PALM OIL ABSTRACTS

A. GENERAL. OILS AND FATS

A00001

ONG, Datuk Professor Augustine S H. The potential of palm oil in the world of oils and fats: Kaufmann Memorial Lecture. ISF-JOCS World Congresses, Tokyo Japan, 26-30 September 1988. Bangi: PORIM, 1988.

The lecture emphasizes the potential role of palm oil in the future of mankind, especially in relation to the human health aspects. Free radicals have been speculated to play a role in human diseases by causing cell damage. This radical damage can be minimized in the presence of β-carotene, Vitamin E and Vitamin C. Both β-carotene and Vitamin E are naturally present in palm oil. The lecture also indicates future areas of research, namely extraction of β-carotene from palm oil methyl esters; studies on the organic chemistry of palm oil, palm oil products, and palm distillate fatty acids and fatty esters; novel applications of palm oil such as modification to produce as ingredients for infant foods, and the use of medium chain triglycerides (MCT) and long chain triglycerides (LCT) for intravenous injection in specific applications.

A00002

MALAYSIA. Ministry of Primary Industries. Statistics on commodities 1988. 3rd edition, Kuala Lumpur: the Ministry of Primary Industries, 1988.

This compendium of statistical data covers various components of the Malaysian primary commodity sector, namely palm oil, rubber, cocoa, timber and forestry products, pepper, pineapple, tobacco, tin and minerals. The data portray trends in and progress of commodities, their impact on trade and the development of the country, and features of the international economy which affect their performance in the world markets.

A00003

PORIM. Persidangan Kebangsaan Kelapa Sawit / Minyak Sawit: Perkembangan Masakini. [National

Conference on Oil Palm/Palm Oil: Current Developments]. Kuala Lumpur, 11-15 October 1988. Bangi : PORIM, 1989.

The set of papers presented concerns the Malaysian oil palm/palm oil industry with emphasis on current developments relating to crop production, processing technology, nutritional value of palm oil and market development.

B. OIL PALM

Cultivation. Crop Management. Plant Protection. Palm Science. Breeding and Genetics. Biotechnology.

B00001

BIN ZAWAWI Zakaria and ABDUL HALIM Hassan. Pengendalian limbah industri minyak sawit - pengalaman Malaysia. Seminar Nasional Pengendalian Limbah Paberik Minyak Sawit dan Karet [Management of effluents in the palm oil industry - the Malaysian experience. National Seminar on the Management of Effluents from Palm Oil and Rubber Factories. (In Indonesian, with an English summary)] Medan, Sumatra, 20-21 December 1988. CP 00449

This paper provides information on the Malaysian experience in managing effluents from the palm oil industry. Palm oil mill effluent (POME) is generally regarded as a valuable resource which could be recycled back to field plantations as fertilizer, particularly for oil palms. Utilization of POME has been proven commercially viable and is not detrimental to the environment. However, the potential of this organic waste has not been fully exploited. The concept of utilization of effluents and the resulting benefits are fully described.

B00002

AHMAD TARMIZI Hashim and PARANJOTHY, K. *In vitro* storage of oil palm polyembryogenic cultures. Simposium Biologi Kebangsaan ke-III (Third National Biology Symposium),Kuala Lumpur, 22-24 November 1988.

Three approaches can be taken to preserve oil palm polyembryogenic cultures, *in vitro*. They are: 1) continous growth under normal conditions, ii) slow growth under limiting conditions, and iii) cryopreservation (in liquid nitrogen). Growth limitation and cryopreservation techniques are suitable for long term preservation of cultures. It was found that 1.5 — 2.27 x 10^{-5}M abscisic acid (ABA), 0.58M and 0.75M sucrose, 0.55M and 0.82M glucose, 0.55M and 0.82M sorbitol, 0.55M and 0.82M mannitol, and incubation at low temperature (15°C) and in non-agitated liquid media of low ionic strengths suppressed the growth and multiplication of the embryoids. About 25% of embryoids precultured in high concentrations of sucrose (> 0.3M) showed some growth recovery after storage in liquid nitrogen. About 9% of the embryoids multiplied and regenerated shoots normally. Ramets obtained from slow-growing and cryopreserved cultures will be field evaluated to ensure clonal fidelity.

