PALM OIL ABSTRACTS

A. GENERAL OILS AND FATS

A00008

Fish oils:Past and present food uses. In JAOCS 1989 Vol 66(12) :1717-1726.

The U.S. Food and Drug Administration on Sept. 15,1989, extended GRAS (generally recognized as safe) status to fully hydrogenated and partially hydrogenated menhaden oil. This article reviews past and present uses of hydrogenated menhaden oil and provides some data on physical and chemical characteristics.

A00009

YASUDA, K. Oils and fats in Japan. In Lipid Technology 1990 Vol 2(1) :17-19.

The per capita consumption of vegetable oil and animal fat are approximately equal in Japan. Palm oil and rapeseed oil production have increased dramatically and, together with soybean oil, these are the major vegetable oils in this country.

B. OIL PALM

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

B00013

FALLAVIER, P ;BREYSSE, M ; OLIVIN, J. Experimental study of potassium dynamics in two tropical soils used for oil palm growing. In Oleagineux 1989 Vol 44(5) :204-207.

The results of potassium retention experiments and of K ion isotopic dilution measurements and the calculation of cation exchange parameters identify three particular values for exchangeable K. The lowest gives the size of the initial exchangeable compartment, whose ions are retained energetically in the absorbing complex. The intermediate value indicates the size it can reach with K applications, without there being

a risk of the additional ions retained being leached away. The highest value gives the maximum size of this compartment; it is of no practical interest since the additional ions retained are very easily leached away.

B00014

RAJANAIDU, N;JALANI Sukaimi; RAO, V ;RUSLAN, A. Genetic variation and genotype x environment (G X E) interaction in oil palm (*Elaeis guineensis*) for bunch yields and its components. SABRAO International Congress 6th, Tokyo Japan, August 1989. CP 00516.

Heritability estimates and G X E interactions were investigated in two oil palm breeding populations using breeding design of North Carolina Model 1 (NCM 1). ANOVA and variance components were calculated where heritability estimates for male and female items were calculated separately using the intra-class correlation coefficient of males (t_m) and females (t_f). The yield, fresh fruit bunches (FFB), bunch number (BNo) and average bunch weight (ABWt) were scored and h^2f ranged from 43 - 100% while the h^2m was 0 - 100% indicating that there was considerable genetic variation for these traits in these populations. The G X E interaction studies showed that there was significant interaction for yield parameters. The results showed that the performance of the progenies tested was not consistent over the years.

B00015

ENDINKEAU, K ;WOODWARD, T W. Preservations of oil palm fruits:Nonoxidative effects of ionizing radiation on palm olein and crude palm oil. In Pertanika 1989 Vol 12(3):377-385.

The effect of gamma-irradiation on palm olein has been investigated. Irradiation doses (0.1 to 1 MGy) caused severe destruction of unsaturated but had little effect on saturated fatty acids. Similar effects were observed in irradiated samples stored for 1 and 2 months at room temperature. Radiation (up to 30 kGy) also caused severe destruction of carotenes in crude palm oil, but had no significant effect on the free fatty acid content. These findings indicate that gamma-radiation may be used for preservation but not for sterilization of palm fruits.

B00016

LEE H K ;LEE K K. Production of ethanol and butanol by *Pichia stipitis* and *Clostridium acetobutylicum* from oil palm fruit bunch stalk acid-prehydrolysates. Programme Advisory Committee Meeting 9th, PORIM Bangi, March 20-25 1989. Bangi: PORIM, 1989. CP 00527

Clostridium acetobylicum and *Pichia stipitis* were investigated for their butanolic and ethanolic abilities when cultured on oil palm fruit bunch stalk acid prehydrolysates. A maximum ethanol concentration of 1.8 g/cc was obtained after 144h only 0.5 g/cc ethanol was produced under agitating conditions. Xylose utilization was better under agitating than static conditions.In contrast, the bacterium produced higher solvent concentration of 4.4 g/cc after 72h of fermentation. Xylose consumption was however incomplete. The physico-chemical method employed in hydrolysing the oil palm fruit stalk was found to be inefficient even through 23 g/cc of xylose were produced from an original 50 g N.W. starting material.

