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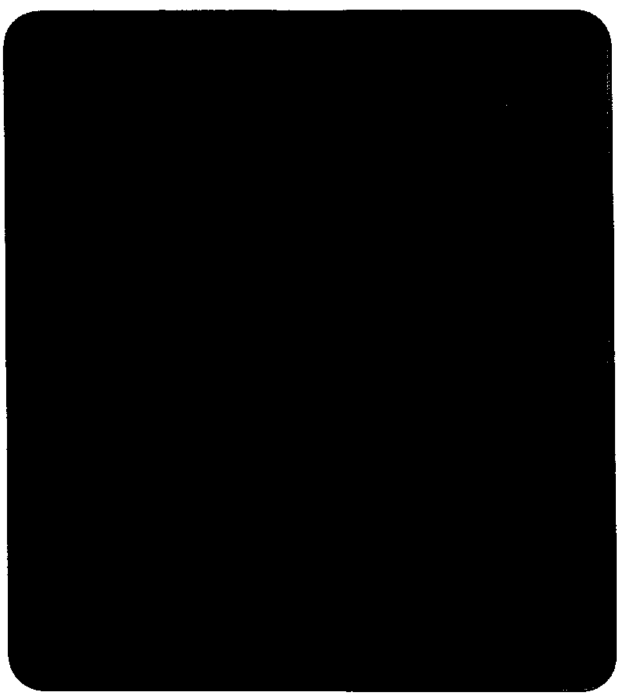
PRODUCTION TO REACH 7.8 MILLION TONNES IN 1995

Total Malaysian CPO production in 1994 was 7.2 million tonnes. The slight decline over the 1993 production is attributed, according to Mr. Chow Chee Seng of PORIM, mainly to cycle effects. He expected that Malaysia will produce 7.8 million tonnes of CPO in 1995, a substantial increase of about 8% over 1994, which is partly due to the increase in mature areas of about 3%.

Source: PORIM Bulletin No. 29



TOWARDS A GREENER PALM OIL INDUSTRY : ENERGY - ENVIRONMENT INTERACTION

by

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Over the last three decades, the agriculturally-based palm oil industry has developed into a major enterprise in Malaysia. Currently there are about 2.2 million hectares under oil palm and 272 palm oil mills producing crude palm oil and palm kernels for further processing by refineries, palm kernel crushers and oleochemical plants.

In 1994, the palm oil mills, besides producing 7.2 million tonnes of crude palm oil, also generated about 18.0 million tonnes of palm oil mill effluent (POME) which has to be treated, before discharge, to an acceptable level stipulated by the Department of Environment (DOE).

Over the last two decades, treatment and disposal methods have been successfully developed and employed by the palm oil mills to treat their mill effluent. Conventional biological systems depending on anaerobic and aerobic or facultative processes are used. If well operated and maintained, these processes are able to treat POME to the discharge standards laid down by the Department of Environment (*Table 1*).

Because of increasing public awareness of environmental problems and the deterioration of rivers, especially in catchment areas, the DOE has been compelled to impose more stringent discharge standards on the palm oil mills and other industrial installations. Zero discharge is mandatory in certain areas.

Over the last ten years, the concept of management of palm oil mill wastes has changed from treatment and disposal to beneficial utilization. POME has been found to contain valuable plant nutrients in substantial amounts (*Table 2*). When applied in a controlled manner to the soil in plantations, it can replace the usual fertilizers to a large extent, and it can also improve crop yield. Land application of POME has become a standard practice for mills that have plantations nearby. This has resulted in a substantial saving on fertilizer bills and increased income from the higher crop yield.

