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Newsletter BERITA ISOPB

THE INTERNATIONAL SOCIETY FOR OIL PALM BREEDERS

PERSATUAN AHLI-AHLI PEMBIAK BAIK KELAPA SAWIT ANTARA BANGSA

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EDITORIAL

In the 1987 International Oil Palm Conference in Kuala Lumpur, a geneticist, from abroad and from another crop, remarked that there were two apparent different approaches in oil palm breeding, from observations on the papers presented and discussions. One group emphasised use of crop physiological parameters in improving yield selection efficiency, while the other group used the more traditional breeding approach of selection, hybridisation, evaluation and selection emphasising mainly yield. PORIM, which evolved from OPGL tended to be influenced by the former group which then led to the hiring of Dr. Geoff Squire for three years to work on the physiological aspects of crop productivity in oil palm. Squire did quite a bit of work, especially with existing data, concentrating on the parameter e or conversion efficiency. He wrote his report and left. Dr. Ian Henson was recruited to replace him.

Before Dr. Henson drew up his research programme, it was felt that it would be useful to get some feedback from the researchers in the industry and from other research institutes on the impact of Dr. Squire's work and the usefulness of crop physiology research in oil palm agronomy and breeding, and to seek new directions, if any. The PORIM Workshop on Productivity of Oil Palm was held at PORIM on May 27, 1989, with these objectives in mind.

Dr. Henson's report on this meeting is featured in this Newsletter.

Many of us tend to view the importance of the oil palm crop in terms of the edible vegetable oil, the palm oil. In fact, oil palm plantations had their origin not for demand for edible oil but for soap making. This is the first industrial (non-food) use of the oil from the oil palm. Today, of course, palm oil is refined and broken down into various components and used mainly in the sophisticated food industry. There are also non-food uses of palm oil e.g. soaps, fuel and others being researched.

The palm kernel oil is a richer source of oleochemicals for industrial (non-food) applications, although it has also food uses. The oleochemical industry has become such a sophisticated and important industry that the marketing officers in some plantation groups have suggested to their breeders, to concentrate more on the kernel oil than the palm oil in their breeing programmes.

Included in this Issue are two write-ups on the industrial applications of oleochemicals, extracted from the Fats & Oils International magazine.

Feature Articles

A. Report of PORIM Workshop on "Productivity of Oil Palm"

This meeting was held at PORIM HQ, Bangi on 27th May 1989 with the aims of:

(i) reviewing the background, principles and methods for evaluating productivity in oil palm;
(ii) discussing the value of different methods;
(iii) identifying areas for future research.

The workshop was attended by over 30 people including physiologists, breeders and agronomists from PORIM, MARDI and the Malaysian Oil Palm Industry. Five papers were presented dealing with concepts and methods of measuring, modelling and analysing productivity. The papers were followed by a general discussion. The meeting was chaired by Dr. K. Paranjothy (PORIM).

In the introductory paper "Analysis of crop productivity – some basic concepts", Dr. Henson (PORIM) outlined general ideas underlying modern analyses of productivity with emphasis on the interception and efficiency of use of crops of solar radiation, an approach first applied systematically to oil palm by Squire (1985). The key factors in this analysis are outlined in Figure 1 which shows how productivity may be viewed as dependent upon incoming radiation, canopy characteristics and basic physiological processes. This is of necessity a simplistic analysis as it neglects other environmental constraints, but has nevertheless proven a useful first step.

Of course, even such a limited analysis would not be possible at all were it not for the development and application of appropriate methos for assessing crop dry weight and leaf area; by no means an easy task with a perennial tree crop. These non-destructive techniques, developed in Malaysia by Corley, Hardon and co-workers were reviewed by Chan Kook Weng (Guthrie, Chemara) in the second paper of the workshop, entitled "Measuring oil palm productivity – present methods". The methods have been widely used in trials conducted in Malaysia and elsewhere and are the means whereby nearly all present data on vegetative growth have been obtained. Mr. Chan evaluated the usefullness and reliability of the techniques in terms of variability, repeatability and heritability of the characters. It was demonstrated that vegetative characters were less variable than yield and consequently plot sizes and levels of replication adequate for distinguishing yield differences should also suffice for vegetative differences. The use of vegetative characters as selection criteria in breeding was discussed.