B00017

PRIOUX, G. Oil palm irrigation:PHCI's technical decisions regarding equipment and water management methods . In Oleagineux 1989 Vol 44(7) :337-340.

Because of the severity of the prevailing water deficit in the Dabou Savannah (Cote d'Ivoire), oil palm cultivation at PHCI can only be intensified using irrigation. Localised irrigation using diffusers has proved the most appropriate method. Theory and practice have shown that with adult trees, and with 2 diffusers per tree covering 30% of the total area, 70% of the evaporation from the class A pan should be applied every 3 days.It is essential to apply KCl in solution in the water

applied in order to meet the minimum requirement of the oil palms. Irrigation is controlled using a network of tensiometers and stomatal opening tests.

B00018

LUBIS A A ;LUBIS R A ;AKIYAT B N; NOIRET, J M. Preliminary results of the oil palm improvement programme at the Marihat Research Station(PPM). In Oleagineux 1989 Vol 44 (10) :463-465.

In 1974, the Marihat station launched a substantial oil palm improvement programme, based on a recurrent selection scheme. Available results make it possible to assess the hybrid value of parents from 7 tenera/pisifera populations and from different dura origins. Tenera between-population variability is considerable. The La Me' and Rispa populations have the best General Combining Ability (GCA). Given their high variability, the other populations provide interesting crosses, though fewer in number. Differences also exist with respect to vertical growth, susceptibility to crown disease and iodine value. Variation between dura origins is lower and the choice of origins is less crucial. Bunch number seems to be a predominant factor in the determination of oil production. These results enable parent GCA to be assessed. These parameters are used as a criterion for constituting an improved population. They are also exploited, along with Specific Combining Ability (SCA), in seed production.

B00019

IRHO. Weaning oil palm ramets. In Oleagineux 1989 Vol 44(12) :576-578.

Raising ramets to the stage where they are ready to be planted out includes a preliminary phase-weaning-which is intended to acclimatize them to natural conditions. This stage, which lasts not longer than 3 to 4 weeks, does not involve much extra cost, either in terms of equipment (easily constructed on site) or of personnel. Except for more consistent and regular fertilization in the prenursery, prenursery and nursery techniques are the same as those generally used for sexually produced material.

C. PALM OIL

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

C00017

YAP P H ;DEMAN, J M ;DEMAN, L. Crystallization characteristics of hydrogenated canola oil as affected by addition of palm oil. In JAOCS 1989 Vol 66(12) :1792-1795.

Addition of palm oil at levels of 5,10 and 15% to selectively and nonselectively hydrogenated canola oil increased the time of isothermal crystallization at 20°C and delayed the appearance of the isothermal crystallization peak as determined by DSC. The degree of supercooling was also increased. Addition of palm oil to canola oil before selective or nonselective hydrogenation decreased the time of the appearance of the isothermal crystallization peak. Rates of crystallization were determined in selectively hydrogenated canola palm oil mixtures which followed first order kinetics.

C00018

The palm oil challenge:Unfair practices. In Investors Digest 1989 12: 20-21.

Effective marketing strategies are a must for Malaysia to hold its own in a competitive international oils mart. Towards this end, research and development assume a critical role in generating new uses for palm oil.

C00019

NOOR AZIAN Morad; MUSTAFA KAMAL Abdul Azis; MOHAMAD Sulong; ABU SAFIAN Sabri ;BULIAM Ismail. Palm kernel oil leaching. Actes du Congres International "Chevreul Pour L'etude Des Corps Gras" Premier Congress Eurolipid Vol 3, Symposium of Malaysian Chemical

Engineers 5th, PWTC, Kuala Lumpur, June 6-9 1989. June 27-28 1989. In Premier Congres Eurolipid Vol 3:1115-1124 In Symposium of Malaysian Chemical Engineers:432-442 In Revue Francaise Des Corps Gras 1989 Vol 36(3-4):194. 665.1: 612.39 (063) ASS CP 00512.

