AA RESEARCH NEWS

January, 89

EDITORIAL

Climate, Weather And Crop Production

It is often said that when two Englishmen meet the first thing they would talk about is the weather. This is because the English weather is so unpredictable! Planters too, like any farmer, are also much concerned about the weather, if not more so, as meeting their daily work schedules depends very much on favourable weather conditions.

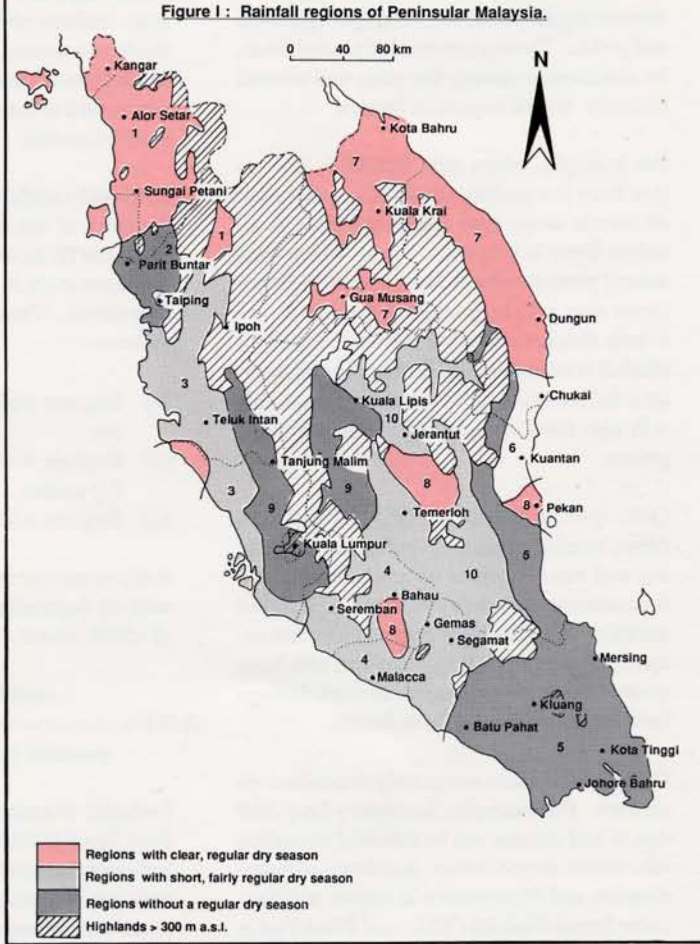
It will thus be very useful to be able to predict the weather. Can we do so? Many planters do not think so, often claiming that the current weather patterns have changed due to effects of recent rapid agricultural and industrial development; that they have often been misled by weather reports (TV, radio, newspaper) and that the rainfall probability charts such as those provided by AAR, based on previous rainfall records would be of little use to them in programming their daily work schedules.

In all fairness to the weatherman, weather prediction is still an inexact science. While he can predict weather on a national, regional or global level with reasonable reliability (for example the prediction of the onset of north-east monsoon is made from studying the weather patterns prevailing in China and South-China Sea some weeks back), this is not so for local areas due to modification by local environmental factors eg. presence of hills, tall buildings, wind, air pollution. This is particularly more so during the inter-monsoon periods (e.g. August to October) where the rain is much of a convectional and localised nature.

Similarly the AAR rainfall probability charts will not predict the exact day or week of rain but they do indicate the number of days of rain and amount of rain per period. These will serve as useful guides in scheduling not only major field operations eg. field burning and land preparation, field planting but also more routine operations such as manuring and chemical weeding. Even for day to day decisions, using the rainfall probability charts as a first guide and listening to the daily weather reports, combined with a keen sense of observation or experience with the local situation and common-sense, a reasonably good prediction can be made.

The rainfall probability charts and weather records are not only useful for scheduling field operations but are also useful for predicting the relative size of peaks and troughs in crop yield a year or two ahead which will enable the manager to plan out the logistics for efficient deployment of machines and labour for minimal cost and maximum crop harvest.

Figure I : Rainfall regions of Peninsular Malaysia.



The main feature article in this issue discusses in greater detail the relationship between weather and (plantation) crop production on a regional basis and focuses on the main climatic limitations on crop productivity and distribution in each major region in Peninsular Malaysia.

Soh, A.C.

Regional rainfall pattern and climatic limitations for plantation crops in Peninsular Malaysia

1. Introduction

Peninsular Malaysia, located in the hot humid tropics, does not experience the extremes of weather like the changing seasons in temperate countries. It was a common belief that the climatic conditions were fairly uniform throughout most of this country. Consequently there had been a tendency in the past to overlook the effects of climate on agricultural development and production. However, it is now widely recognised that there exists distinct climatic differences, particularly rainfall, between broad regions in the country.

2. The influence of climate

On a large scale, the suitability of an area for a given crop is determined by its climate. Climate has a direct influence on the overall growth and performance of a crop because each crop has its own specific climatic needs.

Climatic factors however are modified by the local effects of soils and land management. The integrated effects of all factors determine the potential of the site for the given crop. Thus climate is the overriding factor in determining biomass and production, while soils and land management are modifiers.

HIGHLIGHTS

- **Regional Rainfall Pattern**
- **The Biotechnological Explosion**
- **Plant Biotech'88**

Only when the crop requirements for climate, soils and management factors are met can we expect optimum growth and maximum yields. Where conditions are suboptimal or unfavourable, these limit the potential crop yield. Under such circumstances, actual yields achieved are low and unless these limitations are corrected, yields will not improve.

3. **Rainfall**

Of all the climatic factors, rainfall appears to be most significant in influencing crop growth and yields. The total amount of precipitation, its distribution during the year, and rainfall intensity are all important factors.

For example, where total rainfall is low so that there is a prolonged drought, cultivation of certain crops may not be possible at all unless there is irrigation. Even where total annual precipitation is high, severe moisture stress may still be present if the rain is unevenly distributed during the year. Finally if rainfall is excessive (eg. during the monsoon months) resulting in flooding conditions, this will also have adverse effects on the crops grown.

Quite apart from the direct effects of moisture stress, rainfall influences the degree of leaching and run-off losses of soil nutrients and thus nutrient availability and uptake. Rainfall intensity is particularly important in this respect. High rainfall intensities can also have great effects on management through damage (erosion) of roads and flash floods.

Disease incidences are greatly dependent on climate. For example, ***Secondary Leaf Fall*** due to leaf disease can be severe if excessive rain occurs at refoliation. Incidence of panel diseases and ***Phytophtera*** in rubber and ***Vascular Streak Dieback*** (VSD) and ***Black Pod*** in cocoa, increases sharply under extended wet conditions and high relative humidity.