Improvements in instrumentation now make it possible to routinely measure gas exchange of individual leaves in the field. Yusoff Abdullah (MARDI) described results of such measurements in crops such as rice and cocoa. Sampling variability remains a problem in such studies but with the equipment now available it is becoming possible to evaluate directly the basic processes of photosynthesis and respiration which underlie productivity.

Nonetheless, most such measurements are restricted presently to very small areas of crop surface. Added to this is the very dynamic nature of gas exchange processes and their extreme sensitivity to variations in microclimate. More useful would be a means of determining the gas exchange and hence carbon balance of the whole canopy on a diurnal, weekly or even seasonal basis.

In the absence of a massive phytotron, the interim answer seems to be in the use of models. Some quite elaborate canopy photosynthesis and crop growth models have been developed and validated for annual crops, notably by Dutch workers at Wageningen, and these are now beginning to be applied to perennials including oil palm (e.g. Kraalingen *et al*, 1989; Dufrene, 1989). Dr. Henson (PORIM) described a modelling excercise including a Wageningen-type canopy photosynthesis model which is linked to routines for calculating radiation – dry matter conversion efficiency (*e*), and yield, of small differences in photosynthetic properties (determined at the single leaf level), or to evaluate consequences for productivity of variation in radiation levels or leaf area development. The models can also be used to estimate respiratory losses and to give values for potential productivity.

The application of the radiation analysis approach to oil palm by Squire (1985) resulted in considerable emphasis being given to the value of 'e'. This was largely because the other major determinant of radiation use, fractional interception of the incoming radiation (f), did not vary much in the trials analysed by Squire. Generally, mature oil palm plantings can be expected to intercept a high proportion of the available radiation throughout the year. Variation in productivity is thus mostly a reflection of variation in 'e' and in several breeding programmes '*e*' has been found to vary significantly between progenies. In the last paper of the Workshop, K.C. Chang and V. Rao (PORIM) 'threw a practical spanner in the works' by questioning the need to measure or consider *e* as such, when in most cases, they argued, *e* can be equated directly with total dry matter production (DMP), due to f and f × S (where S = total radiation) being effectively constant. Further, the high correlation between productivity and '*e*', as found by Squire (1985), was not surpising in view of the large element of autocorrelation involved, as:

$$e = DMP/f \times S$$

They went on to show that equally high correlations could be obtained by substituting random numbers for real data, and for data from a heterogenous breeding population with low bunch index there was no preferential association between *e* and bunch yield. The implications are that it may be sufficient for the breeder to consider DMP alone rather than expand extra effort in evaluating '*e*'. This, of course, is a debatable point about which not all physiologists or even breeders would concur. Nevertheless, the presentation was an object lesson in the need to examine and appraise critically the new concepts and approaches.

In the General Discussion it was pointed out that previously, analysis of yield (Y) had been restricted to considering it simply as a function of P, the partition coefficient and CGR, the crop growth rate; i.e. Y = CGR × P.

Introducing the relationshop: $Y = S \times f \times e \times P$ where S = solar radiation (or PAR; photosynthetically active radiation) and f = fractional interception, permitted a more detailed analysis particularly as f, *e* and P are largely independent of each other (see Figure).

The question remains as to whether the components in this analysis are being determined with sufficient accuracy in trials.

Considering first, vegetative dry matter production (which is needed, together with yield, to obtain P). While current methods of assessing DMP appear reliable, it is likely that certain of the formulae, e.g., that relating petiole cross-section to frond dry weight, may not hold for all progenies, palm ages, or sites. Hence, new relationships may need to be established in particular cases, especially to take into account newly introduced planting materials.

Secondly, S. This component is not usually a problem as it it easily measured. However, assumptions of a constant value are common, and could introduce error especially when comparisons are made between different sites or years.

Thirdly f. This is seldom directly measured, being derived from leaf area index (LAI) via standard formulae, e.g. $f = 1 - \exp(-K \times LAI)$ where K, the extinction coefficient, is generally assumed after Squire (1985) to be 0.47.

However, there is evidence that K may vary with palm age and site (some examples are given in Table 1; see also Kraalingen *et al*, 1989). K depends on leaf orientation and canopy structure and hence could also vary with genotype. This could account for some differences in '*e*' found between progenies.

Because of such assumptions in the analysis, apparent variation in '*e*' could be due to variation on characters from which '*e*' is derived rather than '*e*' itself. More detailed and precise measurements are needed to obtain "true" estimates of '*e*', particularly when comparing progenies of diverse origin.

