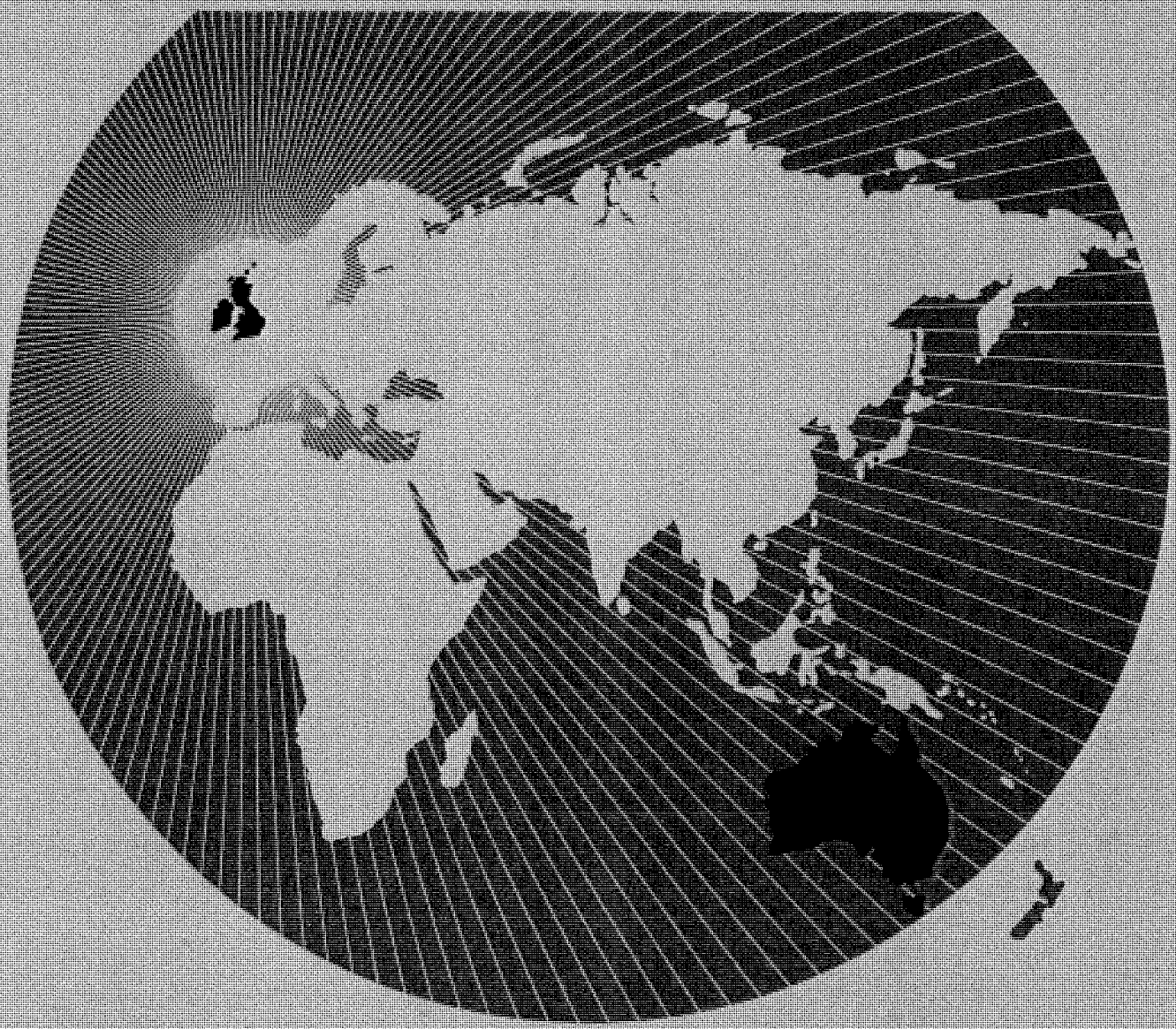

# Report of Visits to The United Kingdom

By I. V. McMichael, SA, 1980; Geoffrey J. Cox, WA, 1980; Dennis A. Hearne, NT, 1980

THE AUSTRALIAN NUFFIELD FARMING SCHOLARSHIPS

# THE AUSTRALIAN NUFFIELD FARMING SCHOLARSHIPS

The Australian Nuffield Farming Scholars Association was formed by ex-scholars in 1974 to continue the Scholarship scheme started in 1950 by Lord Nuffield in the U.K.

The U.K., Canada, New Zealand and Australia participate in the scheme and Australia, through the Australian Nuffield Scholarship Trust Fund, finance two scholars each year to travel and study for six months, principally in the U.K. and Europe.

The Australian Trust Fund has been supported by a large number of companies, organisations, individuals and ex-scholars.

Additionally, Qantas have given invaluable support by flying scholars to and from the U.K.

Scholars, upon their return, are expected to report on their experience for the benefit of all. Copies of their reports are freely available by contacting the Secretary, Australian Nuffield Farming Scholarship Association, C/o Royal Agricultural Society of Victoria, Showgrounds, Epsom Road, Ascot Vale, 3032.



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# 1

By I. V. McMichael
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*— 1980 scholar*

## Acknowledgements

I would like to thank all those who assisted me and made my Nuffield Farming Scholarship Study Tour possible and rewarding.

I would like to make particular reference to:

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Mr Eric Carter, Deputy Director of A.D.A.S.;

Dr Ken Baker, Director Meat and Livestock Commission.

Mr and Mrs Henry Pickering, my "farmer hosts," and to all those U.K. farmers and scholars, who helped me to appreciate their way of life;

To those members of A.D.A.S., M.A.F.F. and the N.F.U. who helped organise part of our program and guide us through the five months.

Finally, I would like to acknowledge the support of all the sponsors of the Nuffield Farming Scholarships in Australia.

## Introduction

For the past eleven years I have been involved in agricultural management. This has included an extensive program of breeding and fattening livestock, the clearing and development of virgin scrub land, pasture production, irrigation and staff training from jackaroo level through to management level.

For me, the Nuffield Farming Scholarship provided an opportunity to gain the experience and knowledge of others in the field of agriculture.

**This report consists of:**

**1. Agricultural Management in Britain;**

**2. Investment in Agriculture;**

**3. Trends in Labor Utilisation and Training;**

**4. Objective selection in beef cattle in France, Germany and Britain.**

It is obvious that the depth of study in such a wide field cannot be very great, but I would hope to give some conclusions that may be of interest to people involved in agriculture in Australia.

# Agricultural management in Britain

Although Britain is a densely populated country relying on imports for nearly half of its food supply, agriculture remains one of the most important industries.

In the past two decades agricultural management has been through two phases of change and is now embarking on a third.

**FARM BUILD UP:** The first phase in the 1950s. A general increase in the size of farm and rationalisation of properties took place. The poorer and smaller farms were sold up and people moved to the city.

**ENTERPRISE CHANGE:** The second phase. A simplification of enterprises and changes to more specialisation from the conglomerate of more traditional management technique. Entry into the Common Market also pressured the need for change in enterprise emphasis.

**FINE TUNING:** The third phase now being entered into. There is greater awareness for the need of a higher degree of specialisation; to keep a constant check on levels of inputs and outputs; to keep a constant check on inter community prices and become more aware of the world scene.

It is this "fine tuning" that has put management pressure on the farm business resources.

### LAND

Land is under a great deal of pressure. Values are unrelated to agricultural production and, as such, percentage yields on capital are very poor in some cases. Average net income for different types of full time farms ranged from 30 pounds per ha. on hilly, upland sheep farms with large areas of rough grazing to 170 pounds per ha.

on specialist dairy farms, excluding pig and poultry farms.

About 65% of the farms are wholly or mainly owner occupied, the balance being tenanted. Death duties have been a major factor in the breaking up of estates. Those surviving are mostly owned by private individuals or family trusts. However, corporate financial institutions are becoming more prominent as large landholders.

### LABOR

While unemployment is high, skilled farm labor is scarce. Part-time unskilled labor is plentiful. In recent years farm workers' earnings have improved considerably in real terms, but this has been offset by manpower economies made possible by increasing mechanisation and larger farms. Labor productivity has risen on average by 3.5% per annum between 1969-1979.

Legislation during recent years affecting the employment of agricultural workers has done little more than anticipate good labor management.

The most significant change is that an employee cannot be dismissed because his attitude is unhelpful or because he does not fit in with the other workers. Moreover, even if the employment of the worker ends, he has the right to remain in the tied house until a suitable alternative residence is found.

This legislation on employment draws attention to the need for improved selection and recruitment techniques. It also represents extra administrative work. The use of contract and part-time labor is therefore becoming more widely spread.

### CAPITAL

The capital required for land and buildings may be provided by the farmer if he is the owner-occupier, or by the landlord, if the farm is let to a tenant. Most of the capital for investment is generated from within the farm business.

Banks are the main source of short and medium term credit; much short term credit is also provided by agricultural merchants. Mortgage loans form the chief source of long-term credit and are provided by specialised financial institutions, such as, the Agricultural Mortgage Corporation Ltd. and private sources.

### MARKETING

Marketing and promotion of agricultural products are receiving more attention from producers keen to improve their returns and their image within the community. Products are marketed through private trade channels, producer co-operatives and marketing boards.

It is felt by some producers that farmers should have an operative role in the market place, in both buying and selling. Hence some co-operatives become not only concerned with marketing, but also with production, services and the supply of farmer requirements.

Marketing boards are essentially producer organisations with statutory powers to regulate the marketing of particular products.

On the individual level it is not uncommon to see a producer market his produce by a wide range of alternatives: Through co-operatives; individual farm shop; pick your own; direct to wholesalers; direct to retailers; livestock direct by weight and grade through the meatworks or through the open auction system, and through marketing boards. This is coupled with individual promotion by making use of attractive surroundings with farm walks and tours. A full explanation to customers of what they are doing and when various products are likely to be available is given.