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TABLE 1. PARAMETER LIMITS FOR DISCHARGE OF PALM OIL MILL EFFLUENT INTO WATERCOURSES

Biochemical oxygen demand*(BOD_3 mg/L)	100
Suspended solid (mg/L)	400
Oil and grease (mg/L)	50
Ammoniacal nitrogen (mg/L)	150
Total nitrogen (mg/L)	200
pH	5 - 9

*BOD_3 - Sample incubated for 3 days at 30°C

However, this procedure is only practicable for plantation groups which have a large enough heactarage of oil palm in the vicinity of their palm oil mills, a condition met by about 30% of the 272 palm oil mills in the country. The rest of them are still relying on the treatment and disposal methods.

Biological treatment systems need proper maintenance and monitoring. They rely solely on microorganisms to break down the pollutants, and these microorganisms are very sensitive to the environment. Thus great care has to be taken to ensure that a suitable environment is maintained for them to thrive. This requires the attention of skilled operators and commitment on the part of management. Effluent treatment has always been regarded as a challenge to the industry.

The palm oil industry faces the challenge of balancing environmental protection, economic vitality and human welfare. There is an urgent need to find ways of preserving the great beauty of the country while keeping its economy healthy.

Growing awareness of the need to prevent pollution has obliged the palm oil producers to take a closer look at their plant operations. Process solutions that meet cost and performance requirements and minimize environmental impact are the preferred option.

Generally speaking, energy and the environment are inextricably intertwined issues, and this certainly applied in the palm oil industry. The production of energy by burning biomass (fibre and shell) is a significant cause of air pollution, but conversely, energy production from biomass can be a major solution to environmental problems.

TABLE 2. CHARACTERISTICS OF PALM OIL MILL EFFLUENT

Parameters		Mineral	
pH	4.7	Phosphorous	180
O & G	4 000	Potassium	2,270
BOD_3	25 000	Magnesium	615
COD	50 000	Calcium	439
TS	40 500	Boron	7.6
SS	18 000	Iron	46.5
TVS	34 000	Manganese	2.0
AN	35	Copper	0.89
TN	750	Zinc	2.3

All parameters in mg/L except pH

O&G - Oil and grease
BOD - Biochemical oxygen demand
TS - Total solids
COD - Chemical oxygen demand
SS - Suspended solids
TVS - Total volatile solids
AN - Ammoniacal nitrogen
TN - Total nitrogen

While profit is the primary objective of the oil palm industry, management must realize that environmental regulations are here to stay, and that if you pollute now, you pay to clean up later. It is often cheaper to prevent waste at source and save the costs of treatment and disposal.

This article discusses a possible system for solving environmental problems through effective energy production and management, which represents a potential business opportunity.

WATER REQUIREMENT AND WATER TREATMENT

Large quantities of water are required in the palm oil milling process. It is estimated that the processing of one tonne of FFB requires 1-1.5 tonnes of water, of which about 0.5 tonne is used as boiler feed water. The rest is used as dilution water, wash water, etc. About half of the water used ends up as POME. The other half is lost as steam mainly through sterilizer exhausts, leakages, etc.

Most palm oil mills obtain their water from natural systems like rivers and tube wells, and it normally contains a high level of dissolved and suspended solids and requires elaborate chemical treatment and purification. Depending on the quality of the water, the cost of chemical treatment varies from RM 0.30 to RM 0.50 per tonne of FFB.

POME is made up of about 95% - 96% water, 0.6% - 0.7% oil and 4% 5% total solids including 2% - 4% suspended solids which are mainly debris from palm mesocarp. Other characteristics are shown in *Table 2*.

An elaborate treatment system is required to reduce the BOD to an acceptable level for discharge. If the water and the solids could be reclaimed from POME, and made into marketable products, this would create a business opportunity for the industry or for venture capitalists.

EVAPORATION TECHNOLOGY FOR PROCESSING PALM OIL MILL EFFLUENT

Evaporation is one of the most widely used unit operations in the chemical processing industries. It is generally applied to remove water from aqueous solutions in a broad range of processing applications, for example :

- Concentration of products - preparing glycerine from sweetwater, making sugar concentrate (syrup) in sugar refineries, dairy industry.
- Recovery of chemicals.
- Concentration of residuals for incineration and heat recovery.
- Desalination of brackish water or sea water.
- Production of natural rubber serum concentrate.

