Palm oil:
nutritional, social and environmental aspects

***Appraisal* by the Fonds français pour l'alimentation et la santé (FFAS, French Fund for Food and Health)**

Palm oil is present in many of the food products that we eat on a daily basis. These include certain biscuits and cakes, spreads, margarines and oils used for frying. It is the subject of controversy. There are accusations that palm oil is bad for health, that it is not clearly labelled on product packaging, that it is responsible for deforestation in Indonesia, and that it harms biodiversity. How much is true?

About the appraisal

In order to compile this appraisal, in June 2012 the FFAS requested an initial written contribution from experts. A high-level paper review committee was then asked to conduct a critical analysis of that document. The FFAS also invited the various stakeholders to a 'multi-perspective' session. This procedure has been closely monitored by the different FFAS departments. It has enabled us to produce an appraisal of the available knowledge, and to present a scientific study that is as objective as possible. Care has been taken to include different perspectives on the subject, and to ensure that the arguments put forward do not lack foundation.

THE FFAS HAS CHOSEN TO COVER ENVIRONMENTAL ASPECTS IN THIS APPRAISAL. WHILE THESE ARE NOT PART OF ITS AREA OF OPERATIONS, THEY ARE CONSIDERED INSEPARABLE FROM OTHER ASPECTS FOR THE PURPOSE OF QUALITY AND RELEVANCE IN THIS ANALYSIS.

THIS DOCUMENT DOES NOT SET OUT TO ESTABLISH A POSITION. INSTEAD, IT AIMS TO PRESENT AN APPRAISAL OF EXISTING SCIENTIFIC KNOWLEDGE IN ORDER TO ALLOW INDIVIDUALS TO FORM THEIR OWN OPINIONS.

I - WHAT WE NEED TO KNOW ABOUT PALM OIL

A solid fat

Palm oil is produced from the pulp of the fruit of the oil palm. Like palm kernel oil, copra oil (produced from coconut), and cocoa butter, palm oil is a solid fat. This means that it is solid at room temperature. As such, it is rich in saturated fats (around 50%) and especially, as the name implies, in palmitic acid. For this reason, its nutritional value is subject to debate.

Crude palm oil is known as 'red palm oil' on account of its colour. This is linked to its high carotenoid content. In Europe, palm oil is usually sold and consumed in its refined form, i.e. after it has been bleached and deodorised.

A global sector dependent on the South

The oil palm is cultivated exclusively in humid tropical regions. There, it represents a significant source of currency for local economies. It is also important for export and as a primary material for local industry.

Today, the majority of palm oil production is supplied by two countries: Indonesia and Malaysia. These two countries alone account for 87% of world supplies. Consumption is highest in countries of the South. This is due to demographic growth and higher living standards in emerging countries with large populations such as India, Indonesia and China. European consumption accounts for 12% of the world total (the population of Europe represents 8% of the world population); the US consumption accounts for 3%.[1]

A known and predictable increase

World fat consumption per capita has more than doubled in 35 years, rising from 11kg per year in 1976 to 24.7kg in 2009. Production is expected to double between now and 2050,[1] despite concerns about the increase in consumption per capita, and about the role played by biofuels (Corley, 2009).

World rates have been on the increase for over a decade.[1] This explains the unprecedented boom among cultivators in the South and in agroindustry. Furthermore, since 2008, parallels have been noted in the development both of vegetable oils that could be used for biodiesel and of crude oil (Jacquemard, 2011).

Multiple uses

Palm oil may be substituted for most other vegetable oils. It has very many uses throughout the world.

- The food industry accounts for 80% of its use: in cooking oils, margarine, fats for baking, pastries and all kinds of food preparation.
- Oleochemistry accounts for 19%: in cosmetics, soaps, lubricants and oils, candles, pharmaceutical products, leather, surfactants, agrochemistry, paints and glosses, and electronics.
- Biodiesel accounts for the other 1%.

II - OVERVIEW OF KNOWN FACTS

Nutritional aspects

Composition

Like all oils, liquid or solid, crude and refined palm oil contains almost 100 % lipids, mainly in the form of triglycerides. These are molecules derived from glycerol with three attached fatty acids. The proportion of saturated fatty acids is around 50 % (Table 1). The unsaturated fatty acids are of the cis configuration.[2]

- Saturated fatty acids	45 - 55	
Lauric acid C12:0		< 0.5
Myristic acid C14:0		0.5 – 2
Palmitic acid C16:0		39.5 – 47.5
Stearic acid C18:0		3.5 – 6
- Monounsaturated fatty acids	38 - 45	
Oleic acid C18:1 n-9		36 – 44
- Polyunsaturated fatty acids	9 - 12	
Linoleic acid C18:2 n-9		9 – 12
αLinolenic acid C18:3 n-3		< 0.5

Table 1 Fatty acid content (%) in standard palm oil

Fatty acids are either essential or non-essential depending on whether they can be biosynthesized in sufficient quantity by the body. In humans, only α-linolenic acid and linoleic acid are strictly essential. This is because they are not synthesized by the body and, consequently, must be supplied entirely from food. Palmitic and oleic acids account for the majority of fatty acids present in palm oil. They are non-essential fatty acids.

Annex 2 shows the composition of palm oil and the other main vegetable oils: soya, rapeseed, sunflower and olive.

A particular feature of palm oil concerns the structure of its triglycerides, i.e. the position of the fatty acids on the glycerol. Only 11% of palmitic acid is at the 2-position, meaning in a central position allowing maximum absorption without hydrolysis by lipases. Most of the saturated fatty acids (87%) of palm oil are in the peripheral 1 and 3-positions. This subjects them to lipase action. They then become free fatty acids. These can, in part, be eliminated in the intestine if they occur in small quantities, and in the presence of calcium in large quantities that is simultaneously present in the digestive tract. They can then form insoluble soaps that precipitate.