It is important that producers keep a constant eye on the marketing scene within the community and make optimum use of price fluctuations. It is necessary that they consider themselves as part of a united Europe rather than the parochial feeling that exists in some areas.

### MANAGEMENT

Management decision making and analysis is generally carried out by a review of past performances. Production statistics, budget control and cash flow analysis are monitored regularly (in most cases, monthly), and collated with market intelligence and research to be able to make better calculated business decisions.

In some cases more senior farm staff aided the budgetary tasks of target setting and goals to be achieved — a commonsense approach to good labor management.

Computers are used in few cases, but it is felt that they are only economically justified in about 5% of cases at present. Many of the larger and more complex producers (who did not own a computer at present) felt that there would be a place for them in the future. They felt that currently the programs were not integrated enough to give them a useful feedback of information, and that alternative services were serving them well at present. Computers will be more widely used in the future and will help aid management decisions in this fine tuning stage.

### CONCLUSION

Management principles of the farm resources in Britain are similar to our own.

The land prices in Britain are getting too high to sustain viable agricultural production. I would question the high level of capital involved in machinery on the majority of farms. With the cost price squeeze, the regular annual changeover price of machinery, together with rising interest rates, must be a doubtful practice.

The most profitable farms I visited had backed off from the high levels of production, rationalising their resources of capital in plant and labor. With reduced overheads, a commonsense approach to labor, and the utilisation of contract and casual staff during peak periods, profitability was increased.

Commodity prices set by the European Communities Common Agricultural policy certainly underpins the market. It aids the budgeting process for the individual, but it is an unreasonable trading practice when surpluses are dumped on third world markets at below the cost of production. The Community is paying the support prices and hence they have the most expensive food production system in the world.

# Investment in agriculture

The pattern of rural land ownership is changing. Farmers are people whose occupation is a way of life that has existed in more or less the same form for centuries. They view change with suspicion and fear, often through ignorance or protection of their way of life. Institutional ownership of rural land, the city moving to the country, has received similar resistance.

### WHO IS INVESTING IN RURAL LAND?

1. Near-neighboring farmers accounted for 60% of all vacant possession farms sold between 1977 and 1979 according to Strutt & Parker (Land Agents).
2. Institutions (Insurance Companies, Assurance Companies, Unit Trusts and Pension Funds) purchased about 15% of similar land during the same period.
3. Individuals and syndicates wanting a sound long-term capital investment.
4. Hobby farmers.

### MOTIVATION AND EXPECTATIONS

For neighboring farmers and persons already engaged in agricultural activities expansion of enterprises in an endeavor to lower overhead and running costs per unit area and increase returns is the incentive.

Institutions see rural land as a

hedge against inflation. In general it is a more business defined approach. They are looking for a 4-6% yield plus a long-tern capital growth. Yield growth is also an important factor.

Land price movements over the decade 1965-1975 have been an average of 11% per annum. In the period 1972-1975 it was as high as 27%.

Combining yield with capital growth it is clear why institutions find land an attractive investment.

In general, institutions are only buying Grade I or II land in the more favored areas.

Acquisition of agricultural land is considered by all financial institutions as a long-term investment. Investment in land forms only a tiny portion of total investments. As there is only a small amount of land changing hands annually, there is very little scope to enlarge on this.

**Financial institutions concerned fall into three main categories:**

1. Insurance companies investing life assurance premiums.
2. Pension funds of individual companies and nationalised industries.
3. Property unit trusts which are designed to provide the public, pension funds and charities with opportunities to invest in land.

Of all the city institutions in the U.K. the pension funds are the most powerful. It is estimated that they own 60% of all equities quoted on the Stock Exchange. Income from pension funds in 1979 was 8000 million pounds. By 1985, based on the present rate of policies being taken out and the number of pension funds increasing, this annual income is expected to be 24,000 million pounds.

Of this vast amount, only between 0.5% and 2.0% is spent on agriculture annually. Of that figure about 30-40% is spent overseas.

Individuals and syndicates view investment in agriculture in a similar manner to institutions.

## MANAGEMENT OPTIONS

Some individuals and syndicates are turning to consultants who are providing a highly specialised farm management service. Such services encompass the management of physical and financial aspects of farm resources. Preparation of annual budgets and cash flow statements are monitored by a computer-based financial recording system. On all this is superimposed a pattern of consultancy visits (varying from 4-50 per annum) to provide advice. This is rounded off by annual reports, identifying plan and actual results and comments.

Almost all the land owned by institutions is freehold, only a few hundred hectares are leased.

**In general the management can be divided into five options:**

a. Buy a farm vacant possession and farm it by installing a manager.

b. Rent the farm in the conventional way.

c. Buy land with vacant possession and enter into a partnership, with the partners supplying the stock and plant and managing the enterprise.

d. Buy owner-occupied land which is leased back to the farmer (who is often prepared to pay a higher rent and has moved his fixed capital to working capital and is likely to improve his own yield — 12% plus, compared with 1.5% land assets).

e. Buy a farm with vacant possession and go into partnership with a young farmer allowing him to pay the equity yearly until he finally buys the farm.

Partnerships are becoming more popular where the institution owns the farm and the tenant farmer manages the farm and provides the working capital.

## THE ROLE OF FINANCIAL INSTITUTIONS IN AGRICULTURAL INVESTMENTS

Institutions, notably the insurance companies and pension funds, only own a small percentage of the total acreage at present, but seem set to increase this amount. They are buying only the better class of land and are insisting on efficiency through charging high rents.

They consider farming as forming part of their long-term portfolio of assets. They have shown to be willing to invest further for improvements, where it will increase the rental value of the land.

Their methods of farming, in many cases, are increasing the chances for young agriculturalists to enter into farming through being a manager or partner. Since legislation allowed security of tenure, let farms are regarded with disfavor. In many cases they are being taken in-hand, when ever possible, and a manager installed.

Tenant farm companies, like Velcourt Farm Managers Ltd., which have sprung up over the past few years, offer the landlord an alternative to letting the land for an almost compulsory two generations.

Institutions are slowly taking the place of the private landlord. They maintain the separation of ownership from farming. The institutions are not affected by the taxes crippling the private landlord as they do not pay them. Their taxation burden can be spread across their total assets. Thus it is unlikely that farming will be disrupted through selling the farms to pay for taxation.

Like private landlords, there are both good and bad institutions, and in the same way the good ones outweigh the bad ones.

## CONCLUSION

Institutions are bound to make more inroads into investment in agriculture in Britain. With such vast sums at their disposal and land at a premium, it is not unreasonable for them to consider Australia even more than they do at present. Currently exchange rates and distance make investment expensive and difficult to manage. However, we are a young small country in people terms with a large land mass requiring outside capital to enable us to develop our resources.

# Trends in labor utilisation and training

Farmers are having to manage a wide range of changes brought about by political, social and economic forces and the need to adopt new technology. One significant result is a smaller, more specialist workforce which is demanding a higher level of supervisory and managerial skill, coupled with the need to exploit opportunities offered by outside services and for sharing resources among farms in order to maintain flexibility, improve husbandry standards and reduce costs.

The trends in structural changes of farm businesses affecting the distribution of agricultural labor are the decline in the number of holdings, the increase in the number of large holdings and the concentration of livestock production into larger enterprises. It seems likely that these trends will continue.

Mechanisation has improved husbandry standards, but its most significant effect has been to reduce the labor force. However, there are some arguments put forward in favor of the work force stabilising.

**These are:**

1. Enterprise employment levels have been reached where further reduction would affect good husbandry and make it difficult to complete even routine tasks. Increasing specialisation of workers could reduce flexibility. Some farmers are encouraging staff to learn a second skill.

2. Machinery costs have risen dramatically and the price for new equipment has reached a level where further substitution for labor is becoming uneconomic.

3. Farming now offers pay and conditions comparable with other industries.

4. An increasing proportion of workers' wives have off-farm jobs and are no longer available as a source of casual labor.

Recent technical advances are leading to improvement in labor productivity through better livestock and crop yields, rather than by saving labor. Some technology requires a higher labor input. If better returns to labor are to be obtained in this way, then a higher calibre of worker will be required.

Legislation has anticipated good labor management. Eight Acts of Parliament passed in recent years have highlighted the need for improved selection and recruitment techniques.

**The Acts are:**
Contracts of Employment
Redundancy Payments
Equal Pay
Trade Union and Labor Relations
Health and Safety at Work
Employment Protection
Sex Discrimination
Agricultural Rent (Tied cottages)

The most significant change is that an employee cannot be dismissed because his attitude is unhelpful or he does not fit in with other workers. Also if his employment is terminated he has the right to remain in a tied house until suitable alternative accommodation is found.

Co-operation and sharing of machinery is becoming more popular, particularly among smaller farmers. The loss of flexibility, resulting from decline in the farm work force, should encourage more farmers to share an extra worker who might be a specialist or an all-rounder. An example is a travelling farm secretary.

Contractors are being increasingly used to provide machinery, know-how and operators at peak labor requirement times.

Technical services are being provided by a growing number of ancillary trades and professions. For example, the Milk Marketing Board provides enterprise costings, artifical inseminations, pregnancy diagnosis, etc. Such services enable new technology to be readily taken up.

## REWARDS

In general basic rates for farm workers are now more in line with other industries. Bonus and incentive schemes are common and numerous. Some are related to over target production, others to percentage of net operating profit. In general, the non-monetary incentives appear to be more appropriate for motivation and improved performance than finanical schemes. If farm workers are to be rewarded through increased performance, then increases in flat rates would seem to be more appropriate.

## TRAINING

Training in agriculture is very well catered for and organised in Britain. Universities and Agricultural Colleges generally cater for the technical training for degrees and Diplomas in Agriculture.