B00003

CHEAH Suan Choo. Enzymic extraction of palm oil. Persidangan Kebangsaan Kelapa Sawit / Minyak Sawit: Perkembangan Masakini, (National Conference on Oil Palm/Palm Oil: Current Developments) Kuala Lumpur, 11-15 October 1988. Bangi : PORIM, 1988. In Persidangan Kebangsaan Kelapa Sawit/Minyak Sawit: Perkembangan Masakini:16p.

The use of commercial cellulase and pectinase preparations for extraction of oil from palm mesocarp was studied. The mesocarp was pre-treated with enzymes and the oil released into the reactant medium in shake flask experiments was quantified. Pre-treatment with cellulase improved the efficiency of oil extraction but pectinase pre-treatment had no effect. In addition, a more efficient clarification

of the crude oil extracted following enzymic pre-treatment was observed. The quality characteristics of the oil indicated that good quality oil is obtainable by this process.

B 00004

MS 157:1988. Specification for oil palm seed for commercial planting. Shah Alam: SIRIM, 1988.

This Malaysian standard covers requirements for selection, preparation and storage of oil palm seeds. Quality requirements are also laid down for pre-heated as well as germinated seeds. Procedures for sampling and tests are included. This standard supercedes MS 157:1973. Specification for oil palm seed for commercial planting

C. PALM OIL

Chemistry. Product Development and Quality End Uses. By-product Utilization.

C00001

SIEW Wai Lin, TAN Yew Ai and CHONG Chiew Let. Stability tests for refined palm oil products. Bangi : PORIM, 1988. PORIM R PO(00141)88

The quality and stability of refined palm oil products were studied with reference to colour, oxidation and hydrolysis. Accelerated tests were used to predict stability. Colour stability was measured at 60°C, 120°C and 180°C and calculated as compound rate at each temperature. The colour stability of processed oils did not show any correlations with their respective quality parameters. Oxidation stability was defined from the Rancimat test; the hydrolytic stability of the processed oils showed strong correlations with the phosphorus content. Equations were developed relating rate of hydrolysis to phosphorus content.

C00002

CHONG Chiew Let and ONG, Datuk Professor Augustine S H. Effect of antioxidant (TBHQ/CA) on the oxidative stability of palm oil. ASEAN Food Conference 88, Bangkok, Thailand, 24-26 October 1988. CP 00483

The effect of THBQ (tertiary-butylhydroquinone) and a synergistic mixture of TBHQ with citric acid (CA) in preventing oxidative deterioration of palm oil over prolonged storage periods was monitored. The oil samples were stored in 60ml medicinal flat bottles as well as in lined and unlined mild steel drums, with and without the antioxidant mixtures, and analysed at intervals for oxidative deterioration. The results indicate that the antioxidant mixture is capable of preventing oxidative deterioration in palm oil as judged by oxidative parameters. The beneficial effect of an inert lining for metal storage containers is also shown for the case of crude palm oil. The colour of the refined oil from the stored crude oil containing the antioxidant mixture is also good. Recommendations for the long-term storage of palm oil are given.

C00003

SALMIAH Ahmad, LEONG Y C, WONG C S and AZMAN Rafiei. Evaluation of performance of safety shoes/rain boots plasticized/stabilized with epodized RBD palm olein and epoxidized soyabean oil. Bangi: PORIM, 1988. PORIM R PO (00134b)88.

The report compares the performance of safety shoes/rain boots plasticized/stabilized with epoxidized RBD palm olein (ERDB PO) and epoxidized soyabean oil (ESBO). ESBO has been the major type of epoxidized material used for the purpose due to its availability and favourable economics. With the co-operation of a local plastics company, safety shoes/rain boots plasticized/stabilized with ERBD PO were produced using proprietary PVC formulations. It was found that ERBD PO performed similarly to ESBO in terms of stabilizing, plasticizing and compatibility properties. ERBD PO could therefore be used to replace ESBO in certain formulations; ERB PO has an economic advantage.

C00004

TANG Thin Sue, ONG, Datuk Professor Augustine S H. Quality control and standards in the palm oil industry. Malaysian Chemical Conference 1988 on Quality and Standards in Chemical Industries, Johor Bahru, Malaysia, 9-10 August 1988. CP 00418

This paper reviews the practice of quality control in various sectors of the palm oil industry — harvesting and milling, processing and fractionation, fatty acid production, palm kernel oil extraction, and handling of processed palm oil during storage and shipment. Factors adversely affecting the various quality parameters are highlighted and recommended practices to avoid or overcome them are discussed. The paper compares the existing national and international standards on palm and palm kernel oil products. Proposals for improvements in quality standards and specifications are made. The role of the PORLA Environmental Quality Act and the PORIM Certificate of Competency Schemes for Oil Mills and Refineries is discussed.