Alongside the principal glyceridic constituents, crude palm oil contains 'minor' compounds: vitamin E, carotenoids, phytosterols and phenolic compounds. All vegetable oils contain vitamin E in varying amounts and different forms. Palm oil has the distinctive feature of largely containing tocotrienols (up to 500 mg/kg crude oil) and tocopherols, especially in alpha form (150 to 200 mg/kg) with the highest vitamin E activity. The refining process causes only minimal vitamin E loss. During heating, tocopherol contents decrease in varying degrees depending on the conditions such as heat intensity. Levels can fall to 40% after ten cycles of frying potatoes.

The pronounced red colour of crude palm oil is due to its particular richness in carotenoids (55 to 2000 mg/kg). Other crude vegetable oils contain much less: around 100 mg/kg. However, the red pigments are removed during the refining process, with bleaching and deodorisation.

Palm oil contains a few phytosterols (40 to 90 mg/100 g) although to a lesser degree than the more unsaturated oils. Finally, palm oil contains phenolic acids (*p*-coumaric, *p*-hydroxybenzoic and ferulic) which have anti-oxidant properties. However, these are present in numerous other foods.

Effects on plasma lipids

In humans, saturated fatty acids always contribute to raising cholesterol levels, with differing effects depending on the length of their chain. The effects of palm oil on lipid parameters must be considered in this context. Over 25 studies have been published on the effects of palm oil on plasma lipids.

Because it contains high amounts (~50%) saturated fatty acids, mainly palmitic acid, palm oil increases LDL cholesterol to an extent similar to that of other oils that are, however, less rich in saturated fatty acids. The rate at which palm oil raises LDL cholesterol is lower than that of oils richer in saturated fatty acids (coconut oil), and of partially hydrogenated vegetable fats. It also raises HDL cholesterol to a limited degree, more so than oils less rich in saturated fatty acids. There have been studies of the effects specific to minor compounds. It is well known that tocotrienols reduce endogenous synthesis of cholesterol.

These effects of palm oil on plasma lipids are in line with the vascular effects that could be attributed to them (cf. below).

SFA: saturated fatty acid
UFA: unsaturated fatty acid
MUFA: monounsaturated fatty acid
PUFA: polyunsaturated fatty acid
TFA: trans fatty acid
HDL: high density lipoprotein
LDL: low density lipoprotein

Technological aspects

Structure and functions

The functions of fats are directly linked to the structure of their principal constituents: i.e. triglycerides. This refers to the nature of the fatty acids and their position on the glycerol. These factors determine the physical properties of fats, such as fusion and solidification, and the chemical properties, especially stability.

Depending on the conditions, fats liquefy or solidify in varying and variable crystalline forms (polymorphism). Polymorphism is the result of the spatial distribution of triglyceride molecules. There are two main categories of crystalline forms. On the one hand, there are those that correspond to a dense and compact arrangement of chains. On the other hand, there are those associated with a more loose arrangement. The more compact forms are generally the more stable (Cansell, 2005).

This polymorphism directly influences the rheological properties.[3] The hardness, or consistency, of a fat depends on:

- its composition in fatty acids; from the more solid to the more fluid: saturated (SFA) > trans monounsaturated (TFA) > cis monounsaturated (MUFA) > polyunsaturated (PUFA);
- its triglyceride structure which influences the level of polymorphism in the solid state;
- conditions involved in its culinary or industrial use: temperature and thermal history (cooling rate and, consequently, crystallization), mechanical performance (agitation, pressure and shearing during crystallization).

As such, vegetable oils that are liquid at room temperature (melting at temperatures below 15°C) contain a maximum of 15% saturated fatty acids. Vegetable oils that have a saturated fatty acid content of around 50% (palm), or over 80% (palm kernel, copra) are semi-liquid or solid at room temperature. This means that they melt at temperatures of between approximately 20 to 30°C (semi-liquid), or above 30°C (solid). These characteristics give the aforesaid vegetable fats properties that affect the flavour of the finished products. The texture of such products may be soft, hard or crisp. This is largely a result of the fat used.

The fats used in numerous food products may be hard or semi-liquid at storage and utilization temperatures: a characteristic that affects the rheological properties and texture of the finished products. This function of fats differs depending on whether they are found in continuous phase or dispersed. This might be in the form of water-in-oil emulsions such as butter and margarine, or oil-in-water types such as mayonnaise, ice-creams or creme chantilly (Cansell, 2005).

Resistance to oxidation is also dependent on fatty acid composition and, to a secondary degree, on the triglyceride structure. Sensitivity to oxidation is directly linked to the degree of unsaturation (Morin et al., 2012). The vegetable fats that are richest in saturated fatty acids offer very high resistance to oxidation: they do not become rancid quickly; and to heat treatments: they are stable in cooking and frying.

Processing methods and extending functionalities

Methods for processing fats have two main purposes:
- fulfilling a practical need for hard (solid) fats for their aforementioned properties required for texturing through crystallization;
- improving stability in terms of oxidative and thermo-oxidative alterations for different applications.

There are three permitted processing methods in food production: hydrogenation, fractionation and interesterification.

Hydrogenation is a chemical transformation. The objective is to solidify vegetable oil, through treatment with hydrogen, transforming unsaturated FA into SFA. Hydrogenation can be partial or total. Depending on the conditions in place, partial hydrogenation is accompanied by the formation, to greater or lesser degree, of trans fatty acids (TFA), mainly monounsaturated. If the reaction is brought to completion (total hydrogenation), all the unsaturated fatty acids are transformed into SFA and the fat no longer contains TFA.

Owing to the cardiovascular risks associated with excessive consumption of TFA, implementation of alternative technological solutions began at the end of the 1990s. One of these is using palm oil. The aim is to minimize, or reduce to zero, the trans fatty acid content of products. Today, in France, levels of TFA consumption are below the limit recommended by the French food safety agency (ANSES), i.e. 2% of total energy input. At the time of writing, partial hydrogenation technology is in clear decline in the food sector.