This research is in its preliminary stage in which the efficiencies of the various methods of extraction were determined. The fundamental aspects of the process of extraction was also explored in an attempt to understand it better.Improved technique of analysis was investigated.To initiate the research it is essential to understand the process and develop correlations of the findings where possible for the bench and pilot scale extractor.

C00020

MUSTAFA KAMAL Abdul Azis; MOHAMAD Sulong ;NOOR AZIAN Morad; MOHD RADZI Ibrahim ;MOHD JEFRI Sharaai. Process modelling and simulation of crude palm oil refining. Symposium of Malaysian Chemical Engineers 5th, PWTC Kuala Lumpur, June 27-28 1989. In Symposium of Malaysian Chemical Engineers:422-431. CP 00512.

The paper discusses the development of a microcomputer process modelling simulation and flowsheeting program for palm oil distillation processes *i.e.* palm oil refining and fatty acids fractionation. The scope of this work encompasses the developments of the properties, estimation, short-cut design, rigorous design and flowsheet modules using a microcomputer spreadsheet program.

C00021

DAVIDSOHN, A. Modern production technology for fatty acid methylester: derived surfactants and soap. In Seifen de Fette Wachse 1988 Vol 114(15) :595-600.

The paper describes the production technology of using methyl esters for manufacture of detergent and soap. Palm oil was mentioned as a possible raw material. Information on production of methyl ester, alpha. sulpho methyl esters were provided. The production of soap by reacting methyl esters with alkali and also the production of alkanolamides by condensation are also described.

C00022

MD ALI A R ;EMBONG M S ;OH Flingoh C H. Simultaneous effect of component fats quality and quantity on cocoa butter extender. AOCS Annual Meeting, Baltimore, April 22-26 1990. CP 00532.

Binary blends of palm mid fraction (PMF) with Borneo tallow (IP), and PMF with sal stearin (SLs) showed eutectic behaviour. To produce cocoa butter extender(CBE) with steep melting profile and contain not less than 70% solid fat at 20 degree C, the maximum amount of PMFI (IV=49.2) and PMF2 (IV=39.8) that could be added to IP were about 10% and 33%, whereas the amount of PMF2 that could be added to SLs1, SLs2 and SLs3 were about 7%, 19% and 38%, respectively. Blend of PMF with iodine value of 37 of lower with IP could fulfill the above specification at any blend ratio.

C00023

ESKIN, N A M ;MALCOLMSON, L ; PIZYBYLSKI, R. Studies on the blending of canola oil with palm oil and palm olein. In INFORM 1990 Vol 1(4) :348.

Canola oil was blended with palm and palm olein and subjected to accelerated heat storage at 60 degrees C 12 days or exposed to fluorescent light (250±25 foot candles) at 40 degrees C for seven days. Sensory evaluation identified five odour characteristics including buttery, fruity, hay-like, fishy and painty. Of these, painty was found to increase consistently during storage, characteristic of rancidity development. Chemical indices of rancidity measured included TBA, peroxide value (PV) and hydroperoxide value (HV) all of which increased during storage. Blending of canola with either palm or palm olein

substantially reduced the development of rancidity as measured by chemical and sensory analyses. Confirmation of this was provided by measuring the total volatiles at the end of the respective storage periods.

C00024

NKPA,N N; OSANU, F C: AROWOLO, T A. Effect of packaging materials on storage stability of crude palm oil. In JAOCS 1990 Vol 67(4): 259-263.