4. **The use of rainfall data**

An understanding of the rainfall pattern of one's estate (area) will enable one to assess the suitability of the area for the selected crop (eg. oil palm, cocoa, rubber etc.). If climatic (rainfall) conditions are found to be less than optimal, appropriate corrective measures or amelioration can be taken to minimise the limitations. This may be in the form of soil or water conservation, mulching, irrigation, drainage etc.

A good knowledge of the rainfall pattern will also be a useful management tool. Critical operations such as felling and burning for a replant can be scheduled during the driest months of the year. Conversely, the relative risk of planting in a month outside the usual planting season for the region can be estimated. By comparing current rainfall with the general trend expected, any unusual or abnormal deviations from the norm can be easily and quickly detected. Appropriate changes can then be made to estate operations such as manuring and spraying schedule to accommodate the changes in rainfall pattern. AAR has sent to all estates in its advisory service rainfall probability charts, generated from actual individual estate records, for this purpose.

Knowing the climatic (and other) limitations, the manager and visiting agronomist can estimate realistic yield potentials for individual fields and estates. Year to year rainfall data can help to explain fluctuations in yield pattern as well as to make more accurate seasonal yield estimates.

5. **Regional rainfall patterns**

Analysis of the rainfall data for Peninsular Malaysia (Nieuwolt *et al*, 1982) has shown that three main regional patterns may be distinguished. They are (shown in Fig. 1) as follows:-

(a) Regions with clear and regular dry season
(b) Regions with a short but fairly regular dry season
(c) Regions without a regular dry season

A dry month (or season) is defined as a month with an Agricultural Rainfall Index (A.R.I.) of <50% where:-

$$\text{A.R.I.} = \frac{\text{monthly rainfall}}{\text{potential evapotranspiration}} \times 100\,\%$$

Potential evapotranspiration data are taken from Scarf (1976). When A.R.I is <50%, it indicates that rainfall is less than half the total crop requirements for the month. Moisture stress can be expected during such months and the severity of stress will be compounded with each consecutive dry month.

Further subdivisions of rainfall regions into ten geographic regions are made based on minor variations of the three main regional rainfall patterns (Fig. 1).

5.1 **Regions with clear and regular dry season**

All areas included in these regions have a distinct dry season that extends over several months during almost every year on record (generally >80% of the time). Included in this group are Perlis, Kedah, Penang and north west Perak (Region 1). Areas on the east coast with similar rainfall pattern are Kelantan, coastal Trengganu and Pahang and the Bahau area in Negri Sembilan (Regions 7, 8).

Figure 2 shows the histogram for the minimum rainfall that can be expected in four out of five years for Region 1. As shown, the dry season usually commences in December and may continue until the following March, a period lasting 3-4 consecutive months.

The east coast of Peninsular Malaysia also has a distinct dry season that lasts from 3-4 months. However it commences in January and lasts until April (Fig. 3, eg. Region 7).

In contrast, September and October in Region 1 and December in Region 7 are excessively wet and severe widespread floods are a regular occurrance.

The prolonged dry season and severe floods within these climatic regions are severe limitations for oil palm and cocoa.

5.2 **Regions with a short but fairly regular dry season**

Areas included in this category (Fig. 1) are south-west Perak and coastal Selangor (Region 3), Malacca and Negri Sembilan (Region 4) northern Johor, southern and northern Pahang (Region 10).

Dry months (A.R.I. <50%) occurs regularly in more than half the years (45 - 80%). However, unlike regions with clear irregular dry season, there are two relatively short dry seasons, each usually lasting one to two months. Slight variations occur between geographic regions. Thus in Region 4 (Fig. 4), two very pronounced dry season of almost equal intensity are evident in January to March and again in July to August. In Region 3 however (Fig. 5), the dry seasons are less distinct, mainly in January and in June-August.

Under this climatic condition some moisture stress can be expected. The severity and duration will be variable depending on the duration of the dry season. Climatic limitations on crops will therefore range from slight or moderate to occassionally severe.

5.3 **Regions without a regular dry season**

Areas with this rainfall pattern are coastal Taiping areas, (Region 2) southern Perak and inland Selangor (Region 9), western Pahang (Region 9) and Johor (Region 5). In these regions dry months (A.R.I. <50%) do occur but in <40% of the years on record. The dry season normally lasts only one or 2 months and usually not in consecutive months (See Fig. 6, Region 5). The dry season occurs irregularly but most commonly in January to February. In contrast, for Region 9, the dry months (irregular) tend to be most likely in January and August (Fig. 7).

Two relatively wet periods are discernable in these region, October to December and April in Region 5 and September to December and April in Region 9. Flooding may occur particularly during the year-end wetter months but it is not a regular feature.

Thus in this climatic region, moisture stress if any are expected to be minimal and of short duration. The generally high and well distributed rainfall makes this a region well suited for plantation crops particularly oil palm and cocoa.

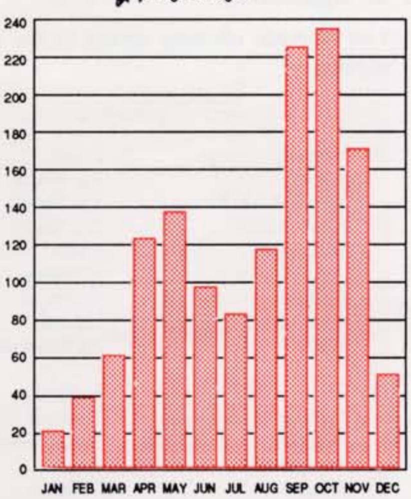
The monthly climatic conditions of the various geographic regions can be summarised as follows in Table 1.

Table 1. Main climatic characteristics of geographic regions (adapted from Nieuwolt *et. al*, 1982)

Region	Months												Other limitations
	J	F	M	A	M	J	J	A	S	O	N	D	
1	D	D	D	df	m	dm	(d)m	m	Fm	Fr	F	D	w
2	f	-	F	F	m	dm	dm	m	fm	F	F	f	w
3	-	d	-	-	m	dm	m	dm	m		f		(Ww)
4	D	D	d		m	m	m	m	m				WW
5	m	dm	dm	m	m	m	dm	m	m	m	fmr	frm	Ww
6	m(d)	D	D	D	d	d	d	d		(f)	fr	Fmr	w
7	D	D	D	D	d	d	d	d		fr	fr	Fr	
8	Dd	Dd	d	m	dm	Dm	(dm)	(m)					-
9	(dr)	d	(df)(f)	(d)	(d)						(r)	Ww	
10	d	Dd	Dd			(d)	Dd	d				(r)	W