C00005

TEAH Yau Kun and ONG, Datuk Professor Augustine S H. Advantages of palm kernel oil over coconut oil in foods. Bangi: PORIM, 1988. In Palm Oil Developments 1988 9 : 20-22.

Palm kernel oil has been assuming ever-increasing importance in recent years. Following the introduction of the pollinating weevil to West Malaysia in 1982, kernel extraction ratios have leaped from around 3.5% of FFB weight to six per cent. Palm kernel oil and coconut oil are the two major lauric oils which are in demand for industrial and specific edible applications.

Palm kernel oil is mainly used in confectionery fats, simulated dairy products, biscuit cream, and industrial margarines, and for nut roasting and spray oils. Palm kernel oil has certain distinct advantages over coconut oil in food applications even though the two can be used interchangeably.

C00006

PORIM. Pocketbook of palm oil uses. Revised edition. Bangi: PORIM, 1988.

This is a revised edition of the original 1987 publication; it gives a brief description of palm oil and palm oil products as well as the many uses of palm oil, both edible and non-edible.

C00007

MS 80:1987. Specification for palm kernel oil. Shah Alam: SIRIM 1987.

This Malaysian standard prescribes the quality requirements and methods of sampling and test for Malaysian palm kernel oil, whether crude or refined/neutralized, bleached and deodorized. This is a revised edition of MS 80:1973. Specification for crude palm kernel oil.

C000008

MS 607:1987. Specification for palm kernel cake and palm kernel meal as animal feedstuffs. Shah Alam: SIRIM, 1987.

This Malaysian standard prescribes the requirements and the methods of sampling and test for palm kernel cake (PKC) and palm kernel meal (PKM) for use as animal feeds. This is a revised edition of MS 607:1979. Specification for palm kernel meal as animal feedstuffs.

C00009

GB 2 197 337A. Hydrogenation of palm stearin. London: The Patent Office, 1988.

This British Patent relates to a process for producing wax from palm oil. Palm stearin or a mixture of palm stearin and cow tallow is hydrogenated until the iodine value (IV) is in the range 1—5. The product may be used in making candles or match heads.

D. ENGINEERING AND TECHNOLOGY

Farm Mechanization. Palm Oil Surveying. Palm Oil Mill Engineering.

D00001

MA Ah Ngan, LEE K M and CHOO K C. SBR process for palm oil refinery waste treatment. Persidangan Kebangsaan Kelapa Sawit/Minyak Sawit: Perkembangan Masakini, (National Conference on Oil Palm/Palm Oil: Current Developments) Kuala Lumpur, 11-15 October 1988. Bangi: PORIM, 1988. In Persidangan Kebangsaan Kelapa Sawit/Minyak Sawit Perkembangan Masakini:12p.

The Sequencing Batch Reactor (SBR) process, for treating palm oil physical refinery wastewater, has gone through laboratory and pilot plant testing and is now being employed in full-scale operation. The process has proven to be very versatile and stable and can sustain high fluctuation in pollution loads (BOD), and can be operated in various modes to the desired final discharge quality. The operation is made simple by the reasonably cheap and reliable microprocessor-based sequencing controller. It requires very little operator attention. The capital and operation costs are relatively much cheaper than those of the conventional continuous activated sludge process. Currently, there are four palm oil refineries using the process to treat their wastewater. Their capacities range from 50m^3/day to 1000m^3/day. Very satisfactory results are obtained, *i.e.* complying with the Department of Environment requirements.

D00002

ABDUL RAHIM Shuib, ABDUL HALIM Hassan and AHMAD Hitam. An improved FFB harvesting pole: with special reference to PORIM aluminium harvesting pole. Persidangan Kebangsaan Kelapa Sawit / Minyak Sawit: Perkembangan Masakini, Kuala Lumpur, 11-15 October 1988. Bangi: PORIM, 1988. In Persidangan Kebangsaan Kelapa Sawit/Minyak Sawit Perkembangan Masakini: 8p.