Lacquered metal cans, green glass bottles, amber glass bottles, clear glass bottles and clear plastic bottles filled with freshly produced Nigerian crude palm oil were stored in direct sunlight (40 ± 1 degree C) and in the dark (27 ± 1 degree C). Assessment of the stability of the oils towards hydrolytic and oxidative deterioration was made periodically by measuring the free fatty acid, peroxide and anisidine values over a period of 98 days. The study showed that crude palm oil packaged in plastic bottles and clear glass bottles recorded higher total oxidation values than oils packaged in either lacquared metal cans or amber and green glass bottles. Lacquered metal cans gave the greatest protection against oxidation. Oxidation proceeded faster in cases where the packaging materials were stored in direct sunlight.

C00025

MS 817:1989. Methods of test for palm oil and palm oil products (first revision). Shah Alam, SIRIM, 1990.

This Malaysian Standard is the first revision of Malaysian Standard MS 817:1983. This revision incorporates a number of minor amendments and additional collection of test procedures suitable for evaluation of palm oil and palm oil products. These additional test procedures are to determine triglycerides, phosphorus, iron, copper, bleachability, deterioration of bleachability index (DOBI), soap content in acid oils, specific extinction in ultra-violet light, ash, total fatty matter, colour, cloud point, apparent density, and titer test.

The methods have been identified and adopted from various accepted standards. The basis of selection and adoption is suitability for palm oil products, ease of operation, practicality, good precision and reproducibility between laboratories. Modifications of standard test methods to cater for unique properties of palm oil products are based on intensive laboratory optimisation studies and interlaboratory collaborative trials.

C00026

SLS 720:1985. Specification for palm oil. Colombo, Sri Lanka Standards Institute, 1985.

This is the national standard specification for palm oil in Sri Lanka. The standard prescribes requirements and methods of sampling and test for palm oil derived from the fleshy mesocarp of the fruit of the oil palm (*Elaeis guineensis*) tree by the process of expression.

D. ENGINEERING AND TECHNOLOGY

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

D00010

MUSTAFA KAMAL Abdul Azis; MOHAMAD Sulong ;NOOR AZIAN Morad; LEE T T ;AZAM Ayob. The influence of plate and packed columns on the mass transfer of free fatty acids. Symposium of Malaysian Chemical Engineers 5th, PWTC Kuala Lumpur, June 27-28 1989. In Symposium of Malaysian Chemical Engineers:265-273. CP 00512.

Stream stripping of free fatty acids from oil and splitting of oil into fatty acids are the key processes in the Malaysian Palm oil and Oleochemicals industry. Both consume an enormous amount of high pressure steam to provide heat and vacuum; typically as much as 30% of the operating costs is due to steam consumption. Recently there has been a new impetus to use medium pressure and

temperature to strip and split fatty acids. This study investigates the mechanisms, mass transfer rates and efficiency of the steam stripping of free fatty acids and splitting of oil to free fatty acids as well the influence of plate and packed columns scale-up on the process.

D00011

YEONG S W ;MOHD JAAFAR Daud ; NANTHAKUMARAN, S. Effect of anti-mould agents on the quality of preserved decanted solid from palm oil mill effluent. In MARDI Research Journal 1989 Vol 17(1): 117-122.

Five trials were conducted to compare the effectiveness of commercial anti-mould agents on the prevention of mouldiness in partially dehydrated palm oil mill effluent (POME) which contained 20-30% dry matter. The anti-mould agent Mycostatin-20 was effective in checking mould growth but ineffective in preventing fermentation of POME. Sodium benzoate and benzoic acid at 2 g/kg level respectively were effective for these two functions. It is suggested that preservation should only be carried out with POME sample alone before being mixed with other feedstuffs. The feed mixture should be fed to animals immediately.

D00012

SIVASOTHY Kandiah. Automation of the sterilization process in a palm oil mill: A thesis submitted in fulfilment for the Degree of Master of Engineering Science Universiti Malaya. Kuala Lumpur, Universiti Malaya, 1989.