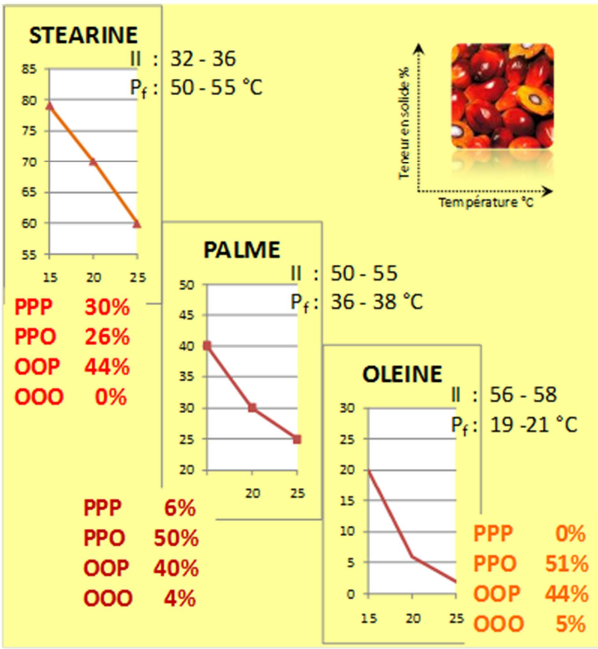
Fractionation is a physical process that consists of crystallizing the triglycerides richest in SFA in a fat using a cooling process based on an established gradient. The process allows the separation of a solid fraction, stearin, from a liquid fraction, olein, that does not crystallize in the given temperature conditions. The tocopherols and tocotrienols are found largely concentrated in the olein fraction.

Interesterification is a transformation with the objective of altering the rheological properties of fats by changing the structure of their triglycerides. The resulting product has the same fatty acid composition as the original fat, except where the interesterification process is conducted across two different oils. However, there is alteration of the proportions of hard and liquid fat at a given temperature.

It is therefore technically possible to respond to the need for a 'solid function' and the objective of stability through appropriate choice of primary materials: liquid or semi-liquid oils, hard fats etc. The combination of several methods makes it possible to avoid creating trans fatty acids. These include total hydrogenation, fractionation and interesterification (Kellens, 1998; Van Duijn, 2000 and 2005; Morin, 2007).

The case of palm oil

The fatty acid composition of palm oil (Table 1) and the structure of its triglycerides (Figure 1) give it quite specific functional characteristics such as stability and solidity. It is generally well adapted in the light of the concerns that arose at the start of the 2000s and the search for alternative fats containing little or no TFA.



<u>Figure 1</u>: Fractionation of palm oil - Composition of triglycerides and comparative characteristics of solid contents according to temperature for the starter oil and liquid and solid fractions (80% olein and 20% stearin) obtained by crystallization at 28°C.
Key: P = palmitic acid; O = oleic acid; P_f = fusion point; II = iodine index
(Morin *et al*, 2012)

Furthermore, palm oil (P_f: 36-38°C), by its composition, is especially adapted to fractionation that produces an olein ((P_f: 19-21°C) and a stearin (P_f: 50-55°C). It is even possible to refractionate these initial fractions in order to produce a range of fractions with fusion points spanning between under 20°C (super olein) and over 50°C (hard stearin), although with much weaker yields for these sub-fractions.

Figure 1 shows the hard fat contents according to temperature, fusion points and levels of unsaturation for palm oil and its first two fractions.

Regulatory aspects - labelling

Regulatory provisions regarding labelling have been in development since the publication of the European regulation on 'provision of food information to consumers'[4] on 22 November 2011. The general provisions of the regulation will come into force on 13 December 2014. The nutrition declaration will not become mandatory on pre-packaged food products until after 13 December 2016.

Before then, and until the established temporary measures come to an end, lists of ingredients in food items may use the following designations: 'Vegetable oil [or fat]'. An indication of the specific vegetable origin of oil(s) may also be included. The use of oil (or fat) processed by hydrogenation must be indicated by the descriptive term 'hydrogenated'.

Nutrition labelling is only compulsory where a nutrition or health claim is made regarding one of the constituents of the food product.

In practice, generic terms such as 'vegetable fat' are more frequently used than specific details of the oils or fats used in the composition of a product. This is largely due to fluctuations in supply that necessitate temporary adjustments to the composition. Such adjustments are incompatible with the time constraints involved in making alterations to labels.

Very occasionally, the use of hydrogenated oil is accompanied by the specification 'totally' or 'partially'. This gives an indirect indication of the possible presence of TFA in the case of partial hydrogenation. Certain sectors, margarine manufacture especially, have chosen to indicate the quantity of TFA (voluntary labelling).

Environmental aspects

An exceptional source of oil

The oil palm produces exceptional oil yields: an average of 3.5 tonnes per hectare. In the most productive Indonesian plantations, yields are over 6 tonnes per hectare. They are reaching over 10 tonnes per hectare in the most successful genetic trials being conducted by Cirad, the French agency for agricultural development. As such, oil palm cultivation supplies 39 % of world vegetable oil production while occupying only 7 % of the agricultural surface area dedicated to oil crops. This is much smaller than the share dedicated to soya (61 %), rape (18 %) and sunflower (14 %). Palm oil has the lowest production costs of vegetable oils, less than 20 % of the costs of soya.

A delicate cohabitation

The biology of the oil palm requires an exclusively intertropical distribution. This necessarily implies cohabitation with the last biodiversity hotspots of the world: the Congo Basin, the Amazon Basin and Borneo.

This delicate cohabitation also affects other large-scale oil producing crops. In the same way, soya cultivation must also deal with serious environmental constraints. This is especially true in Brazil where productive surface areas have increased from 1.7 to 21.7 million hectares in scarcely 40 years.