Local authorities play a large role in providing Agricultural Colleges which have full-time, block-release, day-release and other part-time courses available to farmers and farm workers.

The Agricultural Training Board provides a training advisory service and organises training courses in agriculture and horticulture.

The apprenticeship scheme for agriculture is the usual route to craftsman status. It is organised and run in conjunction with the A.T.B. and the N.F.U. The apprenticeship lasts for three years, during which the apprentice receives training and supervised practices in a selected category of work, attends classes of associated further education, and is tested for his proficiency in skills.

Craftsman status is important as it determines rates of pay. Qualified craftsmen receive a wage premium. During 1979-1980, 21,150 candidates participated in National Proficiency tests for various sections of the craftsman certificate.

Farm worker training is on the increase. It is an extremely well organised and integrated system.

## CONCLUSION

Trends in the labor force are not dissimilar in Australia, however, the historical events and legislation vary. Reward systems are similar.

While there are still large reductions in the farm labor force, there continues to be a steady rise in the demand for all aspects of farm training. Employers are demanding an increase in skilled workforce. There is also a growing awareness of the importance of greater efficiency at supervisory and management levels, which a skilled work force requires.

# Objective selection in beef cattle in France, Germany and Britain.

## FRANCE

French agriculture has often been criticised as being old fashioned and inefficient. It is true that in some instances time has passed some things by, but in terms of crop production and cattle husbandry, the French can be justly proud.

Environmental and soil conditions vary enormously through the length and breadth of the country.

With easily the greatest cattle population in Western Europe, France, unlike other countries, has 25% of its 10 million cow herd as beef suckler cows.

The most popular pure breeds of beef cattle are Simmental, Charolais and Limousin.

The most popular sire for crossbreeding is the Charolais.

A very high proportion of the A.I. bulls are the French Friesian breed and are both reared under performance test conditions and progeny tested for beef, as well as dairy characteristics.

Genetic improvement programs are carried out by Co-operatives which are controlled by two central government bodies. They administer, support and control policy on breed and group developments. This is usually in conjunction with local departments, but emphasis is given to the traditional specialities and needs of the area.

Apart from initial performance recording, all bulls to be used for A.I. are progeny tested. The basic progeny test for all breeds is similar.

**The main criterion for every A.I. bull is:**

1. Calving difficulties — most cows calve at 3 years and are very seasonal in calving pattern (80% plus are dropped in 3 spring months). As cows are reared naturally (i.e. not overfat), this is not the problem it has been to breeders elsewhere. The French have little objection to Caesarean operations when necessary.

2. Growth to 90 days — this gives a good indication of thriftiness and calf adaptability to suckling. It is claimed that growth to 200 days or more can be influenced more by quality and quantity of concentrates fed.

3. Conformation Score at Slaughter — this is usually given by an assessment of the 10-11th rib. The use of a standardised grading system with appropriate pluses and minuses gives a system which leads to comparative analysis.

4. Combination of Growth and Conformation Characters.

A very high proportion of the suckled cows in France are pure bred, and surprisingly few herds which are crossbred. Due to this background, it is desirable to do further progeny tests on maternal characters. The three main breeds participating in this area are Limousin, Charolais and Blond D'Aquitaine.

Annually about 10 bulls from each breed are tested.

Twenty daughters are taken from

the 10 bulls and reared at a central station.

**Details measured include:**

1. Age and weight at maturity (first oestrus).
2. Age at breeding; 3. Length of gestation; 4. Weight of calf: *Mating is always to bulls of known genetic worth so that other variables are minimised.*
5. Ease of calving — very easy to do a caesarean.
6. Calf mortality — a. birth; b. up to 24 hrs; c. — 48 hrs.
7. Dam's milk productivity
8. Weights of calves at 90 to 120 days.

From this information, bulls are then given a characteristics index for the breeding quality of their daughters.

**Characters include:**

1. Fertility
2. Numerical Productivity
3. Mortality
4. Milk Production
5. Calf Growth
6. Ease of Breeding
7. Progeny growth to 18 months
8. Conformation of Progeny
9. Development of Progeny

The work I saw being carried out was very detailed and impressive and geared to their market requirement.

## GERMANY

In Bavaria the aim of the breeding program is to improve the genetic productive capacity to ensure the economic success of cattle husbandry.

The sponsors of the program are breed societies, the A.I. centres and the state administration for animal breeding.

To supervise and execute the breeding program and carry out the necessary measures, the breed societies and A.I. centres have formed regional societies.

**The breeding program is divided into the following stages:**

1. Performance testing — this includes both milk recording and milkability tests, as well as meat performance testing.
2. Estimation of Breeding Value — progeny testing of bulls for fattening performance and carcass quality and evaluation of young cows, (i.e. ease of calving, milkability, etc.)
3. Selection — after an appraisal of the test results of male and female progeny as to performance in calving, milk and milk yield, milkability and external assessment, the above average bulls are selected.
4. Planned Matings — 5-10% of the best are used as sires for planned matings.
5. Rearing of potential breeding animals — bull calves from planned matings are raised in performance testing stations or in an on-farm situation. Females are raised and recorded on-farm.

A.I. plays a very large role in the Bavarian cattle breeding program. 87.5% of the cattle farms, which hold 82.5% of cows carry out A.I. In 1979, the number of first inseminations was 2.3 million.

The breeding program is well thought out and executed.

## BRITAIN

Beef production in the U.K. is based on the dairy industry. Approximately 70% of all the beef produced is derived from dairy breeds. Home beef production accounts for approximately 80% of consumption.

The United Kingdom has about 1 million suckler cows. Generally speaking, the suckler cow is a cross between a beef breed (Hereford, Angus, Galloway) and the Friesian. The hybrid cow has the advantages of availability, fertility and constitution.

Usually pure bred sires of the beef breeds are used as terminal sires. Hereford would be the most dominant, with Charolais, Angus and Simmental.

A.I. is widely used by dairyfarmers. Use in suckler herds is relatively low, but on the increase with the advent of Prostaglandans and other drugs to control ovulation.

The economically important beef production systems involve slaughtering cattle between 15-24 months. Calves are generally reared in the upland areas and fattened in the lowland areas.

Because of the high level of cross breeding to beef bulls, improvement programs concentrate on improving the beef crossing breeds, rather than the beef potential of the Friesian.

Several organisations are actively involved in livestock improvement:

The Meat and Livestock Commission — set up by the Government and paid for by an industry levy. Among some of its functions it provides a range of performance recording and testing services to breeders.

The A.I. organisations — play a vital role in exploration of proven bulls and participate in progeny testing for ease of calving and growth performance.

The breed societies — through normal registrations. Some societies operate type classification schemes which describe the conformation of breeding stock.

**The basic service is:**

1. On-farm weight recording — a bull's individual performance is compared with the rolling breed average for that trait.
2. Central Performance Testing — superior animals are compared for growth, feed conversion efficiency, skeletal size and backfat thickness.
3. Progeny testing of top performance tested animals — a great proportion of this is carried out by the Milk Marketing Board. Records are kept on ease of calving, daughter's production, and carcass evaluation of males. The M.L.C. has a program called the Young Bull proving scheme which is run in conjunction with breed societies for the same purpose.
4. Evaluation of Breeds and Crosses — this is carried out by the M.L.C. to evaluate performance so that their abilities are used to the best advantage.

To my mind the expertise and technological skills within the M.L.C. and A.I. organisations in the field of genetic improvement are frustrated by herd size and lack of co-operation of breed societies and, hence, breeders.

# 2

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## Acknowledgements

My appreciation goes initially to the Australian Nuffield Farming Scholars Association for awarding me a scholarship which allows one basically unlimited access to anything remotely associated with the varied agricultural institutions and operations throughout the United Kingdom and Europe; the "Golden Key" does describe it rather well.

Thanks to the West Australian Association members for their assistance prior to my leaving for the U.K.

My sincere thanks go to the major sponsors, without whom the awards would not be possible, namely: Qantas Airways; Rural and Industries Bank; Western Livestock — Westwools; CSBP & Farmers; Ansett Airlines; and the numerous other organisations who support the Association throughout Australia.

My gratitude goes to the people in the United Kingdom who helped make my stay in their country an experience of a lifetime; with special appreciation to: Capt. John Stewart, Director of Studies, and Mrs Stewart; Mr John Cyster, Chairman of Nuffield; Sir Emrys Jones, Mr Eric Carter, Dr Ken Baker, Program advisors.

The Milk Marketing Board for their generous assistance in supplying a vehicle for the period of my stay in the United Kingdom; Mr Duncan Hodge and family as my host farmer; Mr Michael Horrell — Nuffield Dairy Study Group; Mr Charles Foot — ex National Institute for Research into Dairying; National Farmers Union, Brussels office, for their assistance in Belgium and Netherlands.

My sincere thanks go to the many people who hosted or assisted me but are too numerous to mention personally at this time, but would include Meat and Livestock Commission staff, Milk Marketing Board staff, Experimental Husbandry Farms and Research Institute officers, Agricultural Department Advisory Service personnel, the National Farmers Union and the numerous farmers and associated businessmen.

## Introduction

I am a dairy farmer, 35 years of age, married with 4 children.

I began my farming career in 1964 on the family dairy farm of 114 ha.

In 1977, I began dairy farming in my own right, moving to Busselton, and gradually increasing my original property holding to accommodate 1200 litre daily milk quota, supplying market milk on 12 months supply basis.

**Location:** 26 km south of Busselton (pop. 7000) 214 km south of Perth in S.W. corner of Western Australia. Average rainfall 900 to 1000 mm May to October inclusive.

**Area:** 362 ha comprising dry land, subclovers, and rye grass on sandy loam and 30 ha summer moist, utilised for growing summer crops — maize, sudax, with balance of strawberry clover and lotus minor.

**Dairy Herd:** Comprises Friesian cows using A.I. with British and New Zealand blood lines, to breed replacement heifers, and steer beef sold at auction market. An average of 130 cows milked year round; calving year round.