The advent of the microprocessor has provided the technological basis for far-reaching changes in automation. The literature review presented in the first part of this thesis highlights the impact of microprocessors on process automation. The review also elaborates on the control requirements of the sterilisation process in a palm oil mill and examines the features of some installed control systems. The research carried out was directed towards the development of a personal computer-based system for the control of the sterilisation process in a palm oil mill. Festo programmable controllers were used for direct digital control and an IBM-compatible personal computer system was linked to the programmable controller system and used for supervisory control and process monitoring. The system was installed and tested for a trial period of three months in a commercially operated palm oil mill which had a Taylor 460R analog control system. Software for the personal computer was written in Turbo BASIC with considerations given to achieving desirable user-characteristics and a software structure which would simplify the task of future sofware modifications. The programmable controller system itself was programmed in FPC-BASIC, an extended BASIC interpreter which combines common microcomputer functions with industrial control commands. Most of the effort was concentrated on developing and testing the appropriate software for the programmable controller and personal compurter systems.

Evaluation of the control system under actual operating conditions was attempted by comparing the factory throughtput and the percentage of unstripped bunches before and after the installation of the computer control system. The results were inconclusive because of modifications in process operating conditions introduced by the factory management during the course of assessment. The computer control system, however, facilitated closer monitoring of the process. Tests were carried out to compare time-based control (*i.e.* use of pre-set step times normally recommended by mill operators) with pressure-based control (pressure over-rides the pre-set step times to determine the completion of certain steps). It was found that a slight reduction in retention time is possible with pressure-based control. The project has demonstrated that a personal computer can be utilised for control of the sterilisation process. More attention needs to be given to the

reliability of the communication protocol between the personal computer and the programmable controller system which field trials have shown is sensitive to electrical interferences.

E. NUTRITION

Dietary Fats. Cancer and Carcinogenesis. Coronary Heart Diseases.

E00011

UNGER, Harlow. Poison pen paranoia. In Food Processing 1990 1 :39-40.

The anti-cholesterol craze has hit America's food processors which have had to re-formulate or stand accused of 'poisoning America by using saturated fats'.

E00012

BERGER, K G. USA confuses palm oil and palm kernel oil. In Asia Pacific Food Processing Packaging 1989 11 : 69-71.

Coconut, palm kernel and palm oil have been the subject of a sustained campaign in the USA for a number of years on the grounds that they are highly saturated fats and therefore injurious to health. The campaign culminated in late 1988 with full page advertisements of 'The poisoning of America' attributed to saturated fats, particularly to'the most highly saturated fats, coconut and palm oil' and showing photographs of food packages from major manufacturers, declaring one or other of these oils as an ingredient.

E00013

CHOO Yuen May. Palm oil carotenoids : Chemistry and role. Short Course and Workshop on Lipid Nutrition, PORIM Bangi, December 8-13 1989. Bangi : PORIM, 1989. In Short Course and Workshop on Lipid Nutrition:1p (Abst Only). CP 00514.

Crude palm oil contains the highest concentration of agro-derived carotenoids with a total concentration in the range of 500-700 ppm. It is the world's largest natural plant source of carotenes in terms of retinol (pro-vitamin A) equivalent. Carotenes, in particular beta-carotene which is present predominantly in palm oil, possess both pro-vitamin A and anti-cancer properties. It is also an efficient quencher of singlet oxygen and hence an effective anti-oxidant. The growing importance of carotenes has prompted re-investigation of carotenes in palm oil in terms of their chemistry and physiological activities. This paper, therefore, will cover various chemical aspects of carotenes including their occurrence, sources, methods of extraction and detailed analyses. Various presentations of palm derived carotene concentrate would be described. The importance of carotenes as anti-tumour agents for certain types of cancers would also be presented.