Deforestation causes problems both for the preservation of biodiversity and for the rights of indigenous peoples. However, palm plantations and deforestation are not necessarily related. Public authorities award concessions to forestry companies that exploit the timber. Deforested areas are then left uncultivated. Consequently, they develop into secondary forests or savannahs. Alternatively, they are transformed into cultivated land. Between 1990 and 2005, 21 million hectares of primary forest disappeared in Indonesia. Of these, only 3 million hectares were used for palm plantations. Since 2005, new plantations have been the reason for, on average, 10 % of the deforestation recorded in Indonesia and Malaysia (FAO, 2010). Nevertheless, between 1990 and 2005, over 50 % of the expansion of palm plantations in these two countries took place at the expense of forests and, occasionally, peat bogs (Koh & Wilcove, 2008; Gibbs et al., 2010).

The tensions in this direct relationship are generally aggravated in new pioneer fronts such as Borneo. There, around 30 % of the primary forests felled have been turned over to oil palm (Carlson et al., 2012).

The vast plantation programmes underway in Africa also pose a growing threat to forests (WWF, 2011). Countries involved include Liberia, Angola, Gabon and Cameroon. In effect, a number of factors are leading large Asian companies to invest massively in Africa. These include the growing number of regulations governing the conversion of natural forests, the shortage of land, monitoring of large land acquisitions, and the hopes raised by the programme on Reducing Emissions from Deforestation and Forest Degradation (REDD) in large producer companies such as Malaysia and Indonesia (Hoyle & Levang, 2012).

Social aspects
Oil palm cultivation can generate high, stable revenues. It can create a rural middle class lasting several generations. Few tropical primary materials have been able to do that, to date. As such, in Sumatra, Indonesia, the average income in a complete financial year of an oil palm plantation is as much as 2100 euros per hectare. This compares with only 200 euros for a rice plantation. The comparison of wages is even more striking. On an oil palm plantation, it is 36 euros per person, per day. Whereas in a paddy field it is 1.7 euros per person per day (Hoyle & Levang, 2012).

As with every other type of crop, the spread of oil palm plantations creates conflicts over land. These are exacerbated by the lack of land registries or specific land laws.

Exploitation of the oil palm depends on highly diversified crop systems. These range from family farming of a few hectares to the agro-industrial level of tens of thousands of hectares. Over half of the palm oil produced today comes from small farming operations: around 3 million in number. It is estimated that there are 25 million Indonesians living indirectly from oil palm exploitation (WWF, 2011).

III - CONTROVERSIES

Palm oil and health

Saturated fatty acids, palm oil and cardiovascular risk

The cardiovascular problems resulting from palm oil consumption are among the general concerns regarding the role of saturated fatty acids and the increase in LDL cholesterol that they produce. While cardiovascular risk is increased by a reduction in HDL cholesterol, the protective role of increased HDL has not been clearly demonstrated.

Older epidemiological and clinic studies show that cardiovascular risk increases with the consumption of saturated fatty acids (Kagan et al., 1974; Keys et al., 1986; Shekelle et al., 1981). However other, more recent, epidemiological studies show that this link is tenuous (Esrey et al., 1996; Hu et al., 1999) or non-existent (Boniface & Tefft, 2002). A meta-analysis of the prospective studies published in 2010 did not reveal a statistically significant relationship between saturated fatty acids and risk of coronary heart disease or stroke (Siri-Tarino et al., 2010). However, this study was criticized in the editorial of the journal that published it (*American Journal of Clinical Nutrition*). In the case of intervention studies involving a reduction in saturated fatty acid intake, the results are negative, neutral or positive depending on the study in question. The results are difficult to interpret because the reduction in saturated fatty acid intake is always accompanied by an increase in polyunsaturated fatty acids, as in the Oslo study (Astrup et al., 2010). Meanwhile, studies that assessed substituting SFA with UFA show a reduction in risk (Mozaffarian et al., 2010; Mensink et al., 2003).

The link between cardiovascular diseases and consumption of saturated fatty acids is, however, subject to numerous conflicting factors. These include cholesterol intake, reliability of food data, consideration of other food fats, nature of dietary carbohydrates etc. This partially explains the conflicting results of the studies.

Only three epidemiological studies have attempted to consider the role of palm oil in the risk of cardiovascular disease (Zhang & Kesteloot, 2001; Kabagambe et al., 2005; Chen et al., 2011). These studies suggest an increased cardiovascular risk linked to the consumption of palm oil in cooking. However, their results provide little in the way of information for the population of France where palm oil is not used in cooking.

Overall, an excess of saturated fatty acids is undesirable as, in addition to its effect of raising cholesterol levels, it can have a pro-inflammatory effect and significantly reduce insulin sensitivity (Walrand et al., 2010). In May 2011, ANSES updated its recommended daily allowances for fatty acids. It now recommends limiting them to 12 % of total energy intake, i.e. 27 g a day for an allowance of 2000 calories. For the fatty acids with the highest effects on cholesterol rates, including palmitic acid, the recommendation is 8%.

Replacing palm oil: advantage or inconvenience?

Replacing palm oil could be a negative option if it leads to an increase in trans fatty acid intake. This would happen if partially hydrogenated vegetable fats, which are sources of trans fats, were used in place of palm oil. In effect, intakes of more than 2 % trans fatty acids that result from technological processes raise LDL cholesterol levels and lower those of HDL cholesterol. They are also associated with increased cardiovascular risk. This has been shown by almost all the observation and intervention studies. Reducing trans fatty acids in food products means looking to other, equivalent technologies. These include the use of palm oil or a combination of processing methods.