**Fodder Conservation:** Summer country fodder crops are strip grazed and/or foraged; large round bales hay made in November; supplementary grain purchased and fed in the dairy year round.

I arrived in London on March 1, 1981, to join five other Scholars; 2 from Australia, 1 from Canada, 2 from New Zealand. Planned program as set out by The Nuffield Farming Scholarship Trust (U.K. Organisation) to start on March 3 with briefing by Director of Studies, Capt. John Stewart and meeting with other Nuffield Officials.

The balance of the week was taken up with meetings with Australian High Commissioner, A.D.A.S. (Agricultural Advisory Service), Departmental chiefs, and National Farmers Union officials.

**Week 2:** Wye College (Ashford, Kent) for one day's briefing on E.E.C. then to France for the Paris Agricultural Exposition, and half day visits to an arable dairy, and poultry farms, and Artificial Breeding Co-operative (Dairy Bulls). Belgium, to the National Institute for Agricultural Engineering and Institute for Cattle Feeding.

**Week 3:** Brussels; — three days of meetings with:

- N.F.U. (Brussels office and Organisers of this Section of tour)
- Agricultural Correspondent, Brian Gardiner,
- Organisations of Co-operatives, COPA,
- Council of Ministers, Secretariat,
- U.K. Representatives to E.E.C., Sir Henry Plumb,
- Australian, New Zealand and Canadian Representatives, and
- Final day of discussions at Commission Head Office with representatives of Departments of Overseas Relations, Agricultural advisory Cereals division, Milk, Beef, and International Affairs.

Day 4, back to England; each scholar collecting car supplied for the duration of Scholarship from Milk Marketing Board, to farmer host for 4 days — at Reading.

**Week 4:** To Olney, to the Residence of the Director of Studies: scholars were able to make a base here for the next 4 months. Balance of week; discussions with Advisors, visit to Meat and Livestock Commission.

**Weeks 5 & 6:** Tour arranged by Ministry of Agriculture, Fisheries and Food.

This tour was planned to give us an insight into all forms of agriculture in the West Midlands regions. Enterprises visited included:

- Grass Drying and Poultry at Widnes.
- Milk and Farmhouse Cheese Production in Cheshire, with whey supporting 40 sow piggery.
- Cattle Auction Market in Oswestry (cattle and sheep).
- Veterinary Investigation Centre, Shrewsbury, a major centre for livestock investigation including exotic diseases.

- Hill farming in Wales, Welshpool (suckler cows and sheep in disadvantaged farming area).
- Agricultural Education: — Harper Adams College, Newport (500 students specialising in dairying, sheep and poultry); Walford College, Walford (120 students, 2 dairy herds, bull beef, suckler herd, sheep, cereals, potatoes and pigs).
- Midland Shires Farmers, Worcester (Farmer Co-operative involved in stock feeds, fertiliser and agricultural merchandise).
- Experimental Farms: — Rosemaund E.H.F. (semi intensive bull beef, housing for beef cattle, sheep, plant breeding trials, cereals and hop). Luddington E.H.S. (research into fruit, vegetables, glasshouse crops and nursery stock).
- National Vegetable Research Station (researching problems and breeding vegetable varieties).
- Mixed farms: — visits to farms involved in: dairy, wheat, barley, sheep, beef, rape, grass seed production, grassland management and on farm computers.

For the remaining four months I travelled 10,000 miles studying specific areas associated with my field of agriculture, visiting areas from Cornwall and Sussex in the South of England, to Galloway and Aberdeen in Scotland, also in Holland and Denmark.

My congratulations go to Capt. John Stewart for his organisation of the six weeks planned program. It gave us an excellent insight into British and European Agriculture.

Our visit to the French Agricultural Exposition, although brief, was a great opportunity to see a huge display of European Agricultural Machinery, Horticultural and Food displays. The visits to three French farms showed the more "efficient" of their farmers.

The poultry farm was completely mechanised and obviously a very profitable concern for the owner. I was impressed with the quality of Friesian bulls at the Artificial Breeding Co-operative, but the problems with Foot and Mouth disease and the policy of vaccination made it impossible for them to show stock at public venues.

Our three days in Brussels was indeed an excellent opportunity to endeavor to learn something of the way the European Economic Community operates, of the problems it faces, and of the successes it has achieved. The major successes being the unification of previously warring countries, the opening of borders for trade opportunities, and the support by the stronger for the weaker countries; the problems being mainly surpluses of agricultural production.

## SPECIFIC AREAS STUDIED AND COVERED IN REPORT

Dairying in European Economic Community.

Dairying in United Kingdom, added value, Friesian, Holstein, calf rearing, management.

On Farm Micro Computors, Dairy Programs, Bull beef.

## DAIRY IN THE E.E.C.

The ten members of the E.E.C. produce about a quarter of the world's milk and are the world's largest single milk producer. At the same time the individual member states present widely differing patterns of production and structure. In the past ten years in specific dairy areas, cow numbers have increased by 25% whilst in areas offering alternatives (mainly cropping) cow numbers have decreased by 20%.

The average **size of dairy farms** is approximately 12 cows per herd. The difference between member countries is considerable, Germany having an average of less than 12 cows per herd with 520,000 dairy herds; U.K. having 71,000 herds with an average of 50 cows; Scotland's average being 77 cows, Northern Ireland 24 cows, with England and Wales at 53 cows.

**Milk averages from RECORDED Herds placed:—**

Denmark 5142 kg at 4.35% fat.
Netherlands 5063 kg at 4.02% fat.
U.K. 4837 kg at 3.75% fat.

**National milk yields come up with the following figures:—**

Netherlands 5050 kg at 3.99% fat.
Denmark 4870 kg at 4.28% fat.
U.K. 4790 kg at 3.84% fat.

In 1978 France had the highest national production at 31 million tonnes followed by Germany with 23.6 million tonnes and U.K. with 15.92 million tonnes.

## MILK PRODUCTS

The Netherlands is the E.E.C's major exporter accounting for 30% of butter, 24% of cheese, 61% of condensed milk and 23% of milk powder to non E.E.C. countries.

The U.K., on the other hand, is the community's major importer of dairy products being only 73% self sufficient in dairy products and also having the highest human consumption of milk and milk products at 21.5 billion litres.

**The following figures should highlight where the inefficiencies of the E.E.C.'s milk sector lie:—**

10 member countries produce 100 million tonnes of milk from 25 million cows by 1.8 million dairy farmers,
One third have less than 5 cows,
One tenth have more than 30 cows,
4% have more than 50 cows,
50% of milk produced on farms with less than 25 cows.
25% of milk produced on farms with 50 cows or more.
In the past six years 25% have left the industry.
The average yield being 4000 litres, per cow.

In the 1980 budget for the milk sector of common agricultural policy (CAP) of the E.E.C. calculated over 25 million cows produced a nett cost to the community of **$US250 PER COW!!**

## DAIRY FARMING IN U.K.

I visited milk producing farms varying in size from 40 cows in the old barn type milking shed, through to a family enterprise milking 700-800 cows in 3 units.

Dairy farms are generally very intensive, with one cow per acre being the accepted stocking rate; high concentrate feeding at a rate between 1¼ to 2 ton per cow per lactation; milk price currently 27 cents per litre, with farmers recently experiencing a slight reduction in prices paid to them and generally feeling the financial squeeze over the past two years.

**My impression of the dairy industry was that of one which has seen very affluent times and this factor had been taken up by:**

(a) The equipment suppliers who sold a very expensive and complicated set of equipment for removing milk from cows.

(b) Land prices which rose rapidly to $4000 to $5000 have currently stabilised if not dropped somewhat.

(c) Feeding high quantity, high cost "cake" with prices between $220 to $300 per ton, leading to their term "margin over concentrates" being the rule of the thumb for individual cow profitability.

On the other hand I found that farmers were generally very high calibre managers, playing the high production, high cost field which leaves very little room for error.

I was impressed with the level of agricultural education, the number of farmers and herdsmen who have received training in this field as compared with our situation where the majority are in a "take over father's farm" situation and are lucky to receive a complete secondary education let alone tertiary eduction.

With **DAIRY DESIGN** the herringbone is still by far the most popular. It appears that approximately 120 cows (which is a suitable number for the herringbone dairy) has also evolved as an average for good herd management. It appeared that farmers preferred to split their herds rather than try to manage the larger units, although it was not uncommon to find the 300-400 cow units.

The Rotary design being more suitable for these larger units, Polygon and Trigon parlors being

the latest types available but they are only a glorification of the herringbone design with marginal improvement in cow throughput.

Electronic controlled feeding systems are very common, with computer controlled units now emerging.

## ADDED VALUE

This area is a current growth area amongst milk producers in U.K. It involves processing the milk, on farm, so as to receive a higher return for every litre of milk sold.

At the forefront is the producer-retailer who is involved in packaging and sale of his milk direct to the consumer. Owing to the fact that it is legal to sell raw milk in England, a producer can equip himself with manual bottling equipment at very little cost, so as to increase his earning from one litre of milk from 14 pence per litre to 31 pence per litre.

I carried out the financial exercise with one farmer who was selling less than 100 litres per day; after deducting costs for bottling, industry levy, depreciation on vehicle, delivery etc., was showing very good returns. While this may be good for the individual producer, it could in the long term be detrimental to the price paid to the remainder of the industry, owing to the decreasing percentage being used as bottled milk.

Other farms visited involved in this type of operation were producing farmhouse cheddar, devon cream (clotted cream) and fancy dairy products (sweet lines).

## BLAST FREEZING OF CREAM

This appeared to be a new line in frozen dairy products. It consists of small portions (dessert spoon size) of snap frozen cream bulked into plastic bags of various sizes. The product can then be stored in the household freezer for thawing and use in varying amounts as required. The blast freezing process allows for thawing of cream to its original state.