The Evaporator Pilot Plant

An evaporator pilot plant was installed at a palm oil mill for evaluation. A flow diagram of the pilot plant is shown in *Figure 1*. It consists of a single effect evaporator, of 200 litre capacity; the partial vacuum (600 mm/Hg) required is created by water jet, the corresponding boiling point of water is about 60^{o}C.

POME is collected in a holding tank. It enters the evaporator system (by suction) through a plate heat exchanger which is heated by steam from the palm oil mill. The temperature of the feed is maintained at 80^{o}C.

The evaporation process was operated batchwise and controlled by two level sensors at the 60- litre and 30-litre levels. At the commencement of the batch, when the vacuum and feed temperature had reached 600 mm Hg and 80^{o}C respectively, 60 litres of the POME entered the evaporator via the plate heat exchanger. Because of the big temperature gradient, vapourization began immediately. The liquor in the evaporator was recirculated continuously via the same heat exchanger.

When the liquor in the evaporator dropped to the 30- litre level, fresh POME was admitted. This was effected by means of the level sensors. The process was repeated until the solid concentration of the liquor in the evaporator had reached a pre-set level, e.g. 30 percent. The solid concentrate was then discharged and a new cycle would begin.

Samples of distillate and solid concentrate were collected for analysis. The distillate was analysed for pH, total solids, suspended solids, biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammoniacal nitrogen (AN), total nitrogen (TN) and oil and grease (O & G) according to standard methods. The solid concentrates were analysed for total solid content, moisture content, and potassium, magnesium, phosphorus, nitrogen, amino acids, etc., according to standard methods.

ANALYSIS OF RESULTS

Quality of Distillate

The POME used for the pilot plant trial contained about 3.3% total solids. The solid concentrate produced contained about 20%- 30% solids. In other words about 85% of the water had been distilled off. At the pilot plant, the distillate was recovered and recycled.