This use of palm oil or other fats should only occur in the context of possible substitution. It is not desirable to raise the saturated fatty acid intake of the French people as it is already in excess of the recommended daily allowance. It is a question of replacing palm oil, where technological constraints allow, with oil that is suitably resistant in cooking, for example. Palm oil should only be used when no other oil would be as good.

It should be remembered that the average palm oil consumption remains low in France. During the last decade, it has been fluctuating between 1 and 2 kg per person per year. In 2009, estimates for consumption were made on the basis of quantities of palm oil used in processed food products. According to figures from the French Ministry of Agriculture from 2010, there were 130,000 tonnes of palm oil used in processed food products per year, 31% of them imports. Consumption of palm oil was estimated at 5.5g per person per day or 2kg per person per year. This is around 6% of total fat consumption in adults aged 18 to 79 (Inca2 Study). Apparent average consumption[5] of saturated fatty acids from palm oil is estimated at around 2.7g per person, per day. This is an over-estimation when compared to real consumption with adjustment for losses. The figure 2.7g represents 10% of recommended saturated fatty acid intake for an allowance of 2000kcal. These figures are estimates based on a hypothetical balance between import and export of finished products containing palm oil. There are no data for consumption that demonstrate the, probably significant, individual distribution of palm oil consumption among the French population.

In terms of nutrition, for fats and for other nutrients, it is important that sources should be as varied as possible. This enables consumers to achieve an optimal balance. Indeed, in France, this variety is a reality.

Palm oil and food technology

The question of replacing palm oil with other fats must be addressed in terms of possibilities, impossibilities and compromise. In effect, much depends on the extent to which the texture of the finished product relies on the particular functional characteristics of palm oil. These characteristics include behaviour in crystallization and the ability to maintain solidity at a given temperature. These factors determine the level of suitability of the alternatives although the latter are not always satisfactory in nutritional terms. Those alternatives are just as awkward when it comes to reconciling the nutritional aspects with the sensory properties of the finished product. The nutritional aspects include reducing fat contents and replacing saturated fatty acids with unsaturated fats. The sensory properties should remain unchanged. This could necessitate modifications to production lines, at the very least.

Pleasing texture function

Depending on the case, several options could be considered and selected according to need. These include the following.

a) Using a substitute fat - often a difficult option in terms of the supply chain, questions of tonnages and regularity, and functionality. Certain new varieties of conventional oils (not derived from GMOs) that are richer in saturated fatty acids are being studied or are in development. However the available quantities remain limited;
b) Using fats processed:
   - by fractionation. There are limited resources beyond fractions of palm oil or fats of animal origin.
   - by interesterification and/or total hydrogenation;
c) Formulation combining several of the options above;
d) Reducing the palm oil content, favouring a certified sustainable supply, in combination with one or more of the options above;
e) Using texturing agents, e.g. fibres, glycerides etc.

In order for one, or more, of these options to be selected, it is necessary to be aware of the limitations of introducing them into recipes, and in the quality of the finished product, i.e. in terms of sensory characteristics and keeping qualities. The situations will be different depending on whether it is a case of altering the recipe of a product that is already on sale, or developing a new product for which there is no 'point of reference'.

Solutions often belong to a process of nutritional optimization that involves reducing saturated fatty acids or fat content. It has been possible to implement some such solutions for certain applications in biscuit production. However, puff pastry products remain more difficult to reformulate in this context.

The less crucial 'solidity' function
Where recipes and methods allow, solutions are implemented. Again, they may belong to a wider context of reducing SFA intake. This has happened in the case of oils for frying, both in the food industry and in non-domestic catering. Here, oils rich in oleic acid have proved very satisfactory alternatives in terms of stability, an important criterion for this use. Such oils include varieties of sunflower oil and now rapeseed.

Palm oil and information for consumers
Current regulatory provisions on labelling (see p. 7) mean that, where the designation 'vegetable oil or fat' occurs, the plant of origin of the oils is not generally specified in the list of ingredients. This gives rise to a lack of clarity highlighted by consumers' associations.

The development of labelling regulations, being gradually implemented between now and 2014, provides some responses to these concerns.
- The new regulations specify that, in the case of blends of refined vegetable oils or fats, use of the generic terms 'vegetable oils' or 'vegetable fats', still permitted, shall be accompanied by a list of the specific origins and, possibly, supplemented by the statement 'in variable proportion'.
- Even in the absence of nutrition claims, as of December 2016, nutrition information will be obligatory. It will include seven basic indications, among them fat content including saturated fatty acids. Mono- and polyunsaturated fats especially will be included on a voluntary basis.
- As they are not part of the regulatory nutrition declaration, indications of TFA contents will no longer be possible: neither compulsorily nor voluntarily. Nevertheless, TFA contents will shortly be subject to an impact study and, subsequently, a report by the European Commission.
- The indication of hydrogenated oil (or fat) will have to specify 'wholly' or 'partially'. This will be more precise than at present and obligatory.

Palm oil and social and environmental impacts
When properly planned by governments and implemented by cultivators, oil palm development results in strong economic development for the regions concerned, and a significant reduction in rural poverty. Poorly managed, the increase in plantations risks resulting in the disappearance of high conservation value forests (HCVF). This has negative impacts on local populations and on the environment.

The implementation of new plantation projects, especially in Africa, offers governments and all stakeholders the opportunity to develop a shared strategy. This strategy should be able to guide the rapid expansion and sustainable development of the sector. Consultation among all the actors would involve: government, companies, national centres for agricultural research, local communities, and national and international NGOs. Consultation must be based on the available international standards. These are

ISO 9000 for governance and quality control; ISO 14000 for respect for the environment; and ISO 26000 for social responsibility. The standards developed by the Roundtable on Sustainable Palm Oil (RSPO) must also be included, see below.