## HANNAH RESEARCH INSTITUTE

I was interested to learn from the Hannah Research Institute in Scotland about the development of a milk based protein which is currently being produced by the Scottish Milk Marketing Board at their Galloway Dairy Plant in Stranraer. This product is being used to combine alcohol and cream for the cream liqueur industry. The Irish-based industry is currently utilising 18 million gallons of milk for cream per annum for inclusion in their product.

## FRIESIAN, HOLSTEIN

There is strong industry debate about the merits of the two breeds. The opposition to Holstein being their apparent lack of beefing qualities. This problem is aggravated by Britain obtaining 70-80% of its beef supplies from the dairy herd.

Holsteins are being used in preference to British Friesian by dairy farmers because of their large frame and good milking qualities. Friesian beef producers are unknowingly buying Fr X Holst. calves and finding they are not fattening as well as the straight Friesian, this has now reacted by way of depressing the calf markets. I found two sides to the story: on one hand Bull Beef producers maintain they are going out of fattening "black and whites" because they could not guarantee Friesian cattle. On the other hand, a Holstein Breeder showed his bull fattening operation where Holsteins were being turned off at 11 months of age, at around 400 kgs. live weight, with daily weight gain of 2-3 kgs being recorded.

In work done by the Meat and Livestock Commission on comparisons of the two breeds, the following conclusions were made:—

**Canadian Holstein carcases compared with Friesian carcases of similar external fat cover, and from the same production system, will be on average:**

— be 10% heavier,

— be one or less frequently two conformation classes lower on the MLC classification scale,

— have marginally thinner muscles,

— have 1-2% (of carcase weight) less suitable meat,

— have approximately 1% (of saleable meat) less higher priced cuts.

## ACID MILK FOR CALF REARING

The feeding of acidified milk to calves was developed in Holland in 1973.

It allows for the feeding of fresh or reconstituted milk to calves on an ad lib basis with replenishment being up to three days. Acidifying the milk involves the addition of organic acid to increase the Ph of the milk so that bacteria cannot survive; the aim being to wean calves at 5 weeks. It is claimed that 30% of dairy farmers in England now use the system.

In England acid milk powder was available along with conventional calf rearing milk powder.

Milk replacer powders can be divided into two categories, "medium" and "high acid", the former having a Ph of 5.6-5.8, the latter of 4.2-4.4. The choice of Ph level depends on the composition of the powder. Those containing a high portion of skim milk will fall into the "medium acid" category because casein, their main milk protein constituent, clots at a Ph below about 5.6. "High acid" powders are based on constituents other than skim milk, e.g. whey powder or other non milk proteins, that do not clot at low Ph's.

The "medium acid" powders based on dried skim milk are similar to their predecessors but with the addition of an acid. The "high acid" powder allows a wider choice of protein to be used in formulation and a longer mixed life, thus saving on labor for mixing and feeding.

The acids used are based on organic acids or formalin. Citric, Propionic, Formic, Malic and Fumaric are some of the acids used, at 1% level for "medium" and 2-2½% for "high acid" powders. The same percentages are used for the addition to fresh milk.

The acid **ad lib** feeding has become popular in U.K. because it allows reduction in labor of twice daily feeding and can be set up at low capital cost as compared to systems based on machine feeding of warm milk replacers.

**The advantages and disadvantages could be listed as follows:**

**ADVANTAGES**

1. Convenience.
2. Labor saving.
3. Better calves at weaning.
4. Inhibition of E. Coli?
5. Less scouring.

**DISADVANTAGES**

1. Reduced supervision.
2. High consumption?
3. High check at weaning.

The claims to inhibition of E. Coli (reduction in gut flora) are yet to be substantiated, it could be that well fed calves on a little, and often, basis do better than others on conventional systems.

The Meat and Livestock Commission suggest that calves should have progressively reduced access to the milk over a two week period, with access to concentrate, to facilitate unchecked weaning at 5 weeks.

## FLOW METERS

Flow meters are currently being introduced into the bulk milk collection system in England. The system developed by the Milk Marketing Board of England and Wales consists of three main parts: the meter which fits between the tanker and the farm vat; a totalisor which stores the number of pulses transmitted from the meter and a printer unit which prints out the ticket. The meter is fitted with devices to ensure that only the flow of milk is measured. It consists of an eight bladed rotor or propellor which is turned by the milk as it is pumped in or out of the tanker.

In Scotland and on the continent a different type of meter is used. It

consists of a positive displacement meter (similar to those used in the petroleum industry) and apart from being more complicated is approximately three times as expensive; the M.M.B. meter was costing $2000 per meter to the Board. Approximate costing for sale outside the Board was $4000.

Accuracy — The M.M.B. claims limits of error at 0.35% for farm pick up. This figure being very favorable when compared with plus 1% accuracy for petrol pumps.

To maintain accuracy the Board have set up a meter calibration centre at Crudgington, Shropshire, at which meters will be tested by computerised equipment twice yearly. The centre is designed to be able to handle units from their 2500 road tankers.

Milk producers have readily accepted the changeover owing to the ample evidence of inaccuracies in reading and calibration of the old dip sticks. The future possibilities involve developing a completely automatic system using magnetic tape to record all milk pick up details which could be processed into a central computer, completely removing any possibility of human error. The problem of computer error would then have to be closely monitored.

## THREE TIMES DAILY MILKING

Two properties I visited were three times daily milking. The main attraction for this being an apparent lift in production. The main disadvantage being obvious.

The latest research figures from Boxworth Experimental Husbandry Farm shows that 17% more milk was obtained from three times daily milking, with little increase in feed consumption. This increase makes the procedure financially quite rewarding, but places pressure on the labor requirement.

The best solution appeared to be in having one dairyman doing early morning and mid-day milking and perhaps a casual doing the milking between 8-10 p.m. This situation improves the spread of work hours for the main dairyman, but requires the extra person for the evening milking.

Work carried out in Canada suggests that after three years of 3 x daily milking cows tend to lose condition and that milk yield averaged out to the same as twice daily figures. It would appear that perhaps the best situation would be to 3 x daily milk during the flush period (spring) and twice daily for the remainder.

## GRASSLAND MANAGEMENT

One cannot help but be impressed by the grassland management practices of the British farmers, the phenomenal growth that occurs in spring and summer (up to three cuts of silage) with the help of large amounts of nitrogen (2-3 units of N per day being not uncommon amounts). This growth allows for grazing as well as making silage for winter feed when all cattle are housed. The old argument of break feeding as against set stocking still goes on; having visited farms using both systems and farms using some of each it appears that the matter has still not been resolved.

Visiting the Hannah Research Institute in Ayre I noticed that in work trying to bring white clover back into the grass sward, they were claiming fixation of 160 kg. equivalent N per acre back to the soil. This coincided with the wish of many farmers to cut back on the amount of nitrogen fertiliser used over the growing period.

## ON FARM MICRO COMPUTERS

It is suggested that computers can be economically justified on perhaps 5% of commercial farms in the U.K., the farms would be large estates, or businesses involving general farms, or medium size farms with large dairy (200 cows), pig or poultry units. The main application for farm computers are financial management and livestock monitoring and control.

The main task, when purchasing a computer, is identifying the problems which need solving and then finding the software that is suitable for the job. As my interest was in the dairy programs, I shall restrict my comments to this area.

**The following organisations all had dairy programs available:—**
**Daisy:** Reading University, Reading.
**Farmplan:** Ross-On-Wye, Herefordshire.
**Farmfax:** Winchester, Hampshire.
**Supercow:** Upthorpe, computer programs, Didcot, Oxfordshire.
**Fullwood:** Ellesmere Electronics, Ellesmere.
**Farmdata:** Oldmeldrum, Aberdeen, Scotland.
**Semex:** Guelfe, University of Canada.

Prices for programs ranged from $2000 down. All programs recorded similar information per cow; e.g. name-number, calving date, yield, reproduction status and health information. The differences were in the report presentation.

Reports can be presented so as to highlight different areas: — e.g. production, health, calving patterns, etc. They can be used by the dairyman to assist in herd management, or by the owner to assist in overall supervision of the dairyman and the herd.

In talking to farmers using computers to monitor dairy herds, it becomes clear that it takes time to learn to extract the most out of the program, this can be up to 12 months. It should also be pointed out that it can take 2-3 days to input the cow data in the first instance.

The major problems appear to be in selecting which program is most suited to your own situation, and, the justification of the expenditure of $6000 for your own computer when similar bureau services are available at less than the cost of a service contract, which will cost between 8 and 12% of the computer hardware price.

My conclusion is that for the farmer who already has good records, and used them to his advantage, the one justifiable reason for having a computer is that immediate access to those records will make the difference between owning one, or using a bureau service and waiting the 2-3 weeks for reports to be processed.

## BULL BEEF

Entire cattle are readily accepted by the trade for beef at premium prices over steer beef. The product is sold mainly direct to the supermarket trade which show a keen preference for the lean cuts of meat which entire animals produce. The restriction on greater numbers of entire cattle in the United Kingdom has been the requirement for fencing to be a standard which makes the cost of the operation prohibitive. Therefore, all bulls are currently fattened indoors. These regulations have recently been relaxed.

In Holland 97% of male cattle are entire which proves the acceptability of the product. I recall the story of a Dutch student visiting England and witnessing his first castration operation, which brought tears to his eyes!

Meat and Livestock Commission advisors claim the following results from trials on Friesian bulls and steers:—

| | Bulls | Steers |
|---|---|---|
| Daily gain (kg.): | | |
| Calf rearing | 0.6 | 0.6 |
| 3 months to slaughter | 1.3 | 1.2 |
| Overall | 1.2 | 1.1 |
| Feed conversion ratio | 4.9 | 5.3 |
| Slaughter age (days) | 333 | 328 |
| Slaughter weight (kg) | 436 | 397 |

These differences give bulls a gross margin approximately 50% higher than steers.