The high quality of the distillate collected at the end of the

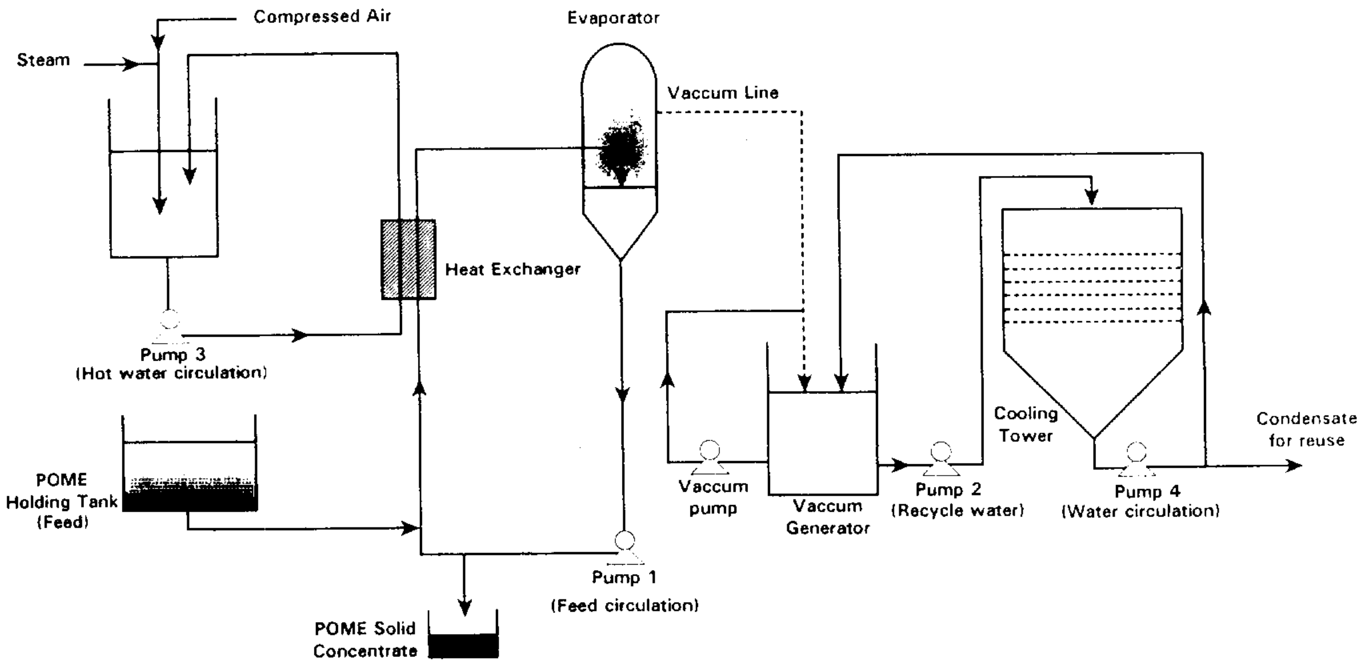

Figure 1. QUICK-EVA Process for Palm Oil Mill Effluent Treatment (A Zero Discharge Process)

run can be seen in *Table 3*. Certainly it can be reused as process water or boiler feedwater with minimum chemical treatment.

For a palm oil mill processing 30 tonnes FFB per hour and generating about 19.5 tonnes of POME, an 85% recovery means that 16 tonnes of water are recovered for recycling. This would be sufficient to meet the requirement for boiler feedwater and could therefore reduce the water intake from the usual outside source.

Solid Concentrate

The single-effect pilot plant scale evaporator can produce a concentrate with a 20% - 30% solid content. It is envisaged that with a commercial plant using a multiple-effect evaporator system, a concentrate 30% solids could be achieved without much difficulty.

Utilization of Solid Concentrate

For a palm oil mill processing 30 tonnes FFB per hour, the volume of solid concentrate (20% solids) obtainable amounts to about 3.2 tonnes per hour as compared to 19.5 tonnes of POME. Thus there is a significant reduction (84%) in volume. Of course, a higher solid concentration corresponds to a lower liquid volume. The concentrate is much easier and simpler to handle even if only for disposal.

Currently all the palm oil mills have constructed their own POME treatment plants; these all have ponds for specific functions. If liquid effluent were replaced by solid concentrate, these ponds could be used to contain the concentrate and there would be virtually no discharge. The solid could be used later when required as fertilizer as is now being practised.

TABLE 3. QUALITY OF DISTILLATE

Appearance	Clear to slightly turbid
pH	5 - 6
Chemical oxygen demand (mg/L)	100
Biochemical oxygen demand (mg/L)	20
Total solids(mg/L)	150
Suspended solids(mg/L)	10
Oil and grease (mg/L)	10
Ammoniacal nitrogen (mg/L)	6
Total nitrogen	20
Iron	Not detectable
Phosphorus	Not detectable

TABLE 4. NUTRIENT ANALYSIS OF SOLID CONCENTRATE FROM EFFLUENT

	Wet Basis (%)	Dry Basis (%)
Total nitrogen	0.41	2.07
Ammoniacal nitrogen	0.03	0.15
Total phosphorus (P_2O_5)	0.19	0.96
Water soluble phosphorus(P_2O_5)	0.15	0.76
Total potassium (K_2O)	1.29	6.51
Total calcium (CaO)	0.023	0.12
Total magnesium (MgO)	0.396	2.00
Total manganese (MnO)	0.003	0.015
Total iron	0.007	0.035
Total sodium	0.004	0.020
Moisture	80.0	

The solid concentrate contains a high level of plant nutrients, especially nitrogen (N), phosphorus (P) and potassium (K), as shown in *Table 4*. It is a good feed material for the manufacture of fertilizer and in fact granular fertilizer has been successfully produced from it by Yokohama Rubber Co. Ltd. of Japan in small scale experiments. In order to produce a balanced fertilizer, other ingredients will have to be incorporated. The effect of the fertilizer on crops will be evaluated. From the field trial, it appears that the small amount of oil in the solid concentrate did not affect the making of the fertilizer. The solid concentrate also contains about 13.5% of protein and some amino acids. Thus it might be used for making other value-added products like animal feed, or as a feed stock for fermentation.