E00014

ONG Augustine S H. Lipid peroxidation, free radicals and degenerative diseases. Short Course and Workshop on Lipid Nutrition, PORIM Bangi, December 8-13 1989. Bangi : PORIM, 1989. In Short Course and Workshop on lipid Nutrition: 40p (Abst-Only). CP 00514.

This lecture covers the discovery of both stable and unstable free radicals exemplified by triphenyl methyl and methyl radicals respectively. The role of free radicals in organic reactions was deduced in 1937. An account of the properties and identification of free radicals is given. The free radical oxidation of lipids and free fatty acids is elaborated with particular reference to palm oil. The important role of antioxidants both natural and synthetic is discussed together with the synergistic effect of Vitamin C. The reaction of free radicals in biological systems is examined with emphasis on oxidation of LDL leading to atherosclerosis.

E00015

Malaysia defends its palm oil industry. In Asia Pacific Food Processing and Packaging

1989 10 : 6-11.

The position of Malaysia's palm oil industry, as the largest single exporter of edible oils and fats in the world, has been rocked by attacks by both the American Soybean Association and the American Heart Savers Foundation. In the aftermath of the whole bitter experience, which ended in July '89 the industry continues to present the facts (and the evidence) on the superior properties of palm oil.

E00016

Palm oil:Countering the ASA attack. In Malaysian Business 1988 1(1) :71.

The anti-palm oil campaign by the American Soyabean Association is a wasteful and futile exercise whose allegations can be disputed scientifically.

E00017

GOH S H ;HEW N F ;ONG Augustine S H;CHOO Yuen May ;BRUMBY, S. Tocotrienols from palm oil:Electron spin resonance spectra of tocotrienoxyl radicals. In JAOCS 1990 Vol 67(4) : 250-254.

The major vitamin E components present in palm oil, *viz.* α-tocopherol, α-, γ- and δ-tocotrienols, have been isolated and their structures verified by the NMR spectra of their acetate and succinate derivatives. Oxidation of gamma- and delta- tocotrienols with alkaline $K_3Fe(CN)_6$ gave isolable dimeric species, which were studied by ^{13}C NMR. Free radicals generated from the monomeric and dimeric tocotrienols were investigated using ESR spectroscopy. The distinction between antioxidant activity and antioxidant capacity of vitamin E isomers is discussed.

E00018

CLEMENS, M R ;LADNER, C ; EHNINGER, G ;EINSELE, H ;RENIN, W. Plasma vitamin E and betacarotene concentrations during radio- chemotherapy preceding bone marrow transplantation. In American Journal of Clinical Nutrition 1990 Vol 51(2):216-219.

Blood from 19 patients was examined for the essential antioxidants alpha-tocopherol and beta-carotene before, during and after bone marrow transplantation (BMT). Marrow ablation and immunosuppression for BMT conditioning was achieved by treatment with high-dose chemotherapy, mostly combined with total body irradiation. All patients required total parenteral nutrition beginning 1 wk before BMT. After conditioning therapy the concentration of absolute and lipid-standardized alpha-tocopherol and beta-carotene in plasma decreased significantly, presumably as a result of an enhanced breakdown of these antioxidants. The loss of these lipid-soluble antioxidants has to be considered as a possible cause for early posttransplant organ toxicity.

F. ECONOMICS

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

F00008

KLCE:Balmy palmy days are over. In Malaysian Business 1989 12(16-31):101-103.

The market remains in the doldrums. Prices are anticipated to fall through to the M$500 mark in the short-term, especially with end November stock figures expected to be worse than October's.

F00009

Figures which don't figure. In Malaysian Business 1990 1(1-15) :84-85.

Conflicting palm oil stock figures confound the market.

F00010

Downstream strategy for higher profits. In Asia Pacific Food Processing and Packaging 1989 10 :12-14.

Venturing downstream is the aim of every palm oil refinery exposed to the speculations and fluctuations of commodity pricing. More than five refineries in Malaysia has been very successful in this. Leading

manufacturer, Lam Soon (M) Berhad, describes its diversification plan, initiated more than three decades ago.