From now on, all sustainable expansion strategies in the sector must include:
- ecological intensification of existing plantations;
- conservation of biodiversity and the permanent forest estate;
- controlled application of the RSPO principles and criteria;
- small-scale cultivators involved in the development of agro-industrial complexes, either through the implementation of production contracts or through support measures for family farming;
- respect for local communities, gaining their prior, freely given, consent, and widespread communication regarding all developments of new plantations;
- study of land law and respect for regulations pertaining to the acquisition of land.

Land planning

High value conservation forests are identified and surrounded by buffer zones including areas of agro-forestry alongside plantations. These allow a reasonable level of human activity: subsistence crops, fruit trees, rubber, medicinal plants and even ecotourism. This practice makes it possible to avoid drastic losses in biodiversity caused by the opening of agricultural zones directly bordering primary forest. The cultivation of oil palm is then integrated into land planning in consultation with local populations (Koh et al., 2009).

Ecological intensification

Areas already planted with palm trees often fall far short of returning the expected yields. It is therefore important to maximize palm plantation operations while ensuring minimum environmental impact. The first requirement of ecological intensification of productivity is for all cultivators, both on family farms and industrial plantations, to have access to selected seeds. It also depends on the implementation of a regulated fertilization programme. This is not only for economic reasons, fertilization currently represents 60% of palm plantation running costs, but is also a question of respecting people and the environment. The challenge is to optimize the effect of inputs, mineral or organic, so that they bring maximum benefit to the plant through regulated and reasonable applications. This will avoid surpluses ending up in groundwater or surface water.

The use of pesticides in oil palm culture can be reduced to minimum applications of herbicides in young plantations in order to limit the growth of cover plants and to create pathways for harvesting. To date, there has been no serious palm disease that did not have an organic solution.

Ecological intensification of oil palm culture is limited by the biological constraints of the plant itself. These make it difficult to mechanize cultivation. As such, it is labour intensive. Oil extraction must occur without delay, otherwise physical and chemical properties are lost. The extraction process therefore requires an effective collection network and sound organization of storage tanks around extraction plants.

There have been significant efforts to compost waste products and recycle the by-products of oil production. Treatment of the latter produces methane, a gas with a serious greenhouse effect, which is now being used to produce biogas.

Certification of plantations

The Roundtable on Sustainable Palm Oil (RSPO) is a multi-actor international initiative for the certification and promotion of sustainable palm oil. The initiative has been running since 2008.[6]

Today, 1.3 million hectares of plantations are RSPO certified. That is around 10 % of the cultivated surface area.

A study has just been conducted on the indirect effects of RSPO certification (WWF, 2012a). It clearly demonstrates the benefits for cultivators. These go beyond the simple bonus on the purchase price of certified oil.

Nevertheless, RSPO certification is still a long way from meeting its objectives. The success of this process will only be apparent in the long term. Demand for certified sustainable palm oil (CSPO) is less than the supply. This can largely be explained by the impossibility of organizing a segregated distribution chain that would guarantee buyers of palm oil derivative products (palm olein and stearin) that they were getting certified products. As a consequence, 52 % of CSPO is put on the market as conventional oil.

Transport constitutes the weak link in the logistical chain, given the difficulty of organizing segregated areas for certified and non-certified products on board ships. This is a problem for which technical solutions must be found.

The RSPO has recently launched an in-depth review of its principles and criteria. It is necessary to adapt these to the specific constraints of small-scale plantations. The Roundtable is making efforts to build better links with those stakeholders that are still under-represented. These include governments; importers from the South such as China, India and Pakistan; small-scale cultivators; and research centres. The RSPO must ensure that a significant part of the responsibility falls to governments. It is they who are ultimately in charge of legislating and ensuring the application of laws covering sustainability criteria. The latter include moratoria on forest exploitation, compulsory standards and land concessions. The RSPO initiative depends on the consensus of all its members voluntarily accepting its principles and criteria. It is considered to have little binding power and, as such, to be largely inefficient. This is particularly true of its capacity to protect forests and limit emissions of greenhouse gases (Laurence et al., 2010; Angerand, 2011). Compulsory national standards have recently appeared, including the Indonesian Sustainable Palm Oil and Malaysian Sustainable Palm Oil standards. This is a sign of successful ownership of the certification process. However, it also signals a need to provide national regulations that are no longer optional but henceforth compulsory.

Investors also have a key role to play (WWF, 2012b) in the sustainable development of the distribution chain. They could make their support dependent on the consideration of governance issues. These would include respect for social and environmental standards and for the RSPO certification status of their beneficiaries.

Research underway
Systems for assessing and certifying oil palm plantations must be robust and accepted by all stakeholders. They must therefore be based on sound scientific foundations. The interpretation of the RSPO principles and criteria addresses numerous questions currently being studied. As such, several collaborative projects now underway are dedicated to understanding the biological, agro-ecological and social foundations for the sustainability of oil palm cultivation. In particular, there is the question of understanding the ecosystems and the impact of plantations (Project SAFE Sime Darby, Imperial College London). Another question is that of creating robust, common agri-environmental indicators (Réseau PalmiNet, Cirad and partners). A further issue is that of characterizing the various oil palm cultivation systems and their environmental, social and economic impacts (Project SPOP – INRA, IRD, Cifor, Cirad).

IV - CONCLUSIONS

Conditions of palm oil use in France
In certain countries of Africa, where palm oil is consumed in its crude state, it is the primary source of fat in the diet. There, it plays an essential role in the intakes of fats, energy and vitamins of adults and, especially, of children. In France, its nutritional role is completely different. Here it belongs to a context of excessive consumption of fats and especially saturated fatty acids. In addition, it is the solid fraction of palm oil (stearin), the part richest in saturated fatty acids that is mainly used. It is therefore appropriate to moderate its use. However, it is not necessary to aim to exclude it. Palm oil has technologically interesting characteristics. These allow a reduction in the use of partial hydrogenation of vegetable fats and, as such, in the presence of trans fatty acids.