ENERGY CONSUMPTION

The energy requirement is the major consideration in the evaporation process. It is envisaged that the heat energy required can be provided by steam and electricity from the palm oil mill. As the fresh POME discharged from the palm oil mill is at 80^{o}C - 90^{o}C, little additional heat is required, but the electrical energy requirement may be quite high. Under standard conditions, the specific energy consumption is taken as one (*i.e.* one kg of steam per kg water evaporated). In recent years, significant advances have taken place in evaporation technology to reduce the energy consumption. A modern evaporator design is able to give a specific energy consumption of 0.1. This can be achieved by increasing the number of evaporators and by efficient thermal vapour recompression. Of course, more evaporators mean higher investment costs. An evaluation of the cost-effectiveness of an evaporation system for palm oil mill effluent is being carried out.

It is well known that all the palm oil mills are self-sufficient in energy, obtained by burning fibre and shell. In fact there is an excess of these solid by-products, which have to be disposed of separately, and this often poses environmental problem. Empty fruit bunches, (EFB) constitute another by-product which has attracted much critical attention because of the emission of white smoke when it is incinerated by the current process. This white smoke, though it actually consists mainly of water vapour, is aesthetically, unacceptable. The Department of

Environment discourages the burning of empty fruit bunches, especially by new establishments. The EFB is a potential 'free' energy source. Thus it is envisaged that the energy demand of the evaporation process could be met without much difficulty. For those palm oil mills with excess boiler and electrical energy generating capacities, the additional investment required would be minimal. It is also well established that if a boiler using solid fuel is operated at about 70% capacity, the black smoke emitted by the boiler will be well below the acceptable minimum level.

CONCLUSION

With the incorporation of the evaporation technology into a palm oil mill to process the effluent, the mill could achieve a closed loop system and there would be no discharge of liquid effluent. This innovative process offers a long-term solution for environmental problems through effective energy management. POME should be considered as a valuable resource, and resource recovery is a much more desirable alternative, from an environmental perspective, than treatment and disposal. The distillate from the evaporation process can be recycled as boiler feedwater with minimal treatment or used as process water with no chemical treatment. The solid concentrate can be used for making fertilizer or other saleable products. Thus there are benefits and business opportunities for the industry if processing POME is considered part of the palm oil production process.

RESEARCH HIGHLIGHTS

Additives to Overcome Cloudiness of Palm Olein

Clear cooking oil is more preferred by consumers especially for use as salad oil. Palm olein loses its clarity because of crystallization at lower temperatures. A study by Dr. Noraini Idris and co-workers indicated that the use of additives could delay the crystallization effect of palm olein so that higher percentages of it can be incorporated in salad oil. The study showed that Famodan TS and Kemest S65K (at level of 0.10%) promoted crystals at temperatures of 15°C and below but delayed crystallization of palm olein at temperature of 20°C. THL-9 showed the best result among other additives investigated. It delayed crystallization at all tested temperatures i.e. 5°C, 15°C and 20°C, and when used at 0.10%, the cold stability of palm olein (IV 56) was improved very significantly from 24 hours (control) to 29 days. However, for higher IVs (60, 65) there was no significant difference of anti-crystallization efect between 0.01% and 0.10% of THL-9 used. At 20°C, 0.01% THL-9 delayed crystallization of palm olein (IV60) up to 53 days while 0.10% THL-9 delayed the crystallization up to 60 days. For palm olein (IV65), all other additives studied (Famodan TS, 565K, THL-3, Lecithin) delayed crystallization of olein at 20°C and in fact, except lecithin, the oil remained clear for more than 180 days at concentration of 0.10% of the additives. However, lecithin also delayed crystallization of palm olein (IV65) significantly for more than 150 days.