Harvesting poles are used to gather fruit bunches from tall palms and it is widely accepted that the harvesters' performance also depends on such poles. Bamboo poles already in use pose some problems, and it was thought that an aluminium implement would be a good replacement since it would be lighter, durable and affordable. Besides that, aluminium poles could be fabricated according to the harvester's needs. A pole with an elliptical cross-section was found to be good in terms of strength, and it fits the human hand well. Three different sizes of aluminium poles were fabricated and tested to assess their performance in regards to flexibility, weight and durability. With these parameters in mind, an appropriate size and design of oil palm harvesting poles have been determined.

D00003

ABDUL RAHIM Shuib and ABDUL HALIM Hassan. Development of harvesting machine for oil palm. Persidangan Kebangsaan Kelapa Sawit/Minyak Sawit: Perkembangan Masakini, Kuala Lumpur, 11-15 October 1988. Bangi: PORIM, 1988. In Persidangan Kebangsaan Kelapa Sawit/Minyak Sawit Perkembangan Masakini: 7p.

Oil palm is one of the major plantation crops in Malaysia and currently occupies about 1.7 million hectares of agricultural land, about 70% of which is under mature palms. Generally, most of the field operations in the oil palm plantations, such as land clearing, planting, pest and disease control, weed control, fertilizer application and FFB transportation are partly or fully mechanized. The major operation which is still not mechanized is the harvesting of FFB, which involves the cutting of fruit bunches and fronds from palms. This paper outlines developments towards mechanizing this operation. The findings on the prototype harvesting machine previously tested and the general physical requirements of a suitable machine are highlighted. A comparison between expected machine performance and output as opposed to manual operation is also given.

D00004

BERGER, K G, MACLELLAN, Malcolm and THIAGARAJAN, T. A technical audit programme for refineries. Annual Meeting of AOCS, Phoenix, USA, 8-12 May 1988. Bangi: PORIM, 1988. CP 00440

Malaysian refineries process 4 1/2 million tonnes of palm oil annually. Of 40 refineries, the largest is handling up to 2800 tonnes/day. As part of the quality assurance system, the Palm Oil Research Institute of Malaysia carries out an independent technical audit. The scheme is voluntary, and evaluations are based on an agreed, itemized mark sheet. Every refinery receives a confidential report detailing points of weakness. Those obtaining sufficient marks are awarded a Certificate with one year's validity. The audit is carried out by two officers under five headings, *viz.* General Appearance, Quality Control, Factory Operations, Storage and Disposal of Products, and Safety and Maintenance. The results of the 5-years' operation is presented and discussed.

D00005

ELIAS bin Awang. Quality deteriorations: their effect on marketability and methods of overcoming them. Second Palm Oil Ship/Shore Surveyors Course 'Dedicated towards Excellence', Melaka, Malaysia, 21-24 November 1988. Bangi: PORIM, 1988. In Second Palm Oil Ship/Shore Surveyors Course. PORIM: 31p. CP 00417

Long distance bulk transportation of RBD palm oil and products by sea-going parcel-tankers often leads to excessive deterioration in quality as indicated by IV, FFA and colour. The need to re-refine the products plus other cost factors such as import duties and logistic problems render RBD palm oil and products highly uncompetitive with locally-produced oils such as those from rapeseed and soyabeans, and even crude palm oil and products from neighbouring competing producers. This paper presents evidence on quality deterioration and discusses how it might affect market potential. It finally presents and discusses nitrogen sparging as an economical technique to tackle quality deterioration and suggests strategies to ensure marketability.

D00006

SLDB/PORIM Workshop on Palm Oil Milling Technology, Kota Kinabalu, Sabah, Malaysia, 21-22 June 1988. Bangi: PORIM, 1988.

These proceedings give an overview and describe the current status of palm oil milling technology. Topics covered include processing technology, POME treatment, mill automation and process control, and mill maintenance and management.

E. NUTRITIONAL VALUES

Dietary Fats. Cancer and Carcinogenesis. Coronary Heart Diseases

E00001

PORIM. New findings and facts on palm oil. Bangi: PORIM, 1989.

This is a compilation of reproduced literature in their original forms from various authorities on the known positive attributes of palm oil.