Another uncertainty concerns the relationship between '*e*' and yield. Present yield models predict that a given increase in '*e*' should have a greater impact on Y than changing any other character. This is because any increase in DMP with '*e*' is assumed to be partitioned entirely into bunches. Y should be positively correlated with '*e*' but V (vegetative DMP)– should not. This was shown to hold in several cases except where density is varied or, as in Chang and Rao's data, where P (i.e. bunch index) tends to be low.

However, it was also considered that Y versus *e* correlations were not of primary importance in selection strategy. It might be more effective to select firstly for high *e* (and hence high DMP), and then aim subsequently to combine this with high P.

Further work is obviously warranted to resolve these issues and breeders need to be rather cautious in their use and assessment of physiological characters.

Work is also needed in understanding how and why *e* (or its components) varies, and why it is low in oil palm compared with other crops. This could best be done by studies of gas exchange.

It was stated that previously established differences between progenies in photosynthetic rate in the nursery were not evident after the palms were established in the field. Field palms may be source-limited, in contrast to nursery palms. Further work needs to be done on this aspect.

Work on other crops has shown that it is possible to select for lower respiration rates. There should be no negative effects of lowering maintenance respiration, and as this constitutes the major loss of carbon by the palm this aspect is important.

High '*e*' on some sites, such as those with a high water table or dense planting, could be due partly to lower carbon allocation to the root system. Excessive root growth in other situations could lower 'e'. This also needs checking.

In an impromtu yet incisive summing up of the meeting, Mr. B.J. Wood (Ebor Research, Sime Darby) pleaded the case for physiological studies to complement ongoing agronomic research to an equal or perhaps even greater extent than that of breeding. Clearly, the physiologist has supporting roles in both spheres and the purpose of the meeting was well served if it succeeded in defining these a little more sharply.

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I.E. Hensen
Palm Oil Research Institute of Malaysia.

Table 1: Values of the extinction coefficient (K) determined for oil palms in different experiments.

Material and location	K	Reference
Nursery palms, Malaysia	−0.72	Squire, 1984
4 year oil palms; density trial, Malaysia		Squire, 1983
Seedling palms	−0.54	
Clonal – Clone 975	−0.65	
3-15 year old palms, density and pruning	−0.47	Squire, 1984
experiments, Malaysia.	−0.47	Squire, 1984
10 year old palms, Malaysia	−0.44	Corley, 1976
9 year old palms, 120 ha^{-1}	−0.47	Gerritsma,
16 year old palms, 56 ha^{-1}	−0.24	1988
both in PNG		
Commercial plantings, PNG		
7 year old palms	−0.34	Breure, 1988
9 year old palms	−0.47	
13 year old palms Cote d'Ivoire	−0.40	Duffrene *et al.*, 1989