Source : ELAEIS 5(1)
Contributed by Johari Minal

Control of Bagworms and Nettle Caterpillars Using *Bacillus thuringiensis*

The use of *Bacillus thuringiensis* as a biocontrol agent needs to be considered because it has many advantages compared to chemical insecticides; it is toxic only to the target insect and is generally harmless to natural enemies, man, fish and livestock. However, *B. thuringiensis* has not been successfully applied in the field against nettle caterpillars and bagworms. Together with his team Dr. Mohd Basri Wahid an entomologist at PORIM, conducted studies on the use of *B. thuringiensis* and discovered that the low success rate may be due to the lack of studies involving screening and the establishment of dosage-response curve for each target pest, from which suitable product and appropriate field application rates could be recommended.

For the purpose of biological control, a mortality of 75% would appear sufficient to reduce the pest population. However, laboratory studies on bagworms for example showed that this is not so. The concentrations of *B. thuringiensis* recommended by manufacturers against *M. plana* may not be suitable either. A large dosage, up to 28 times for certain products, need to be used. This would result in higher cost and is therefore economically not feasible. Dr. Basri suggested that the causes for this lack of effectiveness be investigated. In addition to the commercial preparation, local strains of *B. thuringiensis* should be investigated for the control of bagworms.

Source : ELAEIS 6(2)
Contributed by M. Nasir Basri

APPETIZE – A NEW DESIGNER FAT

A patent has been issued to Brandeis University for 'Appetize', a new group of 'designer fats' based on a combination of animal fat and vegetable oil. The product was developed by Dr K.C. Hayes. 'Appetize' is claimed to have a good flavour and superior texture with none of the cholesterol found in animal fats nor the trans fatty acids created in partially hydrogenated vegetable oils. The product can be substituted for hydrogenated vegetable oils as well as dairy and animal fats in frying, baking, spreads and imitation dairy products. It is said that 'Appetize' will be priced competitively with partially hydrogenated soyabean oil in the USA. There is an arrangement to combine the results of PORIM Nutrition research to commercialise the applicability of appetize.

Contributed by M.A. Jaaffar

Is Age Catching Up On The Oil Palms ?

The declining palm oil extraction rate (OER) has been worrying the oil palm industry for the last couple of years. A seminar was held in December 1993 to specifically discuss this issue.

The main culprit identified by the seminar was the uncollected loose fruits. Other seasonal and environmental effects were also noted.

Mr. Chow Chee Seng of PORIM studied annual data of oil palm planted areas since 1960 and observed that age of oil palm could affect OER. He noted that the average age of mature areas decreased in the 60s to a minimum of 8.6 years in 1973 due to increasing new planting and then rose to 9.5 years in 1980 and 11.3-11.7 years in 1986-87, around which age the oil palm normally gives the highest yield. The average age was 13.3 years in 1993 and is expected to be 15.3-17.5 in 2000-2010. This may imply that on average, the oil palms in Malaysia had reached the maximum productive age of about 12 years in 1988 and began declining since then.

TRANSGENIC OIL PALM BY 2010

Effort are currently directed towards the development of tools and techniques necessary for genetic engineering of oil palm, for the production of oil high in monounsaturates. In order to achieve the above, the oleic acid composition of the palm oil should be more than 60%, while the palmitic acid content should not exceed 25%. The high oleic acid content should facilitate the palm oil industry in the following aspects:

i) diversification of its uses by entry into the liquid oil market
ii) source of oleic acid feedstock for the oleochemical industry

The programme involves two phases, i.e. the development of tools and techniques necessary for the genetic engineering of oil palm and the implementation of the genetic programme as a whole.

