

THE WINSTON CHURCHILL MEMORIAL TRUST OF AUSTRALIA

CHURCHILL FELLOWSHIP 2002

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**To study cultural practices and crop manipulation for Redflesh Grapefruit in the
dry tropics of Australia**

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1. PROJECT DESCRIPTION

INTRODUCTON

This report sets out the details of my 2002 Churchill Fellowship study tour of North America, Spain and South Africa. Due to the trouble in the Middle East, I was advised not to travel to Israel as originally planned, and at the last minute I re-arranged my schedule to visit Spain.

My main areas of study included:

1. Production of disease free planting stock.
2. Cultivar evaluation.
3. Advances in cultural practices.
4. Canopy management.
5. Spray technology and spray machinery.
6. New research and development

My study tour would not have been possible without

1. The generous financial support of the Winston Churchill Memorial Trust .
2. The high regard in which Churchill Fellows are held, worldwide.
3. The support I received from AgWa and its staff.
4. The willingness of scientists, farm advisers and farmers to share their knowledge and experiences with me.
5. The support and understanding of my family, who carried the burden of our farming activities whilst I was away.
6. The loving support and help from my wife who acted as tour leader, navigator, secretary and general organiser whilst we were travelling.

Spain:

Centro de Investigacion y Desarrollo Agroalimentario – Dr Ignatio Porras Castillo,
 Dr. Maria Dolores Fuster Soler and Dr. Eulogio Navarro.
 Instituto Valenciano de Investigaciones Agrarias – Dr. Alejandro Medina

South Africa:

Agricultural Research Council – Dr. Faan van Vuuren
 Citriculture Technical Services – Freek Veldman
 Life Equipment – Gary Thirkettle
 Agricultural Research Council - Research Station-Melalane – Dr.Faan van Vuuren
 Esselen Nursery and Repository – Leon Esselen
 TSB Citrus Division – Hectorspruit –Dr Hoppie Nel, Hennie Greyling

Outcomes

The Ord River Irrigation Area, and other dry tropical areas of Australia, with good soils, plentiful and good quality water, high heat unit accumulation, provide conditions suitable for the growing of excellent quality grapefruit.

Because of climate differences in citrus growing areas, research and trials need to be conducted in the dry tropical areas of Australia.

Due to pests and diseases already established in nearby countries it is necessary that the Australian Quarantine Inspection Service and Plant Health services of Northern Australia be aware of the threats

In order to assist in the development of this industry I will be presenting a paper at the Kununurra Horticulture Review at AgWa on Monday 26th. August 2002.

I will also be presenting a more detailed overview of my tour to interested Citrus growers in the Ord River Irrigation Area and other areas of Western Australia.

I shall also be offering my report to the Kimberley Echo, Kimberley ABC, Market Place News, Good Fruit and Vegetables and the Countryman.

Field days will be arranged at suitable times.

With dedication, goodwill and cooperation a viable and sustainable grapefruit industry can be established in these areas.

This industry could then supply import replacement, and export grapefruit.

3. PROGRAMME

2002.

CALIFORNIA – May 6 - 10

University of California – Kearney Agricultural Centre

Dr. Beth Grafton-Cardwell – Research entomologist, IPM Extension specialist – Pests of citrus and the use of predators.

Mulholland Ranch, Mulholland Citrus, Mulholland Nursery and Mulholland Insectary

Tom Mulholland - Specialist in Delite Mandarins – nursery production and field grown; and also produces *Aphytis melinus* in the insectary.

Pest Management Associates

Jim Stewart, Jim Gorden and Ray Copeland – Management of Citrus groves, pest management , spray technology and canopy management.

Lindcove Research and Extension Center

Louis Whitendale – Superintendent - Citrus Clonal Protection Program, Foundation budwood block.

TEXAS – May 11 – 16

Texas A&M University

Kingsville Citrus Center

Dr. John Da Graca – Deputy Center Direct

Dr. Mani Skaria – Plant pathologist – micropropagation

Dr. Bhimu Patil – Plant physiologist – health benefits of grapefruit limonoids.

Dr. Victor French – Entomologist – pest management in grapefruit.

Dr. Eliezer Louzada – Molecular biologist – plant breeding.

Craig Kahlke & John Watson – Texas virus free budwood program.

Donald Thompson – Citrus grove development and management.

Dwayne Bair – General Manager – Edinburg Citrus Assn. – Co-op. packhouse.

Elias Hernandez – Texas A&M – farm superintendent.

Larry Barberly – Enviro Products Corp. – organic fertilizers.

Dr. Bob Wiedenfield – Soil scientist – citrus water use.

Dr. Julian Sauls – Horticulturist – Citrus extension

FLORIDA – MAY 17 – JUNE 3

University of Florida – Citrus Research and Education Center – Lake Alfred

Dr. Jim Graham – Soil microbiologist – Host and mentor.

Dr. Arnold Schumann – Soil scientist – soil mapping and related management issues.

Monica Lewandowski – Public relations manager – Introduction to center.

Dr Jim Syvertsen – Plant physiologist – Environmental stress physiology of citrus.