I would conclude the following points: Relative to the United Kingdom and Europe:—

- Bulls grow faster than steers, using their feed more efficiently, producing heavier, leaner carcases required by consumers;
- Although bulls are more independent, aggressive, and ride each other more than steers, their management presents no insurmount-

able problems provided attention is paid to safe husbandry.

- Producers are developing management systems and husbandry methods which make bull beef production both profitable, and safe. They also carefully examine the marketing of this product.
- The crest on the neck of bulls suggests a poorer ratio of fore to hind quarters than in steers. Although bulls have a slightly smaller proportion of saleable beef in the higher priced cuts, this disadvantage is minor compared with the high yield of lean beef. Some traders consider the cascases too lean for their particular outlets.
- Traders sometimes complain that bull beef cuts were a dark color, substantially reducing the value of the carcase; evidence of this incident is low, and can be minimised by careful loading, transport and slaughter.

In relating the system to the Australian markets I see problems competing with the British Breeds on the local trade. I suggest that the increased conversion rates could be profitably utilised by Friesian Steer fattening for the export trade.

## CONCLUSION

The area covered by my report represents my observations of British and European agriculture, in fields basically similar to my own enterprise. An area not covered by my report, represents an enormous amount of information, not directly applicable to me, but should allow me to broaden my horizons in my future farming operations.

# 3

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## Acknowledgements

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Captain John Stewart, OBE, director of the British Nuffield Farming Scholarships Trust and his wife, Eileen, also claim personal thanks. Captain Stewart unstintingly helped all of the scholars. While at first we did not fully understand his role and therefore did not appreciate his efforts, as time went on each one of us came to realise just how much unsung work went on behind the scenes to smooth our various ways. Eileen admirably fulfilled her role in providing us with cultural contacts but it was on a personal level that she ably assisted every one of the scholars and made our stay in the U.K. much more pleasant.

Other acknowledgements which must be made include —

- Mr Jefferson of Qantas, London, who ably sorted out my air tickets and provided me with the generous baggage allowance that helped me take home all of my collected reprints and reports;
- Sir Vic Garland, the Australian High Commissioner in London who engineered and executed my presentation to Her Majesty, Queen Elizabeth II and His Royal Highness, Prince Philip, at the Royal Garden Party in Buckingham Palace on the 14th of July, 1981;
- Dr Janet Blake of the University of London's Wye College who provided me with a tremendous insight into British research;
- Dr Graham Hussey of the John Innes Research Institute who opened all of his research to me;
- Dr George Staritsky of Wageningen in Holland who gave me his time, techniques and his published works and proved to be one of my most valuable contacts;
- My first farmer host, Mr Richard Flint and his wife Linda who provided a friendly haven during those first terrible weeks in a strange country, a haven that I was able to revisit on many occasions and never wear out my welcome. Richard's attitudes, behaviour and knowledge epitomised the very highest ideals behind the Nuffield Scholarship;
- In America thanks must go to Mr and Mrs Gillis Douglas for providing a wonderful home away from home. Their assistance and that of their family made my task infinitely easier in that country;
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- The Northern Territory Government, although young in years, showed its political maturity in joining the Nuffield Foundation and thus providing an opportunity for me to study overseas. Sponsorship that was provided gave my airfares and provided a living allowance that greatly reduced the burden which 6 months overseas creates. For their far-sighted vision in joining the Nuffield scheme and thus allowing me to perfect my techniques, I therefore thank our Chief Minister, Mr Paul Everingham, the Minister

for Agriculture, Mr Roger Steele and all of those other officials who were closely linked with my selection.

The Australian Nuffield Farming Scholars Association must also be publicly thanked for their vision in selecting me. One hardly thinks of plant tissue culture as a farming subject; rather it is a science. Faced with a decision, the selection board did make an unprejudiced choice. I am sure that decision must have caused some headaches along the way, having a farming scholar who was not a farmer in the accepted meaning of the word. However, I hope that this report and the obvious gains that have already arisen from my study tour will justify the faith that they had in me.

In closing, one final acknowledgement must be made and that is to a young couple, Lauren and Cindy Oki in Sacramento, California. During the last week of my tour of America, I came down with pneumonitis. Lauren and Cindy took me as a stranger into their home and for a solid week Cindy was a devoted nurse whose only care was my welfare. No amount of thanks could begin to repay the debt I feel to these young people.

There are many, many others who have assisted me. Although space does not allow me to mention them, they know the part they have played and are all assured of my heart-felt gratitude.

# AN INVESTIGATION OF PLANT TISSUE CULTURE METHODS AND TECHNIQUES UTILIZATION OF MATURITY FACTOR TECHNIQUES: ROLE OF PLANT TISSUE CULTURE IN CREATING NURSERY TRENDS AND DEMANDS.

## INTRODUCTION

The Nuffield Farming Scholarship, which I received in 1981, was undoubtedly the turning point in my career.

At last I thought I'd be able to see what the world had to offer. Right at the beginning it is great to report that Australia, in the field of plant tissue culture, is right up amongst the leaders.

In fact, it could be emphatically stated that Australia in many instances is the leader.

Plant tissue culture, as an industry, is fragmented throughout the world, despite the efforts of notables like Dr Ron De Fossard and the I.P.T.C.A. (International Plant Tissue Culture Association).

Often advanced techniques of very real horticultural potential are kept locked up in university laboratories, or are jealously guarded by private labs., which frequently do not have the capital to exploit them. Certainly there is no "clearing house" facility where techniques can be independently assessed and evaluated.

All this leads to a situation where the greatest potential industry in the world is stultified and is in fact suffering from inefficient techniques and formulae. Answers are available, if only you know where and how to look, or have the good fortune to stumble over a good lead, and the ability to exploit that information.

In many cases, where commercial operations have employed plant tissue culture, they rely on published techniques and pre-mixed undefinable media preparations frequently obtaining sub- or marginally economical results.

These poor, and frequently non-reproducible results have badly damaged the image of tissue culture plants, and in fact, I discovered, during my tour, that many of the smaller (up to US$1,000,000 invested capital) laboratories were closing down through lack of guaranteed supply.

I approached my scholarship with a great deal of trepidation. In the U.K. such notables as Blake and Eeuwins, Owens and Hussey had dominated the literature for a long time. Likewise in Europe, with Pierik, Staritsky and Meakers and in the U.S.A., with such names as Murashige and the Nitches. These people had been involved virtually from the beginnings of tissue culture, and here was I, an outback Aussie, coming to both learn and to challenge some of their ideas.

The first six weeks of the scholarship were spent in getting to know my fellow scholars, our British officials and going on a hair-raising tour of Europe, which properly belongs in the pages of a story book.

Most of our time was spent in France, where the highlight of the trip was a day at the Paris show.

There was not a great deal of advantage in this period in terms of tissue culture. The Nuffield selection board saw the trip as a group exercise where each one of us would be exposed to the others' fields. I learned an awful lot about sheep and beef cattle, wheat farming and almost everything except my own field. One of the most interesting events that did take place was a visit to a stock-breeding institute in central France, where bull semen is being stored in liquid nitrogen. The interesting thing is that semen samples that have been in storage for up to 50 years are still viable and capable of giving rise to calves. It is in the field of cryogenics and the instigation of sperm banks, that the French have excelled. I would have liked to have followed this line of thinking more fully, and investigated the possibility of using these techniques on undifferentiated plant tissue, but unfortunately time and organised events were against me.

Armed with a car generously loaned to Nuffield Scholars by the U.K. Milk Marketing Board, I began my private study tour.

## UNITED KINGDOM

Dr Janet Blake, together with Eeuwins and others, pioneered work on the tissue culture of coconut palms and dates. Their work represents a major contribution in the culture of these most difficult of plants. It has also proved to be the basis of the only commercial production of coconut palms through tissue culture.

Published works of Dr Blake set the base for my own successful experiments with coconut tissue, when using modifications to her formulae, I was able to initiate embryoids and subsequent shoots from cross section of floral initiation in young rachilla (flowering spikes).

It was really great experience to work and talk with Dr Blake, and together we initiated a number of trials including one with a maceration process on coconut callus tissue. The idea behind this trial was to crudely macerate coconut callus tissue in a high cytokinin, high auxin mixture and thus try and stimulate the controllable formation of embryoids and rooted plantlets.

This technique, which I had successfully proven on grape leaf segments and also ferns, has since given results with members of the Droseraceae (insectivorous plants) and also several other genera. To date however, no results are available on the coconut trials.

My work at Wye College came under close scrutiny by Professor Schwabe, the Departmental Head, who indicated that the college would be prepared to guide and examine me through a PhD if I chose to accept the offer at any time in the future.

My work also led to Sir Vic Garland choosing me from all the Nuffield Scholars to be presented to Her Majesty, Queen Elizabeth II, His Royal Highness Prince Philip and other members of the Royal Family at the Royal Garden Party in Buckingham Palace on the 4th of July, 1981. At this time, I also met Mrs Thatcher, the Prime Minister of Great Britain and some members of her Cabinet, who all seemed impressed with my work. This in turn led to the commencement of negotiations with Sir Henry Abel Smith (ex Governor of Queensland) on the supply of mangoes to Rhodesia and Zambia.

I spent considerable time also, at East Malling Research Station, where some remarkable work has been done in the past on the tissue culture of apples. Unfortunately emphasis has shifted from tissue culture trials to cuttings and conventional propagation trials.

At Brogdale Research Station however, quite the opposite attitude exists, and there is a heavy emphasis on the tissue culture of fruiting plants. At Brogdale, I had opportunities to discuss my ideas and refine many of my attitudes.

## EUROPE

From the southern part of UK my researches took me first to Belgium, and then into Holland.