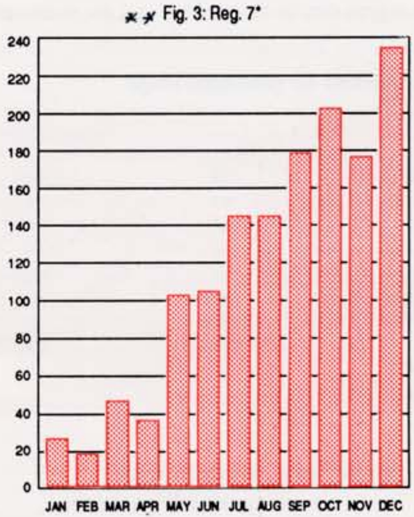
D = Tdry month (A.R.I. <50% for >20% of years recorded)
F = 90% rainfall >200 mm, flash flood likely
d = frequent moisture stress days
W = strong wind gusts possible
m = morning rainfall maximum
WW = serious danger from strong wind gusts
r = sunshine <40% of possible hours.
( ) = only in parts of region
f = 80% rainfall > 200 mm, flash flood possible

** Fig. 2: Reg. 1*



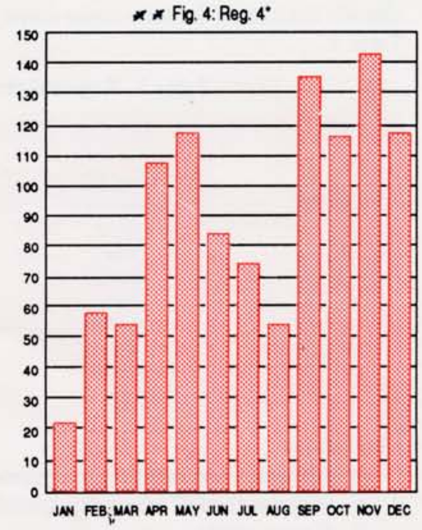
* Based on mean rainfall data from Batu Kawan, Kuala Muda and Malakoff estates.

** Fig. 3: Reg. 7*



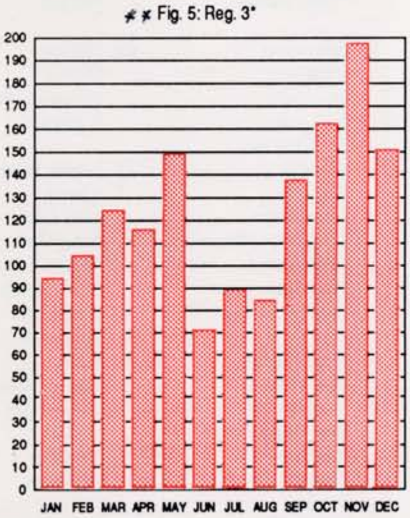
* Based on mean rainfall data from Lepan Kabu, Kuala Gris, Sg. Teku and Taku estates.

** Fig. 4: Reg. 4*



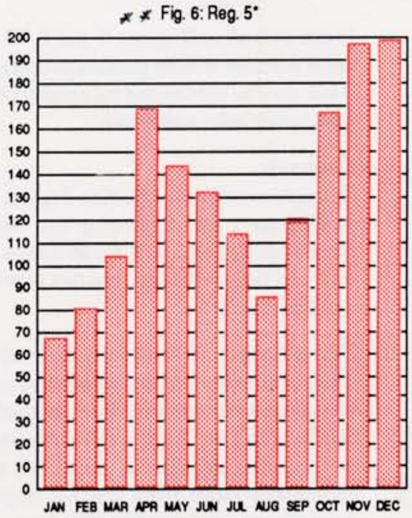
* Based on mean rainfall data from Serting, Jeram Padang, Ayer Hitam, Batang Jelai and Goodwood estates.

** Fig. 5: Reg. 3*



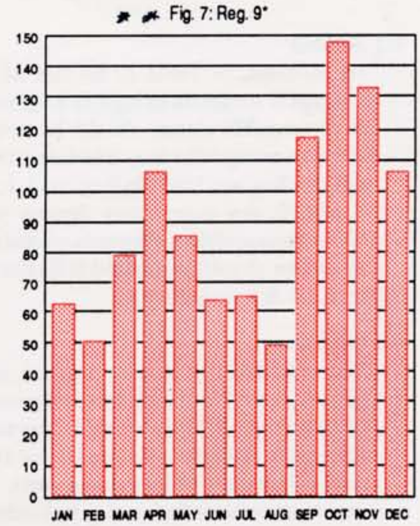
* Based on mean rainfall data from Serapoh, Kuala Kangsar, Pinji, Kampar, Senggang, Bukit Katho, Glenealy and Wan Lee estates.

** Fig. 6: Reg. 5*



* Based on mean rainfall data from Fraser, Kulai Young, Teluk Sengat and Asahi estates.

** Fig. 7: Reg. 9*



* Based on mean rainfall data from Tuan Mee, Coalfields, Java Selangor and Lambourne estates.

NB: ** Indicate Maximum Monthly Rainfall Expected In 1 Out Of 5 Years (20% Probability)

6. Regional climatic limitations for plantation crops

The climatic requirements for plantation crops are given in Table 2.

Table 2 : Climatic requirements of plantation crops

Factors/crops		Rubber	Oil Palm	Cocoa	Coconut
1.Dry season (months)	>2	minor limitation	serious limitation	serious limitation	minor limitation
	>1	-	minor limitation	minor limitation	-
	up to 1 mth.	-	-	desirable	-
2. Surplus rainfall	Short flash floods	minor limitation	minor limitation	minor limitation	minor limitation
	Long floods	serious limitation	serious limitation	serious limitation	serious limitation
3.Wind gusts		serious limitation	minor limitation	minor limitation	minor limitation
4.Sunshine		> 4 hours/day	> 5 hours/day	some shade needed	> 4 hours/day
5. Others	morning rainfall	serious limitation	-	-	-
	high R.H.	minor limitation		serious limitation	-
	lightning	-	minor limitation	-	minor limitation
	small diurnal temp.range		desirable	-	desirable

Note : RH - relative humidity

Based on the climatic requirements of crops and the climatic characteristics of the various regions, climatic limitations for the various crops in each region can be determined and are summarised in Table 3.

Table 3 : Regional climatic limitations for plantation crops

Region	Rubber	Oil Palms	Cocoa	Coconut
1	mwd (P)	D	D	dw
2	mw(G)	S	ws	w
3	dmw	d	w	w
4	mw	d	w	w
5	mw(G)	(r)	w	w(r)
6	dmw	Dsr	Dsw	wr
7	dw(P)	Dr(s)	D(s)w	dr
8	dmv	d	d(w)	(w)
9	- (G)	r	-	r
10	(d)	d		

Limitations

D = dry season too long for good yields
d = irregular rainfall (short dry spells) may depress yields
s = surplus rainfall, flash floods
r = insufficient solar radiation in some months
w = wind damage possible
m = morning rainfall maximum
P = Phytophtera leaf fall
G = Gloeosporium secondary leaf fall
() = only in parts of region

6.1 Rubber

As indicated in Table 3, the risk of wind damage is moderate to high in Regions 1 to 8. Susceptible clones should be avoided. Early morning rains may interfere with tapping for Regions 1 to 6. In Regions 1, 3, 7 and 8 and 10, dry season may depress yields. Clones susceptible to *Phytophtera* and *Gloeosporium* should be avoided in Regions 1, 7 and 2, 5 & 9 respectively.

