such as shea and illipe (used as cocoa butter substitutes), in the global market of vegetable oils with increased interchangeability.