E00002

SUNDRAM, K., KHOR, H T, ONG, Datuk Professor Augustine S H and PATHMANATHAN, R. Effect of dietary palm oils on mammary carcinogenesis in female rats induced by 7,12-dimethylbenz(a)anthracene. In Cancer Research 1989, Vol. 49, March, 1447-1451

Female Sprague-Dawley rats, 50 days of age, were treated with a single dose of 5 mg of 7,12-dimethylbenz(a)anthracene (DMBA) intragastrically. Three days after carcinogen treatment, the rats were put on semisynthetic diets containing 20% by weight of corn oil (CO), soybean oil (SBO), crude palm oil (CPO), refined, bleached, deodorized palm oil (RBD PO)

and metabisulfite-treated palm oil (MCPO) for five months. In the course of the experiments, rats fed on different dietary fats had similar rate of growth. Rats fed 20% CO or SBO diet had higher tumor incidents than rats fed on palm oil (PO) diets; however, differences of mean tumor latency periods among the groups were not statistically significant. At autopsy, rats fed on high CO or SBO diets had significantly more tumors than rats fed on the three PO diets. Our results showed that high PO diets did not promote chemically induced mammary tumorigenesis in female rats when compared to high CO or SBO diets. CO and SBO differ greatly from the palm oils in their contents of tocopherols, tocotrienols and carotenes. But further experiments would be required to determine whether the observed differences in tumor incidence and tumor numbers were due to the differences in these minor components or due to the unique triglyceride structure of the palm oils. Analysis of the fatty acid profiles of plasma total lipids of tumor-bearing rats and of the tumor total lipids showed that, with the exception of arachidonic acid, the fatty acid profiles reflect the nature of the dietary fats. At autopsy, there were no difference in the plasma total cholesterol content among rats fed on different dietary fats, but rats fed on palm oil diets had a significantly higher plasma triglyceride level than that of rats fed CO or SBO diets. As for the tumor lipids, there was no significant difference in the triglyceride, diglyceride and phospholipid levels when the CO or SBO groups were compared to the palm oil groups.

E00003

CHARNOCK, J S, ABEYWARDENA, M Y and MCLENNAN P L. Effect of palm oil enriched diets on cardiac arrhythmia and thrombogenesis in a rat model of sudden cardiac deaths. Paper presented at Fats for the Future II Conference, Auckland, New Zealand 12-17 February, 1989.

Previous experiments in this laboratory have demonstrated significant dietary induced differences in the incidence and severity of experimentally induced cardiac arrhythmia in rats, following occlusion of the coronary artery. In general, feeding highly saturated animal fat supplements enhance, whilst highly polyunsaturated vegetable oils reduce the number of ventricular premature beats (VPB) that are observed after occlusion, as well as the duration of ventricular tachycardia (VT) and the extent of fibrillation (VF). The experiments described in this report demonstrate that long-term feeding (12 months) of either physically refined (RBD), or chemically refined (NBD) palm oil as a 12% (w/w) dietary supplement to a nutritionally adequate stock diet resulted in effects on the parameters of cardiac arrhythmia (VPB; VT; VF), which are intermediate between those of sheep kidney fat (SKF) or sunflower seed oil (SSO) fed animals. In addition, the production of prostacyclin (PGI_2) by the vessel wall and thromboxane (TXA_2) by whole blood were investigated by radioimmuno assay as both these metabolites of the arachidonate cascade have been implicated in cardiovascular homeostasis and thrombogenesis. Despite its 50% content of saturated fatty acids, in this long-term study in the rat, palm oil dietary supplements resulted in a prostacyclin/thromboxane balance which differed from that of the sheep fat supplemented group. Since the eicosanoids PGI_2 and TXA_2 are regarded as local hormones which have their biological effect at their sites of production, and as current research in our laboratory suggests a direct link between cardiac eicosanoid production and arrhythmia, future investigations might be more sharply focused upon the myocardial rather than the vessel wall/platelet production of these biologically active fatty acid metabolites.

E 00004

NG, Tony K W. Nutritional studies on Malaysian processed palm oil: A thesis

submitted in partial fulfilment of the requirement for the Degree of Doctor of Philosophy, University of Malaya. Kuala Lumpur: University of Malaya, 1987.

A rat bioassay study was undertaken to obtain more information on the nutirtional role of palm oil and to gain further insights on the effects of the oil on blood lipids and arterial thrombosis.