In Belgium I was able to visit several commercial nurseries, all of which practise tissue culture as an integral part of their normal plant production. In the case of bromeliads it is noted that the techniques used (which are supposed to be among the best in the world) result in a cull percentage of **up to 40%.** This is occasioned by the prevailing attitude throughout most of Europe that the only rapid multiplication method of any worth is via callus manipulation. I proved the fallacy of this theory over 2 years ago in my own laboratory and have not, despite many thousands of plants produced over many different species and varieties, had a single visible mutation with my technique. That is, that I have not needed to cull **whatsoever** which is quite obviously a different story to the one in Europe.

As most of the bromeliads sold in Europe today are the result of tissue culture techniques and as the family rates as the fourth highest seller on the European market (that is many, many millions of plants per year) the advantage of the Darwin developed technique is readily seen.

It must be emphasised that my technique, based as it is on adventitious and axillary shoot formation, and totally ignoring the currently preferred and accepted technique of callus multiplication, is **proven.** It gives as great, or greater, production rates than existing techniques in a shorter time, with **none** of the potential dangers inherent in any technique that is based on a callus phase.

Other plants of prime importance to the European horticultural scene include the gerbera daisy, particularly the black-eyed and sunburst varieties, gloxinia and African violet. Once again, the prevailing techniques in Europe insist on de-differentation into callus as a preliminary step to rapid multiplication. All of these plants may be produced in numbers in excess of 15 billion per year from a single explant without using a callus phase and without any of the attendant problems of mutation or variation coming into the cloneline.

From Belgium I toured north into Holland and visited most of the major laboratories in that country, both at private and university levels.

The Nuffield Scholarship and knowledge of the British Nuffield Board stood me in good stead here and did, indeed, open many doors for me. Mention must also be made of the Australian High Commissioner in the Hague, who made me most welcome, and gave me many valuable contacts. My prime target in Holland however, was the University at Wageningen in the centre of the country. Here, in a rural setting, is a large University devoted completely to farming and horticultural pursuits and within that University is one of the finest tissue culture facilities anywhere in the world. The Dutch, very early in the piece, seem to have realised the advantages of tissue culture in a commercial sense both for farming crops as well as horticultural crops. The Institute at Wageningen is geared extensively to the exploitation of these crops.

There are two schools of thought in Wageningen, one headed by Dr Pierik, a great proponent of the callus multiplication technique. The other is headed by George Staritsky, who, like myself, believes cultures started from larger explants and taken through little or no callus development give far better yields of superior plants. Staritsky explained to an incredible depth his research, the results that he had achieved and the methods by which he had achieved those results. In view of the comments made earlier about the 40% cull rate in Bromeliads, it is probably worthwhile to point out that in Staritsky's work on coffee (growing coffee embryoids and subsequent plantlets from leaf tissue) a total of 20,000 plants produced from a single leaf explant, gave only two plants with a different ploidy level. These were actually tetraploids instead of the normal diploid. This to me sums up the huge advantages of the more modern way of thinking, where if it is at all possible, the callus phase is totally ignored.

Pierik, as a proponent of the callus technique was quite emphatic, that no reputable tissue culture technique could be worked out that did not go through the callus phase, despite Staritsky's work being done less than half a mile from his own laboratory.

The best results that Pierik has achieved appear to be with Bromeliads. Even with his most modern techniques using involved apparatus and liquid culture on moving frames, those Bromeliads were still giving as much as 20-25% maturation, which to Pierik seemed to be an acceptable norm. I must say that in both Europe, England and even in America, Pierik is regarded as one of the doyens of tissue culture and so this attitude is very widespread.

There were many nurseries in Holland that have completely geared themselves around plant tissue culture. The foremost of these is Boerkerstein Brothers in De Lier, just south of the Hague. Here, in the most modern nursery I have seen in the world, are pro-

duced some 17,000,000 plants annually. Approximately a third of these are derived from sterile cultures.

Sion Nursery in Rijkswijk was another truly incredible place, growing many millions of Nephrolepis fern and Rex begonia, all originally from tissue cultures. Holland, of all the European countries, is the only place to capitalise on the concept. Even so, much of what they produce and grow is via primitive — even antiquated — techniques. Generally multiplication rates for ferns and begonias are considered good if in excess of an average x 10 a month; any higher is excellent.

(By way of comparison, our Rex begonia medium is giving yields of x400 to1000 per month, depending on variety!!)

Northern Holland had a great deal to offer, and I spent considerable time in the Flevoland and the polder areas of the North. Farming students, met through the auspices of the British Nuffield Foundation, proved to be superb hosts, and through them I gained great insights into the role that plant tissue culture can play in helping agriculture.

The Flevoland is a great producer of tulips, hyacinths and potatoes. All three plants are amenable to tissue culture and all have been tested extensively by Dr Graham Hussey, of the John Innes Research Institute, in Norwich, Norfolk.

Through my Dutch farmer hosts, I was able to observe the expansions and refinement of Dr Hussey's work at the University of Groningen.

Production of seed potatoes is an immensely profitable aspect of farming. Unfortunately it takes up a vast acreage of land.

From results observed at Dr Hussey's laboratory, and also those seen at Groningen, it is obvious that the culture of marble-sized axillary bulbils is not only possible, but a highly desirable and economical method of producing seed potatoes. Amplification of the existing technique will give a situation where off-season bulbils could be produced in the laboratory all winter and be available for direct sowing from a modified potato drill, early in the season, thus freeing large areas of land for field production of edible crops, rather than "seed" potatoes.

Holland, with its varied aspects and wholehearted support of the tissue culture concept, was by far the most valuable part of my scholarship.

Back in England, it was through the auspices of Captain John Stewart that I was able to go to John Innes Research Institute at Norwich to meet Dr Graham Hussey and I must say that the time spent at Norwich was most memorable.

His laboratory assistant also turned out to be very helpful and she spent quite a considerable time with me gong over his current research and then turned me loose in the library where I was able to photocopy some 1000 odd individual papers. This incidentally gave me an excessive baggage by the time I returned to Australia of close to 100 kilos.

Without doubt, Dr Hussey, of all the people I met on this scholarship, made me think. More than that, he made me retreat to secure ground to re-examine my theories — and then helped me reconstruct a few of them in a more thorough and realistic manner.

Contacts organised in Australia, and exploited once I arrived in the U.K., led to lively correspondence with Dr Hannah Lillian-Kipnis, of Bet Dagan, Israel and Antonio Ferrari of the firm Zanzai Ferrari in Italy.

Dr Lillian-Kipnis, like me, had trained under Dr Ron de Fosard, of the University of New England, in Armidale, N.S.W.

It is interesting to note that she, like me, has achieved "maturity factor" symptoms in plants grown in tissue cultue, but arrived at these symptoms from an entirely different set of criteria. Obviously there is a lot yet to be understood about the triggering mechanism involved in this "maturity factor."

Lillian-Kipnis has done some very remarkable work on date palms.

Probably the most outstanding results she has achieved is that cultures taken from specially treated palms have produced flowers within 3 years of deflasking from culture.

Normally, a seedling date plant will take 12 to 25 years to reproduce a flower.

It is not until then that the seedling plant can be identified as being male or female. This is the biggest problem facing any would-be date farmer. The more usual technique of chopping off suckers from plants of known fruiting potential is fine but the number of suckers produced by any one plant is fairly limited and is certainly not conducive to starting up a large industry anywhere in the world.

The breakthroughs that Dr Lillian-Kipnis has achieved are obviously of very real significance. From her specially treated parent plants she was able to take leaf tissue and stimulate that tissue (without callus formation) into producing embryoids. These embryoids were then further multiplied, or put on special mediums to produce roots. Once this had occurred, the plants were pricked out in the normal manner of seedlings. The fact that she did retain a maturity factor is indicated in that some of the treated plants produced flowers within three years of deflasking. Other plants derived from tissue which came from palms which had not been pretreated did not retain the maturity and reverted back to juvenile status so that the palms, while being of a known sex and clone line, will probably take as long to produce fruit as a normal seedling.

The people at Zanzai-Ferrari are not professional scientists. The firm is one of the largest producers of fruiting plants in Southern Europe and they specialise in virus-free trees grafted onto known growth-modifying root stocks. A lot of the scion material used in their trials orginates from tissue cultured shoot tips, where virus symptom free status can be easily monitored and maintained. I imagine they would be interested in my "in vitro" grafting technique, where, with some species (e.g. rose, citrus, etc.) graft union commences within 24 hours, and recovery is 100%.

However, of greatest interest at Zanzai was the fact that they were using a technique published by Buxus, to grow strawberries in culture. This outdated technique was superseded by de Fossard, and de Fossard's technique, in turn, has been improved by me. Despite primitive techniques, Zanzai Ferrari have one of the biggest organisations in Europe, producing virus symptom-free strawberry plants.

Their technique basically is to grow the material in culture and then to prick out into heated peat beds in plastic tunnel houses during the winter. The plants are forced along during the winter and in late winter/early spring are big enough to be lifted, trimmed, packaged and sent out. They have some 16 or so different varieties of strawberries that are treated this way and their technique is essential to the European market because of the extreme prevalence of virus and bacterial diseases. No strawberry plant is a viable proposition after about 2 years in the ground anywhere in the south or eastern parts of Europe.

The size of this operation may be gauged by the fact that they employ some 800 seasonal female workers in the strawberry operation alone!

Their worker complement could be reduced quite considerably if they had our modification of the de Fossard technique to work with at the laboratory level. Using our technique, it is theoretically possible to produce in excess of 15 billion plants per year from a single 1 mm x 1 mm explant. To date, no visible mutations have been observed with all the plants we have produced (several thousand at the time of writing this report).

I accepted an invitation during April, 1981, to attend a course at Stoneleigh, run by an ADAS sub-

sidiary. These courses were designed to help teachers to teach. The week there was an absolute revelation and opened a whole new way of cummunication to me. one that I feel has had immense value in my life ever since.