6.2 Oil Palm

The extended dry season common in Regions 1, 6 and 7 will limit the yield potentials of oil palms. Although usually less severe, dry spells in Regions 3, 4 and 8 and 10 will probably depress yields in some years. In the east coast, solar radiation may be inadequate during the monsoon months (Regions 5, 6, 7 and 9). Flooding will affect relatively lower lying areas in Regions 2, 6 and 7.

6.3 Cocoa

Prolonged drought conditions in Regions 1 and 7 will limit high cocoa yields and to a lesser extend in Regions 6 and 8. Risks of wind damage will be present in Regions 2 - 7 but may be minimised by careful planting out shelter belts and shade.

6.4 Coconuts

Drought conditions will also depress yields in Regions 1 and 7. During the monsoon months in Regions 6, 7, 8 and 9 solar radiation will be insufficient, but this is probably a minor limitation.

7. The influence of local soils and relief

The climatic regions thus described are very broad generalizations based primarily on rainfall records. Regional boundaries indicate gradual transitional zones and are not necessarily static since climate (especially rainfall) can vary considerably from year to year. Interpretation of Fig. 1 for land-use planning must bear these points in mind.

As mentioned earlier, local conditions can have significant effects on the overall suitability. Hills, depressions, swamps etc. can cause local variation in rainfall pattern. Thus on-site inspection is an essential step in land-use planning to take into account local soils and relief conditions.

For example, in some areas, climatic data may indicate long droughts but this may be completely neutralised in areas where the ground water table is permanently high. Such areas include peats and local depressions. Shallow soils, acid sulphate soils and BRIS soils also strongly modify the overall suitability of the area so that climatic factors may be of secondary importance. Again one needs to be aware of these conditions when making interpretations. Except for the main towns, climatic data for Sabah are very limited. Estate records are also largely of relatively short time-span. Thus although similar rainfall analysis can be made as for Peninsular Malaysia, reliability is poorer. However the basic principles discussed in this article are still applicable for Sabah.

8. Appendix 1

List of AAR advisory estates in the vari[illegible] regions.

Region

1) Kupang, Pelam, Lubok Anak Batu, Kuala Muda, Malakoff, Batu Pekaka, Stothard, Batu Kawan, BMR

2) TRP, Malaya, Windsor, Stoughton, Allagar, Ghim Khoon, Batu Lintang, Buntar, Subur, *Bkt. Tebuan

3) Senggang, Pinji, Wan Lim, Serapoh, K. Kangsar, Gleneally, Kampar, Lambourne, Kombok (Mantin), Connemara, Wan Lee, Tronoh Malay

4) New Pogoh, Bkt. Dato, Voules, Ban Heng, Kombok, Gadek, Serting, Btg. Jelai, Malay Rompin, Goodwood, Ayer Hitam, Jeram Padang, *Ulu Pedas, Bekoh

5) Fraser, Sg. Bekok, Sg. Tamok, See Sun, Paloh, Kekayan, Tertinggi, Landak, Sg.Penggeli, PKEINJ, K.Young, Chellam, Kim Loong, Asahi, T.Sengat, Eldred, N. Paloh, Chamek, Rengam, Pakloh

6) Mawar, Cherul, Ketengah Perwira, T.Bakti

7) Lepan Kabu, Cheng, Lian Lee, Tong Guan, Secure Enterprise, Bukit Belah, Kuala Hau, Sg. Sokor, Taku, Kuala Pertang, Pasir Gajah, Kerilla, Yayasan, Sg.Tasan

8) Bukit Kledek

9) Escot, Tg. Malim, Changkat Asa, Bkt. Katho, Kerling

Sg. Jemih	Kim Swee Loong	
Sg. Gapi	Hwa Li	
*Coalfields	Kemasul	
Tuan Mee	Selbourne	
Malra		
Sedgeley	* Estates with rainfall that does not conform to the regional pattern, probably because of local modifying factors.	
Balau		
Sg. Kawang		
Renjok		
Tuan		
Liew Weng Chee		
10) Asia Oil Palm		*Kee, K.K.*
Pahang Oil Palm		

9. References

1. Nieuwolts, *Set al*. (1982). Agroecological regions in Peninsular Malaysia. (MARDI, Selangor)
2. Scarf, F. (1976) Evaporation in Peninsular Malaysia. Water Resources Publication No. 5, DOA, KS.

B. THE BIOTECHNOLOGICAL EXPLOSION

These days, if one should leaf through the pages of any international business and scientific newspapers or magazines, there is bound to be some news on biotechnology, be it a scientific breakthrough, the release of a biotechnological product, a court dispute on a patent, the fate or fortunes of a biotechnological company etc. This is indeed the age of biotechnology, for many of the big companies around the world, including some newly formed from venture capital, have ventured into this area in one form or another. What is biotechnology and how did this situation come about?

Biotechnology, in simple terms, means the industrialisation of biological processes. If so, what is it so different from the brewing, fermentation technology and industrial microbiology? Not so different except that in biotechnology, with a host of gene manipulation or genetic engineering techniques recently developed, it is possible to manipulate cells to become like factories to produce more and better quality products. The cells involved need not be restricted to microorganisms i.e. bacteria or yeast but also cells of higher plants or animals. Also, the products may not be limited to those of the cells original ability but also of acquired ability due to the introduction of a gene from another organism. In many biotechnological processes involving cell-cultures many of the techniques of industrial microbiology are adapted and adopted. Again, biotechnology is not confined to cell-culture but can also involve whole plants and animals in the production of super or novel agricultural varieties and breeds and other applications such as kits for diagnosis and treatment of diseases and genetic disorders in plants, animals and man.

Biotechnology is really a technology evolved from a host of techniques. For example plant biotechnology, involves techniques to manipulate genes i.e. recombinant DNA and somaclonal variation techniques and techniques to regenerate cells to plants i.e. tissue culture technique. The driving force behind the development of biotechnology is the recombinant DNA technique.

The recombinant DNA technique has its origin in the 1950's with the discovery that genes are made from DNA or nucleic acids, that DNA exists in 4 forms : A (adenine), T (thymine), C (cytosine) and G (guanine) and combinations of 3 of these forms, will code for the synthesis of the 22 essential amino-acids, combinations of which give rise to proteins and life. From this, further revelations were made on how the codes are transcribed by another group of nucleic acids (messenger RNA) and then translated into the respective amino-acids. Scientists also learned how to copy and synthesise DNA and RNA. Subsequently in the late 60's and early 70's scientists discovered a group of enzymes known as restriction enzymes or endonucleases, which cut DNA at specific sites, and found that if they cut two different DNA strands with the same enzyme, and then mix them together and allow them to rejoin hybrid DNA of the two strands can be obtained. They then took the circular plasmid DNA of the gasterointestinal bacterium *Escherichia coli*, cut it with an enzyme and then mixed to the DNA fragments of a foreign source cut by the same enzyme, plasmids with inserted DNA fragments of the foreign source were obtained. When these hybrid plasmids were put back into the host bacteria and the latter allowed to multiply, the hybrid plasmids (recombinant DNA) are multiplied with the inserted foreign DNA cloned multi-fold.