F00011

LIONG K T. CPO Futures:Signal to reverse. In Malaysian Business 1990 2(1-15):73-75.

The message to long position holders is to take the profit and run.

F00012

All's well at the farm. In Malaysian Business 1990 2(16-28):49-50.

Sensible & stable policies reap rewards for Malaysia's agro-based industry.

F00013

Geared for growth. In Malaysian Business 1990 2(16-28):25-27.

West Germany and Malaysia, long-time trading and investment partners, are set to increase co-operation.

F00014

Going nowhere fast. In Malaysian Business 1990 16-28 :73-75.

Conflicting signals contribute to a standstill in prices in the KLCE.

F00015

Plantation management:Plantations and development. In Far Eastern Agriculture 1990 1-2 :22-24.

While critics of plantations see them as enclaves owned or dominated by transnational corporations, offering poor conditions and low wages to their workers, and supporters see them as capital-intensive large farms, contributing vital foreign exchange, both images are partial and somewhat outdated. Many developing country governments now see plantations as positive assets, despite past misgivings. However, the prospects for estate expansion are constrained by the market outlook and competing demands for land.

F00016

Commodity:Is there a future for RBD. In/Malaysian Business 1990 3(16-31):72-73.

Interest in the new palm oil contract seems to be fading despite strong support from the KLCE.

F00017

BHATTACHARYYA, B. No threat to us. In Malaysian Business 1990 4(1-15):73.

Malaysia need not worry about India's move towards self-reliance in edible oils. As the industry grows in India there will be a greater demand for raw materials.

F00018

Tight trading range. In Investors Digest 1990 4 :26-27.

The bulls had a field day on the cocoa tin fronts on the KLCE last month, with price soaring to new highs. On the flip side of the coin, bearish factors and uncertainty in the palm oil sector kept prices down.

F00019

LIONG K T. Where's the oomph. In Malaysian Business 1990 5(16-31):62-63.

Even major events on the world soyabean market could not shake the palm oil price out of its narrow trading range.

F00020

NAYAGAM, James. Labour utilization and adjustments: A study of the Malaysian natural rubber industry: A thesis submitted in fulfilment of the requirements for the Degree of Doctor of Philosophy Universiti Malaya Kuala Lumpur, Universiti Malaya, 1990.

This thesis is concerned with the labour factor in the production of natural rubber (NR) in Malaysia. The specific ohjectives are to: (i) examine the continued dependence on labour intensive method of production, (ii) analyse the extent and causes of labour shortage, and (iii) consider and evaluate possible adjustments to labour supply and labour demand. Documentation of past research and development activities indicated

that they were mainly concerned in improving the productivity of land and trees rather than that of labour. This concern then was justifiable because of the continuous decreasing price and the formidable competition by synthetic rubber. Also, availability of labour then was not an issue. Analyses of data collected from sampled estates and smallholdings indicated that since late 1970s some of them faced labour shortage mainly due to the outflow of workers. In terms of additional workers required by the industry the percentage was comparatively low. However, the shortage is expected to deteriorate over time. Detailed computations and economic analyses showed that increasing labour supply by improving labour price and importing migrant workers provided limited scope in solving the labour shortage. On the other hand, the adoption of labour saving techniques would not only solve the problem effectively but also, enable growers to improve the workers' wage levels.

CORRIGENDUM

Elaeis Volume 1 No. 2 December 1989.
p. 135, B00011 should read

MOHD RAFIQ bin Norsham. Behaviour and movement of barn owls (*Tyto alba*) and rats (*Rattus* spp.) : A thesis submitted to Universiti Kebangsaan Malaysia in partial fulfilment of the requirements for the degree of Bachelor of Science with Honours in Zoology. Kuala Lumpur, Universiti Kebangsaan Malaysia, 1988.