The palmitic acid content in oil palm is higher than in any other oil bearing crop accounting for 44% of the total fatty acid composition. Although palmitic acid is a saturated fatty acid, research has shown that it does not cause a rise in cholesterol level. Only fatty acids such as myristic and lauric cause a rise in the cholesterol level. Palm oil economic value can be enhanced if the palmitic acid content is reduced and the oleic acid content increased.

To modify the fatty acid composition of oil palm, the pathway for fatty acid biosynthesis has to be understood. Although the general fatty acid biosynthetic pathway is known, the regulation of the pathway is not fully understood. Palmitic acid is first synthesised by a series of enzymes known as fatty acid synthase (FAS). The number of carbon atoms in palmitic acid is then increased to form stearic acid, which is eventually desaturated to form oleic acid. The fatty acid biosynthetic pathway is thought to be the same for all crops although the composition of fatty acids differs. The different crops must have different regulatory mechanisms for producing the oils unique to various crops.

The first requirement for modifying the fatty acid composition was to identify and purify the enzymes responsible for producing high palmitic acid in the oil palm mesocarp. After the enzymes are purified, the gene sequence responsible for their production can be identified. The gene sequence that can be modified by inserting suitable foreign genes, which can alter the pathway to produce more oleic acid and reduce the palmitic acid content in the tissue. The investigation at PORIM has shown that two principal enzymes contributing to high palmitic levels in the mesocarp are acyl ACP thioesterase and ß-keto acyl ACP synthase II. Both enzymes have been purified. The genes (target genes) for these two important enzymes will then be isolated.

In order to manipulate for oil quality one has to ensure that the target genes are expressed at the right rime and place. Since we aim to manipulate mesocarp oil, the introduced gene has to be expressed in the mesocarp and not for example in the leaf. It also has to be expressed during oil synthesis. Thus temporal and mesocarp specific genes have to be identified. Acyl carrier protein (ACP) which is a cofactor involved in fatty acid biosynthesis was chosen as the temporal marker. Two ACP genes and eight mesocarp specific genes have been putatively isolated and are being characterised.

Transformation is a method of introducing foreign genes into a system. Stable transformation is a prequisite for genetic manipulation. It would be impossible to introduce a foreign gene into oil palm without a suitable transformation system.

A plant which has been inserted with a foreign gene is known as a transgenic plant. The first transgenic plant appeared less than 10 years ago, and since then more than 50 plant species have been transformed. Plants resistant to pest and producing fruits with long shelf life have been successfully produced through genetic engineering.

Several techniques have been introduced to produce transgenic plant, with the most popular being particle bombardment. In this technique, DNA is placed on a microprojectile and shot into the tissue. Several plant species like rice and corn have been successfully transformed using this technique. A transformation technique employing pollen has also shown encouraging results in corn and tobacco. Transformation can also be achieved by inserting the foreign gene into the Ti-plasmid of Agrobacterium tumefaciens (a micro-organism), which then can integrate with the genome of a particular plant.

Technology involved in transformation is progressing rapidly with the development of new techniques taking place. At present optimization of transformation techniques to produce a transgenic oil palm tree is being carried out at PORIM and several local universities.

It is envisaged that the first transgenic oil palm will be field planted by the year 2010.

Contributed by Dr. S. Ravigadevi

IN BRIEF

MEXICAN LABELLING RULES

- The Mexican Ministry of Commerce has proposed new labelling and packaging regulations for imported goods. The new rules would require Spanish labelling for all products imported into the country, effective early 1995.

  The Biscuit & Cracker Manu-facturers' Association of the USA, which would be most affected by this proposed ruling, has asked the Mexican authorities to reconsider the labelling requirement. At present, Spanish language stickers are allowed on goods imported by Mexico that are produced in the USA and labelled in English.