This is the recombinant DNA technique. Figure 1 illustrates how the technique is used to mass-produce insulin.

Figure 2 illustrates how the technique is used to genetically transform a plant with a desired gene from an alien species. Here a second vector is required as *E.coli_* does not infect plants. The vector commonly used is *Agrobacterium tumefaciens*, which causes crown-gall disease in many dicolyledonous plants. There are other but less efficient techniques to introduce foreign DNA into plants eg. microinjection, electroporation.

BIOTECHNOLOGY ACHIEVEMENTS

A) Human Health-Care Products

Drugs : Human insulin for diabetics
Human growth hormone for dwarfism
Interleukin - 2 for boosting immune system
Interferon to combat certain types of cancer eg. leukemia
Tissue plasminogen activator (TPA)
Factor 8 - a blood clotting agent for haemophiliacs.
Erythroprotein (EPO) - used to treat anaemia.
Relaxin - hormone to relax cervix during labour.

Some 150 biotechnology drugs are in the pipeline undergoing clinical trials, including diagnostic kits for heart disease, hepatitis and AIDS.

Some of the above drugs are expected to generate annual sales of US$1/2 - 1 billion world-wide.

B) Agricultural Products

1) Animals

Bovine somatotropin
– hormone which can boost milk production in dairy cattle by 30% with only 6% more feed.

Porcine somatotropin
– hormone which reduces 70% backfat in pig and reduce feed cost by 25%.

Vaccines against diseases eg. coccidiosis in poultry. Diagnostic kits for diseases eg. toxoplasmosis in sheep.

Transgenic (genetically engineered) pig which has extra growth hormone to increase food conversion efficiency and hence grow faster.

Transgenic sheep which grow faster.

2. Crops

Herbicide *(Roundup, Basta, Arsenal)* resistant crops (tobacco, tomato, sugar-beets, potatoes, rapeseed, poplars). Pest resistant crops (tobacco, tomato, potato, lettuce, cauliflower) containing the *Bacillus thurengensis* toxin gene, virus resistant crop (sugar beets).

Biotechnology related agricultural products have been predicted to exceed an annual $100 billion sales by the turn of the century.

How safe are Biotechnological Products?

Because many biotechnological products are life forms made in the laboratory using genetic engineering techniques involving divergent species, there is a popular fearof a mad-cap scientist who will liberate a Frankensteinian microbe which will annihilate all life forms or populate the earth with Hitler-style super races of man, animals and plants. Some moralists and environmentalists are lobbying and staging legal battles to prevent the release of genetically engineered organisms.

Genetically engineered organisms can pose a number of dangers; their presence might disturb the balance of the environment in unintended ways; they might multiply uncontrollably and therefore become pests or weeds; they might be dispersed to areas far from their intended sites; they might produce unintended effects, they might transfer the new bits of DNA to other organisms. Environmentalist objectors use much of these arguments in their campaigns. Jeremy Rifkin, a veteran campaigner believes that genetic engineering breaches species integrity, by-passing the genetic boundaries that naturally separate species and make inter-breeding between animals nearby impossible. He wants a five-year moratorium on the free release of genetically materials of any kind and wants to ban the patenting of transgenic animals, biological warfare research, commerial surrogate motherhood, commercial use of foetal tissues and bovine somatotropin.

Many of the issues raised by the environmentalists are however no more peculiar to the genetically-engineered organism than to a traditionally-bred one. A plant or animal with one or two novel genes inserted is not likely to wreak havoc in the environment than a traditionally-bred cultivar or breed. Furthermore, even if pollen from an engineered herbicide resistant plant were to fertilise a weed, the risk of it upsetting the natural balance would be small. Similarly if natural boundaries have been that sacrosanct, there would not have been the evolution of so many species!

The record todate showed that biotechnology is pretty safe. There have been no confirmed reports of trouble resulting from the 20 or so released into the environment. In fact, in 1975 during the first conference on the recombinant DNA technique in California, because of its possible potential dangers, the scientists themselves called a voluntary morartorium on certain types of recombinant DNA techniques and strict controls placed on others under the guidelines established under the auspices of the U.S. National Institute of Health. Hundreds of thousands of recombinant DNA experiments have been performed todate without report of a single serious genetic accident. This has allayed the fears of both scientists and the public, and the rules governing research have been relaxed and presently 90% of the recombinant DNA experiments in the U.S. are exempted from the NIH guidelines.

Nevertheless, partly because of the lobbies of pressure groups, and partly because most biotechnological products deal with medicine (health) and agriculture (food), strict governmental regulations, involving five different agencies, are laid down for the release of genetically engineered organisms into the environment. Some of the measures taken appeared somewhat overkills. For example, during the first field trial of "Frostban" the ice-minus strain of the bacteria, *Pseudomonas syringae* which can prevent frost damage, the scientists were made to wear space-suits! Industrialists have argued that regulatory overkills would hinder the development and availability of beneficial biotechnological products, because of the longer time and higher costs needed to undertake tests to fulfill the regulatory requirements. Optimistically, in time the regulatory requirements will be more rationalised as more biotechnological products prove to be safe.

Can Life be Patented?

The awarding of the patent by the U.S. Patent Office to Dr. Chakrabarty of General Electric for a genetically manipulated microbe which can break down crude oil in 1980 set the precedence that biotechnologically developed organisms can be patented. The principle held was that the microbe is a man-made organism not found in nature. By 1985 patents were granted to genetically engineered plants. Recently patent protection has been extended to genetically engineered animals. With the imminent granting of many such patents many moral and ethical issues regarding the ownership of transgenic animals was brought to the fore by social and religious groups. Some of the fears brought up were:

a) Such patents would sanction the use of animal kingdom as a spare-parts shop for genetic engineers and that it would make them less sensitive to animal suffering.

b) The patents would reduce the ordinary farmer to a licensor of the animals he rears (i.e. he cannot reproduce his own animals), and eventually concentrating control of the livestock and poultry industries in the hands of a few large corporations.

c) Patenting humans would amount to enslaving them.

A few researchers have argued that they should be able to own human embryos, eggs, sperm or other human tissues used for research.

Another researcher wants to hold a copyright on the genetic information contained within the human genome.

A patient with a rare form of cancer donated his spleen for research into producing factors to treat cancer and AIDS subsequently wanted a royalty on the drugs produced!

Soh, A.C.
Extracted in large part from The Economist. A Survey of Biotechnology; the Genetic Alternative, April 30 1988.