The nutritional balance is understood as a food regime and not in terms of each food item. It is therefore from this perspective that palm oil must be understood in the overall context of fat consumption. In France, average consumption is 2 kg per person, per year. This level does not currently constitute a nutrition problem although it is a reminder of the need for a balanced diet.

In regulatory terms, developments are tending towards a compromise between consumer expectations of greater transparency and the limitations experienced by the food industry. Examples include nutrition information for each product and labelling for the specific origins of vegetable oils in the list of ingredients by the 2014 deadline.

The role of consumers in the North
Western consumers are in a position to improve the sector by insisting that processors respect existing regulations on sustainability, and by encouraging them to do better. There are undeniable social and environmental advantages in adopting a strategy of encouraging the use of RSPO certified oil, or even oil subject to more demanding standards if available and verifiable.

Eradication strategies, if it were necessary to implement them fully, could turn out to be wholly counterproductive. In effect, demand is met by countries of the South experiencing strong economic and demographic growth. Withdrawing the 17% market share (if we include biofuels) destined to supply the North would remove every constraint associated with certification: such constraints do not apply in the markets of the South. This would create a risk of inflating the supply. As such, this would encourage the production of non-sustainable palm oil and of other vegetable oils that would not necessarily be any more ecologically acceptable.

In effect, yield levels of oil palms are 6 to 10 times greater on average that those of other oil-bearing crops. Therefore, replacing palm oil with other vegetable oils would require the use of larger agricultural surface areas for the production of equivalent tonnage. This would involve result in new environmental impacts associated with the conversion of natural ecosystems into cultivated lands.

* *
*

Finally, this multidisciplinary approach involves the nutritional, social and environmental aspects of the production and consumption of palm oil. As such, it shows that the need for palm oil can be considered to belong to the category of reasonable practices. The following would therefore be justified on scientific grounds:

- managing and organizing oil palm development, taking into account the agro-ecological, social and environmental questions affecting the South;
- creating certification processes based on sound scientific foundations and shared values;
- making every effort to ensure that certified palm oil represents as great a share possible of the total oil available on the market;
- taking steps so that the inclusion of palm oil is justified on a case by case basis by companies in the food industry sector, and that substitutions with other oils meet the criteria of optimum nutrition;
- taking steps so that current levels of palm oil consumption observed in France do not increase significantly;
- ensuring that consumers in the North have detailed information about the different aspects of palm oil production and consumption, in order to avoid a situation in which partial knowledge of these aspects led to initiatives being taken that would endanger efforts to organize the sector and limit its impacts.

Report compiled by the Fonds français pour l'alimentation et la santé (French Fund for Food and Health)

Initial written contribution by:
Dr Jean-Michel Lecerf, Service de Nutrition, Institut Pasteur de Lille (Nutrition Service, Pasteur Institute, Lille)
Odile Morin, Communication scientifique et technique, (Scientific and Technical Communications) Iterg, Pessac
Alain Rival, Correspondant Filière palmier à huile, Cirad, Montpellier (Oil Palm Sector Contact, Cirad, Montpellier)

Scientific coordination: Pr. Bernard Guy-Grand, Board Member

'Multi-perspective' session: 40 participants representing stakeholders and civil society

Procedural supervision: Scientific Board

REFERENCES

Angerand S (2011). Arnaque à l'huile de palme durable : 12 questions pour comprendre les enjeux. *http://www.amisdelaterre.org/IMG/pdf/rapport_arnaque_huile_de_palme_durable_mai_2011.pdf*

ANSES (2011). Actualisation des apports nutritionnels conseillés pour les acides gras. Rapport d'expertise collective ANSES, May 2011, 323 pages.

Astrup A, Dyerberg J, Elwood P, *et al*. (2011). The role of reducing intakes of saturated fat in the prevention of cardiovascular disease. Where does the evidence stand in 2010? *Am J Clin Nutr*, 93:684-688.

Boniface DR, Tefft ME (2002). Dietary fats and 16-year coronary heart disease mortality in a cohort of men and women in Great Britain. *Eur J Clin Nutr*, 56:786-792.

Cansell M (2005). Impact de la cristallisation des corps gras sur les propriétés de produits finis. *Oléagineux Corps gras Lipides – OCL*, 12(5-6):427-431.

Carlson KM *et al*. (2012). Committed carbon emissions, deforestation, and community land conversion from oil palm plantation expansion in West Kalimantan, Indonesia. *PNAS*, 109(19):7559-7564. doi:10.1073/pnas.1200452109.

Chen BK, Seligman B, Farquhar JW, Goldhaber-Fiebert JD (2011). Multi-country analysis of palm oil consumption and cardiovascular disease mortality for countries at different stages of economic development: 1980-1997. *Global Health*, 7:45.

Corley RHV (2009). How much palm oil do we need? *Environmental Science & Policy*, 12:134–139.

FAO (2010). Global Forest Resources Assessment 2010: Main Report (Food and Agric Org of the UN, Rome, Italy).

Esrey KL, Joseph L, Grover SA (1996). Relationship between dietary intake and coronary heart disease mortality: lipid research clinics prevalence follow-up study. *J Clin Epidemiol*, 49:211-216.

Gibbs *et al.* (2010). Tropical forests were the primary sources of new agricultural land in the 1980s and 1990s. *PNAS*, 1-6.

Hoyle D, Levang P (2012). Le développement du palmier à huile au Cameroun. 16p.
http://awsassets.panda.org/downloads/developpmentpalmierhuilecameroun.pdf

Hu FB, Stampfer MJ, Manson JE, *et al*. (1999). Dietary saturated fats and their food sources in relation to the risk of coronary heart disease in women. *Am J Clin Nutr*, 70:1001-1008.

Jacquemard JC (2011). *Le palmier à huile. Agricultures tropicales en poche*. Quae Editions, 240p.