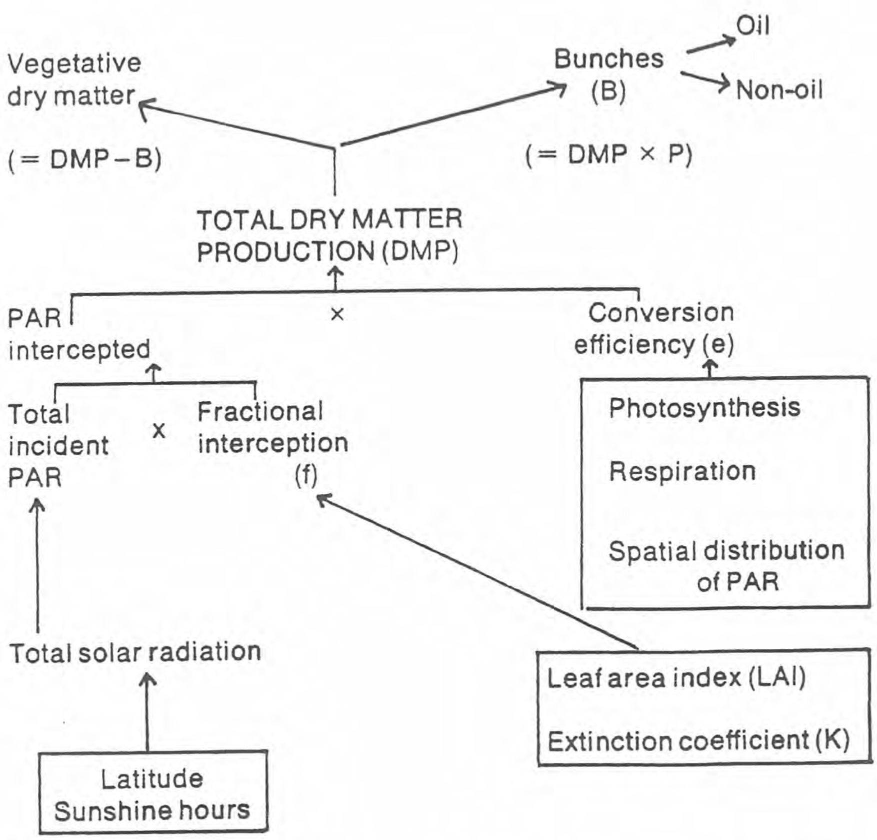

Figure 1 – Analysis of growth and yield in terms of the utilisation of solar energy by oil palm

B. The Soap Story – The Detergent Industry

One of the early large scale uses of oils and fats was the production of soap by the saponification of natural fatty acids and soda. William Hesketh Lever (Unilever) began the foundation of palm oil plantations in Asia at the beginning of the century to provide a raw material supply for the growing soap industry in Europe at that time. Historically, soap has been made almost exclusively from natural oils e.g. palm oil and fats e.g. tallow.

Soap has the major disadvantage of precipitation in hard water, necessitating efforts to remove it. With the advent of early washing machines in the U.S., the synthetic detergent industry began with the development of light duty products for household washing which would not precipitate scum in hard water.

In the 1940's Procter & Gamble introduced Tide and Dreft, detergent products based on sulphates of fatty alcohols derived from natural oils and fats. By early 1950's, the cheap availability in the U.S. of petrochemical products e.g. dodecylbenzene led to a second wave of more powerful products which were based on sulphonates of benzene derivations and so-called detergent builders e.g. sodium tripolyphosphate.

In 1960's, with environmental concern over the pollution of public water courses with detergent foam which would not break down at sewage treatment works the non-biodegradeable alkylkenzene sulphonates was replaced by biodegradeable linear alkybenzene sulphonates (LAS) based detergents. By about 1970's synthetic detergents constituted about 85% of the total volume of soap and detergent market in the U.S., 75% in Japan and with similar developments in W. Europe.

Although the detergent industry market in the developed countries is very mature, changes still occur. One main area is in the decline in usage of LAS products and the growth in products based on detergent alcohols, derived from natural oils and fat or mineral oil. The change is principally because of public concern with the environment and energy costs as well as demographic changes i.e. increasing demand for cool temperature laundering and convenience products.

The three major derivatives of detergent alcohols are the alcohol sulphates (AS) e.g. lauryl sulphate, alcohol ethoxylates (AE) and alcohol ether sulphates (AES). AS and AES work similarly as LAS and are anionic surfactants. AE is a nonionic surfactant which can be used alone or in conjunction with other types of active ingredients, permitting a great variety of formulations and multi-acting products.

Over recent years, AE has become the backbone of the modern powder industry and is used extensively in heavy duty application and in commercial laundry formulations as well as in cosmetics and pharmaceutical products. AES represents the newest range of products which have undergone the highest growth rate recently.

LAS and AE dominate the large volume detergent market with LAS still the largest product in volume terms. However, the consumption of alcohol based products represents roughly twice the value of LAS based products.

Over the past decade, LAS based detergents are falling into disfavour because of difficulties with the detergent builders e.g. sodium triplyphosphate (STPP) were required to counteract the effects of hard water. Concern over the eutrophication effects of phosphate in water led to a search to replace STPP, which has not been fruitfull.

New detergent formulations based on AE operate at low temperatures without the need for building. AES products are often employed to enhance solubility effect of LAS and AE and are usually used when enzymes are incorporated into laundry formulations. Modern detergents based on alcohols are complicated formulations having high efficiency with low foam, tolerant to hard water (even sea water) stable in the presence of enzymes and capable of being totally effective in short washing times. Above all they are becoming one-shot multi-acting duties, combining the basic laundering operation with fabric conditioning bleaching and enzyme stain removal.

Detegent alcohols can be manufactured either from natural oils and fats or from a petrochemical feedstock, principally ethylene. The choice of source by the producer, although can be dependent of his plant design and product range, is much dictated by relative cost. For the past several years mineral oil prices have been weak. Currently mineral oil futures appear to be set firm again thus giving added interest to the use of natural oils once again.