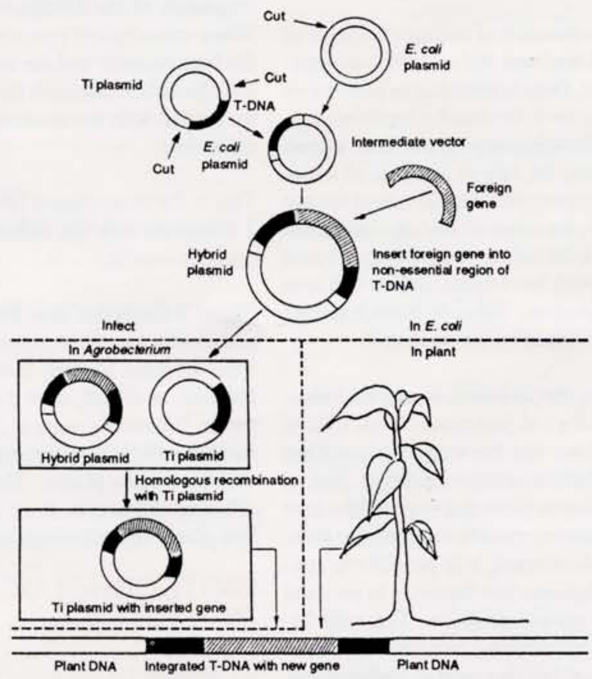


Figure 2. Genetic transformation of plants with Ti plasmid vector.

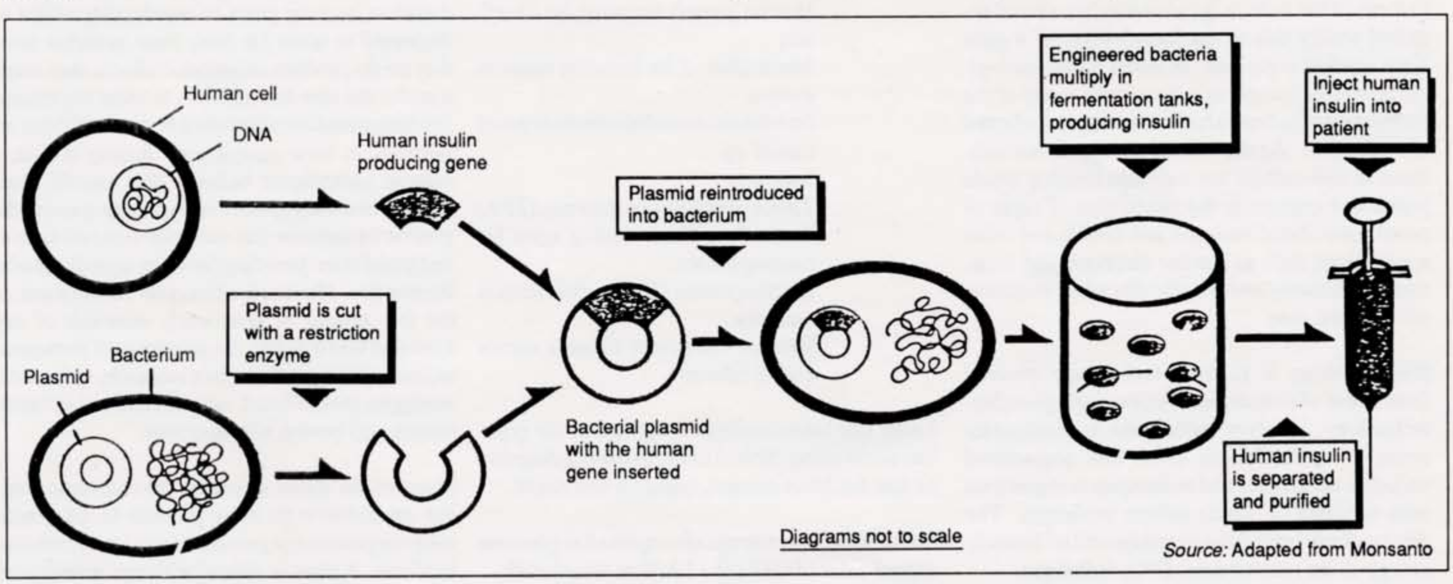


Figure 1. Mass-producing human insulin.

CONFERENCE NEWS

Plant Biotech '88: Technological Applications and Commercial Opportunities. 11-13 May 1988, Singapore.

Organised by:-
Science Council of Singapore
Primary Production Department
National University of Singapore

Introduction

The first Plant Biotech Conference was organised two years ago, directed towards company directors and policy-makers to introduce them to this new exciting area of business. This is the follow-up directed towards R & D personnel as well as businessmen, reviewing the latest scientific breakthroughs, developments in technological applications and commercial opportunities. The speakers chosen were a good balance of academicians and R & D directors (who are well-known scientists in this area) of biotechnological firms and seed companies. They gave a rather balanced view of the excitement of scientific breakthroughs and prospects and the sobering challenges of translating them into commercial applications.

Highlights

National Policy-Papers

The primary aim of the organisers of this Conference is to attract investors to Singapore in the area of plant biotechnology. In 1987, besides orchids, Singapore's exports and entrepot trade in plants and plant products were worth S$550 million. With scarcity of land resources inhibiting their involvement in extensive agriculture and recognising the imminent explosion of plant biotechnological industries, they reckoned that Singapore is strategically situated to develop this technology for and servicing this largely agricultural S.E. Asian region. Singapore has excellent infrastructural facilities for trade e.g. shipping, plant quarantine, telecommunications; and by providing good investment incentives and excellent research opportunities and facilites, they hope to attract top companies and scientists to Singapore to achieve this end. The set-ups of their ultramodem facility, the Institute of Molecular & Cell Biology and the 10 agrotechnological parks totalling 2,000 ha. are testimonies of their commitment.

China is paying quite a bit of attention in this area of plant biotechnology and the paper presented their achievements, current research interests and their national policy. They have solved the basic food and clothing problems for their one billion people with traditional agricultural technology. But with shrinking of available agricultural land, a still increasing population and improvement in peoples' living standards; they are venturing into this new area to test its purported potential. Plant biotechnology started in China in the seventies and was mainly in the use of tissue culture in crop improvement. In the eighties, they have ventured into the genetic engineering area.

The achievements of the Chinese in the area of tissue culture, anther culture and haploid breeding in many crops e.g. rice, wheat, maize, soybean, cabbage, have been well known. These were achieved by the sheer number of scientists working on each crop. A notable achievement claimed was the faster growing and higher yielding of the tissue-cultured rubber clones (with own root system) than the bud-grafted clones.

The Chinese government has made a mid and long term plan in R & D in biotechnology. The Chinese Academy of Agricultural Sciences had more than 20 biotechnology research units (plant and animals) in its 36 affiliated research institutes; and laboratories have been set up in most of the provincial and municipal academies of agricultural sciences and agricultural colleges.