Kabagambe EK, Baylin A, Ascherio A, Campos H (2005). The type of oil used for cooking is associated with the risk of nonfatal acute myocardial infarction in Costa Rica. *J Nutr*, 135:2674-2679.

Kagan A, Harris BR, Winkelstein WJ, *et al*. (1974). Epidemiologic studies of coronary heart disease and stroke in Japanese men living in Japan, Hawaii and California: demographic, physical, dietary and biochemical characteristics. *J Chronic Dis*, 27:345-364.

Kellens M (1998). Etat des lieux et évaluation des procédés de modification des matières grasses par combinaison de l'hydrogénation, de l'interestérification et du fractionnement – 1ère partie. *Oléagineux Corps gras Lipides – OCL*, 5(5):384-391.

Keys A, Menotti A, Karvonen MJ, *et al*. (1986). The diet and 15-year death rate in the seven countries study. *Am J Epidemiol,* 124:903-915.

Koh L.P, Wilcove DS (2008). Is oil palm agriculture really destroying tropical biodiversity? *Conservation Letters*, 1: 60-64.

Koh LP *et al.* (2009). Designer landscapes for sustainable biofuels. *Trends in Ecology & Evolution*, 24(8):431-438. *http://dx.doi.org/10.1016/j.tree.2009.03.012*

Laurence WF *et al*. (2010). Improving the Performance of the Roundtable on Sustainable Palm Oil for Nature Conservation. *Conservation Biology* 24(2):1523-1739. *http://dx.doi.org/10.1111/j.1523-1739.2010.01448.x*

Morin O (2007), Huiles végétales et margarines : évolution de la qualité – Les solutions technologiques à la réduction des acides gras trans. *Cah Nutr Diét*, 42(5):247-253.

Morin O, Pagès-Xatart-Parès X (2012), Huiles et corps gras végétaux : ressources fonctionnelles et intérêt nutritionnel. *Oléagineux Corps gras Lipides – OCL*, 19(2):63-72.

Mozaffarian D, Micha R, Wallace S (2010). Effects on Coronary Heat Disease of Increasing Polyunsaturated Fat in Place of Saturated Fat: A Systematic Review and Metaanalysis of Randomized Controlled Trials. *PLoS Med* 7(3): e1000252. *http://dx.doi.org/10.1371/journal.pmed.1000252*

Shekelle RB, Shryock AM, Paul O, *et al.* (1981). Diet, serum cholesterol, and death from coronary heart disease. The western electric study. *N Engl J Med*, 304:65-70.

Siri-Tarino PW, Sun Q, Hu FB, Krauss RM (2010). Meta-analysis of prospective cohort studies evaluating the association of saturated fat with cardiovascular disease. *Am J Clin Nutr*, 91:535-546.
Van Duijn G (2000). Technical aspects of trans reduction in margarines. *Oléagineux Corps gras Lipides – OCL*, 7(1):95-98.
Van Duijn G (2005). Technical aspects of trans reduction in modified fats. *Oléagineux Corps gras Lipides – OCL,* 12(5-6):422-426.
Walrand S, Fisch F, Bourre JM (2010). Do saturated fatty acids have the same metabolic effect? *Nutr Clin Metab*, 24:63-75.
WWF (2011). *Huile de palme : de la déforestation à la nécessaire durabilité*. Rapport, 40p. http://wwf.fr/media/files/rapport-huile-de-palme-2011
WWF (2012a). *Sustainability in Palm Oil Production: Analysis of Incremental Financial Costs and Benefits of RSPO Compliance*. http://assets.worldwildlife.org/publications/350/files/original/Profitability_and_Sustainability_in_Palm_Oil_Production.pdf?1345734683
WWF (2012b). Palm Oil Investor Review: Investor Guidance on Palm Oil: The role of investors in supporting the development of a sustainable palm oil industry. Report, 24 p. http://awsassets.panda.org/downloads/wwf_palmoil_investorreview.pdf
Zhang J, Kesteloot H (2001). Differences in all-cause, cardiovascular and cancer mortality between Hong Kong and Singapore: Role of nutrition. *Eur J Epidemiol*, 17:469-477.

Useful websites

- RSPO - Roundtable on Sustainable Palm Oil: **www.rspo.org/**
- Round Table on Responsible Soy Association: **www.responsiblesoy.org/**
- FSC Forest Stewardship Council: **www.fsc.org/**
- Report *Palmier à huile et Développement Durable*: Oléagineux, Corps Gras, Lipides: **www.revue-ocl.fr/archives/sommaire.phtml?cle_parution=3447**
- Stability of Altered Forest Ecosystems (SAFE) Project: **www.safeproject.net/**
- Palm Indicators Network - PalmiNet: **http://community.plantnet-project.org/pg/groups/2879/palminet/**
- Greenpalm: **http://www.greenpalm.org/**
- SPOP: Sustainable Development of Palm Oil Production: Designing strategies from improved knowledge on oil palm cropping systems **http://www.agence-nationale-recherche.fr/programmes-de-recherche/environnement-et-ressources-biologiques/viabilite-et-adaptation-des-ecosystemes-productifs-territoires-et-ressources-aux-changements-globaux/fiche-projet-agrobiosphere/?tx_lwmsuivibilan_pi2%5BCODE%5D=ANR-11-AGRO-0007**

Notes

[1] *Cf.* Annex 1.
[2] Unsaturated fatty acids can have two different geometric structures: cis and trans. Monounsaturated trans fatty acids only occur in animal products or in vegetable fats that have undergone partial hydrogenation.
[3] Rheology: study of the phenomena governing the flow and deformation of materials: plasticity, viscosity, elasticity.
[4] Regulation (EU) No 1169/2011 of 25 October 2011, EU OJ L 304 of 22 November 2011, p. 18-63.
[5] Apparent consumption is measured on the basis of quantities available.
[6] For more information, see Annex 3.