Extracted fro. Oils & Fats International Issue Two

C. Specialty Uses of Oils & Fats

Outside the edible oil, bulk soap and detergent markets, natural fats and oils are used in a very wide range of applications. For some of these applications, vegetable-based oils can be used directly after extraction/refining without recourse to further chemical processing, to create a range of derived products called oleochemicals.

As direct uses, palm and soyabean oil are compounded in annual feedstuffs and rapeseed oil is used for lubricating oil additives, leather treatment and cattle food. Castor oil is used in pharmceuticals, cosme-

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tics, and in manufacture of wetting agents, pest-control products, lubricants and textile processing materials. Coconut oil is used in cosmetics because of its fatty acid composition.

For applications with or more demanding technical performance, products derived from natural oils are much preferred and the business of manufacturing and supplying these materials has developed into a large global industry.

In the conversion, the triglyceride oil or fat is split into fatty acids and glycerine by continuous hydrolysis with water at high termperature and pressure The resulting mixture of fatty acids and glycerine solution is separated. The aqueous phase is concentrated and refined to produce glycerine of purity of up to 99.8 percent. The crude fatty acids are purified by vacuum distillation and separated into saturated and unsaturated components by low temperature crystallisation. Individual fatty acids may be produced in purities up to 99% by fractional distillation.

Methyl esters are produced by catalysis of fatty acid with methy-alcohol. Methyl esters are used to replace fatty acids in certain applications because they are less corrosive and more easily purified by distillation. Their main use is for the production of fatty alcohols although they are also used directly in cosmetics/ointments, having high skin penetration and ability to keep skin soft and smooth without causing greasy films.

Amides are produced by reacting fatty acids with ammonia under mild temperature and pressure. Upon dehydration and hydrogenation, they yield fatty amines which form soluble salts with mineral or organic acids, and quartenary ammonium compounds with alkylating agents. Such materials are effective corrosion inhibitors, flotation agents for concentrating minerals and of value in the petroleum industry. They are used as cationic surfactants, antimicrobial disinfectants and as textile and paper softners.

Industrys' need for oleachemicals are diverse. Many processes utilise inherent physical characteristics such on lubricity, viscosity, solvent power and compatibility. Others rely on the chemical structure and reactivity of the materials. Manufacturers are also now very aware of the need to use substance friendly to the environment. Since oleochemicals are biodegradable and non-toxic, they satisfy this need admirably.

Further examples of uses of products of the oleochemical industry are:-

1) Supply of monomeric and polymeric fatty acid plasticisers for use in the production of PVC, especially which has met extreme requirements such as with food packaging films.
2) Amides are used in high speed production of polyolefin packaging e.g. erucamide is a slip additive which stops film sticking and blocking.
3) Lubricant-base stocks range for high performance engine and industrial lubricants, which outperform conventional mineral oils.
4) Fatty acids upgraded by hydrogenation, distillation or fractionation and modified by polymerisation or oxidation processing give a broad range of fatty and dicarboxylic acids which are used in the production of high quality ester lubricants.

Molecular variation provides a range of products satisfying the requirements for most lubricant applications e.g. industrial gear oil, biodegradable chain saw oils, lubricants for the textile industry, low smoke two-stroke oils and metal working fluids.

5) Fractionated fatty-acids including lauric, myristic and palmitic acids are used to manufacture top quality esters. They are used in bath oils etc. Isostearic acid, dimer acids and their derivatives are used to produce non-irritant, non-sensitising, non-greasy skin-care agents for sun-tan gels, creams and liquids.
6) Glycerine has long been used as a humectant in cosmetics. Personal care products using glycerine include shaving preparations, after-shave lotions, antiperspirants and toothpastes.
7) Many pharmaceuticals e.g. salts, acids, alkdis, organic and unorganic used glycerine as the solvent. Its soothing effect on irritated throat membrances is employed in cough mixture preparations.
8) The surface coating industry uses a very broad range of oleochemicals including glycerine, short-chain acids, dimer/trimer acids and conjugated fatty acids.
Glycerine permits reaction, with all types of acid and forms the backbone of many different coating resins. Gycerol triacetate is employed as a plasticeser in the manufacture of cigarette filter rods from cellulose acetate too. Pure glycerine is also used as a moisturing agent to tobacco products in facilitating tobacco processing, reduces break up losses and enables the production of fresh tasking cigarettes.
9) Oleochemicals are widely used in the paper and packaging industries. Large quantities of stearine and employed in the manufacture of calcium stearate, a major ingredient in the production of paper coatings.
The process of paper recycling requires fatty-acids for the de-inking technique.