Tissue Culture Papers

Propagation of orchids is the classical example of the commercial application of the tissue culture technique which gave the impetus to research into tissue culture cloning of other crop species. Even for orchids, Dr. Hew of the National University of Singapore revealed that the majority of the orchid species and varieties exhibit variations in their clonal offsprings, many to such a high degree negating commercial cloning feasibility. He also reviewed the contribution of tissue-culture to the multi-million dollar cut-flower tropical orchid export market industry to Singapore ($10 million). Thailand ($40-50 million) and the region. Lately the demand in Europe for orchids from the region has dropped, and overtaken by new varieties (Cymbidium) from Holland. He stressed that the market is still there but there must be greater efforts in breeding and tissue culture coupled with improved cultural practices and post harvest technology, to ensure a continuous supply of new improved varieties of uniform high quality to stay competitive; which is the essence of a ornamental plant market.

Dr. Irwin Chu of Twyford Plant Laboratories, California, gave a very candid analysis of what it takes to be a profitable commercial micropropagation (tissue-culture) business:-

i) **Production and timely delivery of uniform high quality product by total controlled production system.**

   Materials sold must be of assured uniform size and quality. Offtypes must not exceed 1.5%. They ensure this by working with known species and varieties with known tissue culture protocols.

ii) **Reduced production costs and increased efficiency.**

   Their expected multiplication rate is 1 plant to 3 plants in 4 weeks, to 60,000 plants in 12 months. With 20 starting plants, 1 million plants should be obtained by 1 year. 85% survival must be achieved in the greenhouse which uses a fogging system with automatic relative humidity control. Cost per plantlet in the lab. is about 1 cent per week, hence if plants can exit from the lab sooner, cost will be reduced. Rooting is most costly (5 cents/plant) hence it is best if it can be achieved outside the lab. Substantial savings can also be achieved using liquid instead of solid media, minimising washing.

   He reckoned that by computerised control of process and management, and streamlining with automation, and perhaps robotics; the cost can be substantially reduced.

iii) **"Added value" plants i.e. high priced plants.**

   The message conveyed by Dr.Chu was that commercial micropropagation business is a high cost business and to be profitable especially in the U.S, the company must be very efficient to produce high volume products of uniform high quality and high price, at low cost and on time.

The paper by Dr. Euuwens of Unilever, on tissue culture of date, coconut and oil palms essentially reviewed their work mainly on the oil-palm which was nothing new to us. Even on the question of reasearch on resolving on clonal abnormalities in oil palm, nothing new was revealed. He suspected that a particular hormone was responsible in their scaling-up process. He indicated that they are working with RFLP's and isozyme analyses as possible screening aids for early detection of abnormalities; and threw up a 'wild' idea that if the fruits produced by the premature inflorescence (in the laboratory) are normal then the cultures could be expected to produce normal palms. 'Wild' because premature flowering is considered to be indicative of abnormal culture physiology by some tissue culturists.

Reassessing Unilever's work on the oil-palm with experiences with the orchid tissue culture and Dr. Chu's talk on ornamental micropropagation, it is evident that oil-palm clonal propagation (besides the abnormality problem) has yet to reach the commercialisation stage and should remain very much R & D.

Genetic Engineering Papers

Dr. Jaworski reviewed the development of the recombinant DNA technique (i.e. how genes are isolated from an organism, spliced into the plasmid and multiplied in the bacterium *E.coli*, and then introduced into another plant/organism, using *Agrobacterium* as a vector,by microjection, by electroporation or literally shooting in the DNA with a gun, thereby genetically transforming the plant) into a technology. Monsanto (a chemical firm, maker of Round-up) is a leader in the field and has a number of genetically engineered products under regulatory field testing or already in the market e.g. tobacco plants resistant to Round-up, tomato plants containing the *Bacillus thuringensis* toxin gene, hence resistant to caterpillar pests, bovine somatotropin which improve efficiency of milk production in cows and another which reduces backfat in meat. As indication of Monsanto's commitment in this area of molecular biology, its research budget for 1986 was $600 million and employs more than a thousand scientists. Interestingly Monsanto is not interested in selling the products. Rather they prefer to sell the technology to seed companies. Either that or they buy up seed companies which will then use their technology.

Dr. Jaworski also revealed the rather cumbersome if not restrictive regulatory testing procedures involving 5 different regulatory bodies i.e. agriculture, food and drug, environment, occupational hazards, and health, with different testing requirements before the genetically engineered product can be considered safe for release to the public.

The pesticide industry is a >US$17 billion industry and yet still 50% of the world crop is lost to pest damage. 99% of the pesticides are synthetic chemicals but their use are declining due to pest resistance, toxic effects on nontarget species, and environmental contamination. Furthermore regulatory controls are becoming more stringent with the public becoming more environmental-conscious, the cost of introducing a new chemical can exceed US$35 million with a time requirement of over 7 years. Whereas the development of a biopesticide costs under $10 million and may be introduced into the market within 4 years. There are a range of 'biorational' pesticides (a newly coined term which perhaps needs more formal definition) depending on the strategies:-

a) developing predatory parasites e.g. insects, nematodes, of pests & weeds.
b) developing diseases of pests and weeds.
c) developing toxins of pests and weeds.
d) developing growth regulators to alter development of the pest.
e) developing behaviour modifiers of pests.
f) developing competitive and antagonistic agents. e.g. 'Dagger' a biofungicide which binds iron in the soil, depriving the "damping-off" fungus attacking cotton of this important trace element.

Many of the large agrichemical companies are investing at least 10% of the R & D budget in these biotechnical approaches to hedge against the decline of their synthetic products.

DNAP, a biotechnological firm, was originally backed by Campbell Soup, a multinational food company. Their expertise is in the use of somaclonal variation (variation arising from tissue culture) in the development of crop varieties. They are gearing their products to the sophisticated packaged and convenienced-food markets where faddism, and diet-health consciousness of consumers are important and where they can command higher price (and volume) for their products. A product which they have developed and test-marketing in the U.S. are the "Vegesnax", which are packaged fresh, crisp, juicy and nutritious small carrots, and celery sticks to replace potato chips as the most popular snack food.

The commonly used vector for plant transformation is the crown gall bacterium *Agrobacterium tumefasciens* . There is another, *Agrobacterium rhizogenes*, which also injects its plasmid DNA to the host plant and alters the plant development in terms of root induction, ability of roots to grow in culture etc. This phenomenon has a lot of biotechnological applications. The root cultures may be transformed to produce secondary metabolites, with medicinal value e.g. hyoscojamine and scopolamine and those responsible for mediating plant/bacteria interactions. These root cultures have also served to propagate the obligate parasite, *Polymyxa betae*, for use as a standard inoculum in breeding for resistance to rhizomania in sugar beet. It is also used as a biological test of cadmium availability in contaminated soils. This system can be also used to study uptake of certain nutrients in plants as microbial-plant associations are suspected to be involved. Interest is also directed to the genes encoded in the Ri T-DNA which cause morphological changes in the whole plant with the hope that the knowledge gained will lead to biotechnological alteration of plant form e.g. flowering, branching, root/shoot ratio.