After successful completion of the course, I spent quite a lot of time involved with officers of the National Proficiency Test Council.

The whole testing concept of the British technique is slowly being embodied into the N.T. apprenticeship course — much to the benefit of the local people being trained.

This must surely rate as one of the spin-off advantages that he Nuffield Scholarship has had. Not only for me, but for the whole Horticultural Industry in the Northern Territory.

## UNITED STATES

Not long after completing this course, I was able to get my U.S.A visa and began my trek across that country.

Once again, I must praise the wisdom the flexibility of the British Nuffield Board. John Stewart and John Cyster had no real authority to grant me travel rights. However, once they realised that I could not gain all I needed to know in the U.K. they readily agreed to my travel.

Finally all travel arrangements were made and I set off for Florida. I had only one contact in that area and he only by correspondence, a man called Buck Ackermann. At 70, that man could put most men half his age to shame. I know he'd exhausted me by the time I left Florida. Thanks to him, I saw everything and met everyone who could possibly help me in that state.

At the Fairchild Botanic Gardens, I met up with Dr. Ponenoe. He was sufficiently interested in me and my work to cancel a whole day's appointments just to show me around the laboratories and trial plots that the garden maintains. They are doing a great deal of interesting work on the tissue culture of palms and have achieved results similar to those obtained by Blake in the U.K. and ours in Australia.

From Fairchild, Mr Ackermann took me down to Homestead, Florida where some of the most original and exciting work in plant tissue culture is being conducted.

At the I.F.A.S. Agricultural Research and Education Centre, part of the University of Florida, Drs Litz and Conover have performed major breakthroughs in the tissue culture of Carica papaya, other Carica spp., and some natural hybrids. However, the most exciting part of their work is the fusion of protoplasts of certain species.

Generally, Carica papaya is very susceptible to ring spot virus disease in Florida. This disease precludes the edible papaya being grown as a commercial crop. However, an inedible species (C. cauliflora) is resistant to this virus. Unfortunately, these two species are not sexually compatible and all attempts to create a hybrid with the fruit of the edible species and the disease resistance of the other, have failed.

Litz and Conover have created man-made hybrids however, with protoplast fusion. A protoplast is a cell, minus its cell wall. When the cell walls are digested away, it is possible to fuse the contents of two dissimilar cells. This in turn gives rise to the recombination of the genetic matrix of each cell, in a manner different from either donor cell. Rather like throwing a line into the middle of the ocean and hoping to catch a fish before starving to death — but, sooner or later, the re-combinant material should give rise to hybrid plants which exhibit the best possible characteristics of both (or several "parents"). Such a hybrid can then be exploited in the normal tissue culture way.

It was my very great privilege to observe this work in progress, and I hope one day soon to be able to reproduce their research program in Australia.

After a number of other visits, I flew to Montgomery, Alabama.

This stopover was to be a week-long Rest and Recreation period for me. instead, it set the groundwork for what will be a multi-million dollar investment in Australia in general and in my work in particular (see attached papers for further information — The Maturity Factor).

My last round of talks and visits were in California, first on the track of the elusive Toshio Murashige, and then to several very large commercial nurseries who employ plant tissue culture as their only source of propagation.

It is interesting to note however, one example, which, to me, typifies American state of development in the commercialisation of plant tissue culture.

At Apopka (near Orlando) in Florida, I visited a $3,000,000 complex called Oakdell. This tissue culture facility is owned by Wayerhauser and is engaged in the production of 4 varieties of Nephrolepis fern. The president of the company showed me over the complex, and proudly announced their most recent multiplication rates — x 8 every 42 weeks!! We grow the same 4 varieties (and some 60 others as well) and average a x 50 multiplication every 8-12 weeks! Oakdell and its backers believe however, that their yield is high by American standards. It is truly amazing that a country can have such incredible scientists doing earth-shattering research and have the commercial operations plodding along on such borderline rates of multiplication.

My last stop in the U.S.A was Sacramento, where I hoped to study and observe at the University of California at Davis. Unfortunately a pneumonia bug intervened and I spent almost 2 weeks in bed instead. Even that had its good points though. My hosts Lauren and Cindy Oki are part of the Oki Nursery complex. This Nursery has a very large tissue culture facility, currently producing ficus and sparagus plants for the nursery trade.

# A tissue culture system which gives greatly improved multiplication rates and another which supports a new process called the "Maturity Factor".

This report sets out evidence to support an entirely new dimension in rapid multiplication of horticultural plants. The process has been successfully applied to a wide range of plants (list available from author). In some instances, multiplication rates are so great as to be almost meaningless. In most cases a rate of **at least** x 50 per multiplication has been achieved. Some species fall short of this target, but the fault lies not with the technique but rather its refinement in that particular instance.

Some species in fact give very low yields when initially placed on to a multiplication medium. Experience has shown that yields per explant per time generally increase dramatically after the second or third time through the system. A good example is Syngonium podophyllum c.v. "white butterfly". Initial explants usually give an increment of x 3 to x 10. Dividing and replanting this tissue gives an average increase to around x 20. Thereafter, increment per explant generally stabilises at x 30 to x 40.

Some species of plants have far exceeded the target of x 50 per cycle. In fact, one plant group (Droseraceae) in response to a new process has given a yield probably in excess of x 2000 per cycle! Two other families, filicales (the ferns) and vitaceae (grapes), have given similar yields in a short time with this new process.

The aim of this paper is to highlight some aspects of the process and to point out the enormous financial potential inherent in this breakthrough. Much of the work described is unique and nothing like it is currently being performed in commercial tissue culture laboratories in the western world.

The concept of a "maturity fact-

or" is a novel aproach to an occasionally seen phenomenon. This phenomenon — the retention of mature morphological characteristics and the ability to produce functional flowers "de novo" from regenerated tissue in a short time — is the theme of several papers that I have written. I believe I now have a workable technique for retaining maturity in adult, "in vitro" cultured material.

On an experimental basis, this material, when grown out, has behaved in a predictable manner. All woody plants so far tested with this technique have exhibited precocious "de novo" flowering in a very short time.

**With further refinement and supported by independent field trials, this technique could become the greatest single advance in the propagation of edible or horticultural crops since man began farming.**

This technique is not offered up as an accomplished fact at this point. It is an exciting concept which should, given sufficient funding and research, become the centre pin of a brand new style of farming.

It is supported by well documented evidence, and has passed from mere theory to an acceptable, workable hypothesis.

The "maturity factor" is offered as a second string to this project — one that could be developed to take a substantial part of production once initial cash flow and clientele were established with the proven rapid multiplication part of the project.

In all then, this paper offers two techniques; one proven, workable and extremely economical, the other somewhat past experimental, but not yet proven to the point of being an immediate viable commercial venture. However, with further trials, this latter technique could become a major income earner for the companies which undertake its exploitation.

This report provides evidence that suggests an amazing market potential for any corporation that utilises the techniques described.

To make the best possible use of these techniques, and to secure a major share of the potential world market **before** competitors realise what is happening, requires two basic things.

One is a laboratory sufficiently large and sufficiently sophisticated to produce the numbers envisaged, the other is a nursery suitably adapted to grow on the crop to tube plant size or larger if required.

To effectively cover the potential world market, two or three bases would be necessary, to minimise freight and packing considerations.

The first would be in Darwin, Northern Territory, Australia. This is my home town and site of my existing laboratory and nursery. A new facility based here would be able to cater, not only to the entire Australian and New Zealand market but the projected Asian one as well. Such places as Japan, Hongkong, Singapore, Malaysia and Indonesia are very close by air and airlines are constantly looking for freight which could make Australian connections worth while.

A similar sized facility based in the USA, somewhere below the fall line — e.g. central or southern Alabama, Georgia or that general region — would cater for the American, Canadian, South American and Caribbean markets.

A third facility, either complete or partial in its scope, could be located in England or Europe with the view to satisfying the European and British demands, along with those of the Arab world.

Construction in Darwin of a laboratory facility of suitable size and sophistication would cost approximately $A500,000, fully equipped and operational.

It has been estimated that $750,000 to $1,000,000 would be needed to upgrade Tropicus Nursery to the point of being a suitable controlled environment, automated facility capable of handling the output of the proposed laboratory. This upgrade could be done in stages, but the exponential buildup of the laboratory produce makes it desirable to redesign the nursery **before** any output from the lab needs to be handled. Obviously the mist house unit is of prime importance, closely followed by controlled environment greenhouses.

**NOTE:** Detailed costings of a proposed laboratory complex in Australia; Tables of Projection of Rates of Multiplication of Plantlets over a 12 months period; and Potential Sales Examples charts are available from Mr Hearne or the ANFSA.

A potential investor would need to be aware of further cost considerations in setting up sales and distribution.

Market outlets could be Australia, U.S.A., U.K., Europe, Japan, Hong Kong and Mexico.

Plants would include strawberries, roses, ferns, Venus fly traps, Nepenthes, Sarracenia, Pinguicula, Darlingtonia, Drosera, Byblis, Cephalotus, Fraser fir trees, grapes, etc.

As for returns a five per cent penetration of the California and Oregon strawberry market alone could result in around $495,000.

Only two per cent penetration of the U.S. rose market could mean $1,600,000, and two per cent of the European market (excluding the U.K.) about $2,800,000 per year.

For some of the carnivorous plants Australia has special advantages over other sources.

Some of these bring remarkable prices. For example at the 1981 Chelsea Flower Show mediocre Sarracenia plants were bringing up to $60 each.

World wide demand exists for these plants which cannot be satisfied by existing suppliers.

Yet it is possible to multiply them at better than 2000 per month.

These are just a few indications of sales potential.

Gross sales in excess of millions of plants per week would not be impossible to conceive or to achieve, given sufficient lead in time and growing space.

# The Australian Nuffield Farming Scholars Association thanks . . .

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