10) Textiles and leather industries rely heavily on oleochemicals. Esters are major components of textile auxiliaries and various derivations make excellent fat liquours for leather processing. Oleyl oleate replaces sperm whale oil in leather processing.

Extracted from Oils & Fats International Issue Two

NEWS

PORIM

Professor Jalani b. Sukaimi joined PORIM in March as the new Director of Biology, replacing Dr. Haji Halim b. Hassan (ISOPB Vice-President), who could devote his time back to his first portfolio as Deputy Director General. Professor Jalani, a B.Agric.Sc. (Malaya) and PhD (Reading) graduate majoring in plant breeding and genetics, came to PORIM from Universiti Kebangsaan Malaysia (National University of Malaysia) where he was a lecturer, a faculty dean, a full professor and deputy vice-chancellor for academic and research affairs. He was also a IAEA and Fulbright Fellow, spending some time in the leading universities e.g. Iowa State, Cornell, Harvard, Yale, Tufts in the U.S. PORIM's Biology Division will benefit from his direction.

IRHO

Mr.J.P. Gascon retired from IRHO after more than 30 years in oil palm breeding. Mr. Gascon is of course synonymous with the famous palm, L2T. With his retirement, Mr. J. Meunier assumed his position as Head of the Plant Breeding Division, while Mr. J.M. Noiret remained as the Director of Research in Paris. Both Messrs. Meunier and Nioret have long been associated with Mn. Gascon since the early days in Ivory Coast.

Commodity News

Tropical Oils Issue

The Malaysian Oil Palm Growers Council has continued its battle with the American Soybean Association over the tropical oils on health issue by taking advertisements in the U.S. national press extolling the virtues of palm oil.

This follows attempts by the ASA to get palm and coconut oil labelled as bad for health in new food legislation. Following meetings in early March between MOPGC and ASA, there were reports of toning down on the allegations of health dangers and of war of words. More recently, however, the Malaysian Minister of Primary Industries, has led another delegation to the U.S. amid reports that the tropical oils labelling bill which was voted out at the last session of Congress might again be introduced.

Malaysia is the world's largest producer and exporter of palm oil with total exports increasing from 4.22 million tonnes in 1987 to 4.34 million tonnes in 1988. India remains the largest importer of Malaysian palm oil at over a million tonnes but exports have also increased substantially into China, Egypt, Jordan, Turkey and South Korea.

Imports into China rose from 85,000 tonnes in 1987 to 215,000 tonnes in 1988, while imports to Egypt rose from 36,000 tonnes to 107,000 tonnes over the same period. U.S. imports have been in the order of 200,000 tonnes in recent years.

Indonesia

In an effort to improve added value, the Indonesian Ministry of Agriculture has started plans to increase sales of processed palm oil at the expense of crude oil exports. Of the 800,000 tonnes of palm oil exported in 1988, 600,000 tonnes were crude oil. Export are expected to rise to 900,000 tonnes in 1989, as refined oil exports develop.

HEAR, HEAR

High Erucic acid rapeseed, HEAR, is a crop of diminishing importance for European producers even though demand is on the increase. This is because of the insistence of the Eastern bloc countries to grow double-low rapeseed for food. HEAR readily cross pollinates with low-Erucic rapeseed types e.g. canola; as such it cannot be planted in close proximity with edible types. Hence with the growing importance of the edible types, HEAR production is relegated to marginal regions. Similarly, HEAR oil must be processed separately. Owing to the low volumes involved processors are not willing to handle HEAR and the extra work required to prevent contamination of edible oil.

Europe's loss is U.S.'s gain. The U.S. is emerging as a significant producer of HEAR and as HEAR development increased the U.S. could play a dominant role in the world HEAR market, which has traditionally being dominated by Europe, China and Canada. By 1991, U.S. production of HEAR is expected to be 20-25,000 acres increasing to 30,000 if not 60,000 acres in 1992. Until 1986, virtually all HEAR came from the Pacific Northwest states e.g. Washington, Oregon. Since 1986 the mid-South states of Tennessee, Missouri, Arkansas and Mississippi have started production.

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