An area arising from the development in molecular biological techniques, which has generated a lot of interest in terms of its application to breeding and genetic analysis, is the RFLP (restriction fragment length polymorphism). When the DNA of an individual is digested by a restriction enzyme, the resulting fragments will be separated in a gel electrophoresis in a pattern according to the various sizes of the fragments cut. Individuals with identical genetic constitution, will give the same pattern; related individuals with minor differences in the pattern while unrelated individuals will have different patterns. These banding pattern differences phenomenon is known as RFLP. These RFLP's can be used as genetic markers to 'fingerprint' plant varieties and clones, for variety protection rights, to establish relationship between plants, to organise germplasm and reduce breeding stocks, (in U.K., this is used by the immigration department to check applicants for immigration applying on family reunion grounds) and to assist in breeding if the differences in yielding ability and quality and other complex traits can be traced to particular RFLP's. Dr. Bollinger of a biotech firm, Native Plants Institute (Utah), who gave the talk, reckoned that his lab. can run several thousand analysis per month, and his charges were US$72.50/sample for a one-off analysis e.g. 'fingerprinting', and about US$65.00 per test for routine breeding screening analysis.

On our subsequent discussion with the research director of Pioneer Hi-bred, a seed company, he appeared also to be excited with this tool, as his scientists have isolated as a start four genes which could account for 5% of the yield variation; but he was not too sure about its use in practical routine plant breeding and selection because of the high cost and effort although these will be substantially reduced with subsequent development.

In his talk, the director of Pioneer Hi-bred which deals with hybrid seeds of commodity crops, revealed that the company spends about 10% of the R & D budget in biotechnology research. He also discussed some considerations he has to face in trying to translate these new and costly biotechnological techniques into commercial application in the development of varieties of low value commodity crops.

In corn or maize, there are only two inbred lines (with poor breeding values) which can regenerate from tissue culture. Hence they can only use these two lines to accommodate novel genes from other species. After which, they have to transfer the novel gene in these two lines to superior inbred lines for hybrid seed production. This requires conventional backcross breeding which may take some 6 years, by which time, the superior inbred lines may be superseded by better inbred lines. Secondly because of the high cost of varietal development with this new techniques there must be patent rights to protect their investments and the new varieties developed must be a high value added-product.

Dr. Green, of George Ball, a vegetable and ornamental seed company also stressed on the high R & D cost of biotechnology and its commercial applciations. In his vegetable and ornamental seeds industry the situation is more critical because of the fragmented and complex markets due to the interaction of geographic, cultural and climatic factors. So the choice of varieties and the ability to get high value-added advantage becomes crucial in deciding commitment of large financial and scientific resources in this approach.

Conclusion

The impression gained from this useful meeting is that plant biotech is high-tech and is expensive. While it is a very exciting area from the scientific view-point, to be able to translate it into a profitable commercial enterprise in the production of improved plant varieties, requires a good knowledge of the markets, to identify the varieties and the added-values needed to ensure a high price product, and a patient and firm financial and scientific commitment to ensure development of a successful and efficient technology.

Seed companies involved with commodity and staple food crops are a bit cautious in their approach to this area, as they are dealing with generally low value products. Large chemical and packaged food comapnies are very bullish in this area because of the need to protect their existing business and the availability of surplus funds. Many of these companies are buying up seed companies; and some scientists have expressed the fear that the new technology will go into the development of high-cost seeds of varieties, which are dependent on the proprietory chemicals of these companies or which are geared towards the faddism and consumer preference of the affluent markets; rather than to the development of varieties which feed and clothe the less priviledged in the Third World.

Soh, A.C.

AAR NEWS

Mr. P. Kayaroganam, rubber agronomist at AAR since its inception and previously holding the same position at Taiko Plantations Sdn. Bhd., has left his research job at AAR to take up an estate management position at Taiko Plantations Sdn. Bhd. Presently he is attached to Tuan Mee Estate.

On February 25, 1989, AAR Sports Club held its AGM (cum lunch) in which the following were elected to office.

President	:	Ramli Aziz
V. President	:	See Choon Mooi
Secretary	:	Sulimah Osman
Treasurer	:	Noraini Mohd Noor
Committee Members	:	K. Gopal Rosita Mohd. Akhir K. Barry
Adviser	:	Soh Aik Chin

High on the agenda in the sports programme for 1989 will be the exchange games series with Kelko S.C. and Boustead S.C.

Commodity News

Palm Oil

Malaysia

The Malaysian Oil Palm Grower's Council (MOPGC) sponsored a nationwide newspaper advertisement blitz in the U.S., involving the major U.S. newspapers and covering the major cities, proclaiming the health benefits of palm oil and countering the discrediting health-risk claims for palm oil by the American Heart Savers Association.

U.S.A., Brazil Agentina

Good news for palm oil exporting countries. As a consequence of the severe drought in 1988, the U.S. soybean stocks may reach critically reduced levels in 1989. Similarly the continuing drought may also affect the 1989 soyabean crop in Brazil and Argentina.

France

The EEC has announced measures to halt the rise in oilseed production and the "butter mountain" has shrunk to modest levels. Such developments may open up better prospects for palm oil in France which has been a difficult market for palm oil.

India

An expert group has recommended the setting up of a National Oil Palm Development Board. Preliminary surveys revealed that about 575,000 ha in nine states could be used for oil palm cultivations. The group suggested a strategy for planting 25,000 ha of oil palm by the form of the next century.

RUBBER

RSS 1 price held firm at around $3.04 per kg at the time of writing (4/3/88), with SMR cv/c at only 4 to 5 sen higher. Compared against November 1988 price stated in the previous newsletter, the RSS 1 price has improved by about 29 sen.

Of late, trading was rather quiet with prices fluctuating narrowly. Traders warned of a lack of demand in Western markets where supplies remain plentiful. They said Asian producers had plenty of stocks to compensate for the effects of the wintering period.

The latest Malaysian statistics showed a 5% increase in 1988 production in the country to a record 1.66 million tonnes, although an increase in domestic consumption prevented any effect on exports. Official Malaysian sources also predicted that prices will continue firm in 1989. They expect a 100,000 tonne shotfall in production over consumption in the period.

The latest International Rubber Study Group statistics revealed a record level of world consumption of NR at 5.11 milion tonnes, against 4.8 million tonnes in 1987, and a world production increase to 5.04 million tonnes against 4.77 million tonnes. Production & consumption of synthetic rubber also achieved record levels at 9.98 million tonnes (9.4 million tonnes in 1987) and 9.95 million tonnes (9.61 million tonnes in 1987) respectively.

NST 2/2/89, 21/2/89, 6/3/89