Refined, bleached and deodorized (RBD) palm oil, RBD palm olein and RBD palm stearin were found to be easily digested, well absorbed, efficiently utilized for growth and to provide essentially the same amount of energy, *i.e.* 9.0 kcal/g, as other common edible oils and fats. In respect to these classical nutritional criteria, RBD palm olein was shown to be a better oil than RBD palm stearin and the unfractionated RBD palm oil. Long-term feeding of rats indicated that refined palm oil and its fractions were non-toxic and supported normal growth and maintenance when consumed as the main source of dietary fat; these effects were also demonstrated in a multi-generation rat bioassay for RBD palm olein. However, for optimal reproductive performance, a need was found for supplementing the palm oil diets with additional amounts of essential fatty acids (EFA) in order to satisfy increased EFA requirements during pregnancy and lactation. Purified diets containing 25 energy % and 50 energy % RBD palm oil fed to rats for 12 weeks, resulted in blood cholesterol and HDL-cholesterol levels that were no different from those of diets containing 5 energy % and 50 energy % corn oil. However, the relatively low blood lipid levels reached by all the dietary groups seemed to suggest that the strain of rat used possessed a resistance to fat-induced changes that had not been expected. Palm oil feeding also resulted in a favourable low or reduction in the plasma level of the prothrombotic metabolite, TxB_2 that was comparable to that of the corn oil-fed animals but significantly lower than that obtained with the coconut oil diet, suggesting that palm oil consumption is associated with a low risk to thrombosis. Semi-chronic toxicological tests on rats fed EFA-adequate diets containing heated RBD palm oil, RBD palm olein, RBD palm stearin and hydrogenated soybean oil with 25% polar material at 30 energy % for 90 days or more, demonstrated that although histopathological examination of the major organs did not reveal any abnormality, all the heated fats caused enlargements of the liver, kidney and heart, elevation of serum alkaline phosphatase and urea, and affected adversely reproductive performance with respect to stillbirths, weight of pups and pre-weaning mortality. Thus, polar compounds in heated fats should not be regarded as entirely harmless to humans. However, the maximal permissable intake of 2.8 g polar material per head daily estimated, suggests that this amount of polar material arising from heated fats is unlikely to be exceeded in the ordinary Malaysian diet.

F. TECHNO-ECONOMICS

Production Costs. Socio-economics. Market Development. Futures Trading

F00001

YUSOF bin Basiron. Perennial crop allocation in Malaysia: A macro model simulation and optimal control approach. International Seminar on Malaysian Agricultural Policy: Issues and Directions, UPM Serdang, 21-23 June 1988. Bangi: PORIM, 1988. In Workshop on Malaysian Palm Oil Industry for the year 2000: 46p. PORIM CP 00406.

This paper attempts to address the crop allocation problem with a macro approach, taking into consideration the interaction effects of the various sectors of the Malaysian economy when a certain crop allocation policy is adopted. The technique involves building a macroeconomic model of the Malaysian economy and simulating the model under various crop allocation strategies. In theory, similar simulation techniques can also be

employed to study future crop allocation strategies for rubber and oil palm. A more efficient optimal control approach is used on the same model to examine the crop allocation policy for the period 1984-1995.

F00002

TEAH Yau Kun and YOON Suk Hoo. Dietary oils and fats in South Korea - current and future trends.In Palm Oil Developments 1989 10; 7—10.

Lipids constitute one of the three major components of foods and are recognized as essential nutrients in both human and animal diets. The dietary oils and fats of South Korea are discussed. In the early 1960s, the total calorie intake per person per day in South Korea averaged 1900 Kilocalories. By the mid-1980s, it had increased to 2600 Kilocalories and the contribution of oils and fats to this intake had increased from six to 15 per cent. The various reasons behind the increase in consumption of oils and fats are discussed as well as the various usages of different types of oils and fats in South Korea, including palm oil.

F00003

MALEK Mansoor and BARLOW, Colin. The production structure of the Malaysian oil palm industry with special reference to the smallholder subsector. PORIM Occasional Paper No. 24. 60 pp. Bangi : PORIM, 1988.

The objectives of this study are to investigate the production structure of the main subsectors of the Malaysian oil palm industry, to highlight the problems of the group and independent smallholdings, and to examine the future development of these smallholdings with reference to facilitating policies. A comparison is made between oil palm and rubber. The structures of the estates, group smallholdings and independent smallholdings are then reviewed in turn. The major problems of the smallholding subsectors are next discussed, and group smallholdings are seen to face high costs, scarcities of labour and land, and particular difficulties with small *in situ* schemes. Independent smallholdings have problems through poor extension and lack of access to finance for planting. Routes towards overcoming these problems are suggested. The future expansion of all oil palm subsectors is finally reviewed.