**Programme
(contd.)**

Dr. Adair Wheaton – Horticulturalist – design of citrus groves, mechanical pruning.
 Ronald Muraro – Extension economist – economics of growing citrus in Florida
 Dr. Gene Albrigo – Citriculturist – regulation of flowering, fruit set and fruit development
 Dr. Jude Grosser – Plant Cell Geneticist – molecular methods and tissue culture citrus variety improvement
 Dr. Bill Castle – Horticulturalist – citrus variety and rootstock development and evaluation
 Dr. Fred Gmitter – Horticulturalist – variety improvement by gene manipulation and cloning
 Dr. Clay McCoy – Entomologist – citrus IPM using pathogens, parasites and predators
 Dr. Masoud Salyani – Agricultural and Biological Engineer – spray atomisation, transport and deposition.

Florida Agricultural Conference and Trade Show – Citrus Section - Lakeland Center – Lakeland

Dr. Harold Browning – CREC – introduction
 Dr. Mike Kesinger – Bureau of Citrus Budwood Registration – trends in rootstock and variety use in Florida.
 Dr. Kim Bowman – USDA – promising new rootstocks being developed by USDA.
 Dr. Jude Grosser – CREC – promising new rootstocks being developed by University of Florida.
 Dr. Fred Gmitter – CREC – new varieties.
 Dennis Broadway – Haines City Citrus Growers – variety considerations based on packinghouse needs.
 Fran Becker – Peace River Citrus Products – variety considerations based on citrus processing needs.
 Renee Goodrich – CREC – Understanding citrus processing
 Dr. Herb Nigg – CREC – Comparison of spray oils for mite control in Florida citrus.
 Dr. Pete Timmer – CREC – Comparison of spray oils for disease control in Florida citrus.
 Dr. Carl Childers – CREC – Asian Citrus Psyllid – A new and emerging pest.
 Craig Meyer – Florida Dept. of Agriculture – Citrus canker update
 Dr Ken Kuhl – Florida Dept. of Agriculture – Citrus Best Management Practices for the Ridge Citrus Production region in Florida
 John Langford – Reduced cost citrus production practices and their impact on productivity.
 Mike Roberts – Pro Source One – Computer based technology solutions for Florida citrus.

Kerr Center for Sustainable Agriculture – Vero Beach Research Station

Robert Adair – Executive Director – a leader in the sustainable agriculture movement

USDA – Agricultural Research Service

Dr. Jose Chaparro – Research Geneticist – breeding pathogen, insect, and chill resistant citrus varieties
 Dr. Greg. McCollum – Research Plant Physiologist – Effects of chilling damage on citrus.

**Programme
(contd.)**

University of Florida – Indian River Research and Education Center

Dr. Ed Stover – Citrus Horticulture – teaching and extension work.

Dr. Mark Ritenour – Post Harvest Physiology – extension and education

Dr. Bob Pelosi – Citriculture – post harvest research and extension.

University of Florida – Southwest Florida Research and Education Center

Dr. Tom Obrezza - Soil and Water Science – Water movement in soil and subsequent translocation of N into sub-surface water table.

Dr. Robert Rouse – Citriculture – Assessing different combinations of rootstocks and scions.

Sun Ag, Inc. – fellesmere farms – Fellsmere.

Mark Sanchez – General Manager

Mike Munroe – Production Manager – grow 24,000 acres of citrus

SPAIN – June 3 – 17

Region de Murcia – Centro de Investigacion y Desarrollo Agroalimentario

Dr. Eulogio Molina Navarro – Director

Dr. Ignacio Porras Castillo – Grapefruit Specialist – Extension

Dr. Maria Dolores Fuster Soler – Biologist _ Citrus flavenoids

Instituto Valenciano de Investigaciones Agrarias

Dr. Alejandro Medina – Citriculturist – Software for classification of citrus.

SOUTH AFRICA June 19 – July 5

Agricultural Research Council – Instiute for Tropical and Subtropical Crops - Nelspruit

Dr. Faan van Vuuren – Plant disease management – plant variety assessment

Agricultural Research Council – research Farm - Malelane

Citriculture Technical Services - Nelspruit

Freek Veldman – Variety assessment – Citriculture consultancy

Esselen Nursery – Malelane

Leon Esselen – Propagation of Citrus Cultivars – Repository of citrus varieties

Life Equipment – Nelspruit

Gary Thirkettle – Manufacturers of farm equipment – particularly oscillating boom sprays.

Transvaal Sugar Limited – Hectorspruit

Dr. Hoppie Nel – General Manager - Grow 1600 Ha of citrus

Hennie Grayling –Farm manager

4. INTRODUCTION

The major citrus growing areas in Australia are south of the tropics in sub-tropical or Mediterranean type climates. These areas generally don't achieve the high accumulated heat units which are common in the dry arid tropics of Northern Australia.

High accumulated heat units contribute to high sugar to acid ratios, which means sweet fruit.

Grapefruit and Pummelo are regarded as true tropical citrus because of the high accumulated heat units required to produce sweet fruit.

The growing of citrus in hot arid climates has its problems.

The aim of my study was to determine what cultural practices and crop manipulation techniques are being implemented on grapefruit crops in similar growing conditions in other citrus producing countries.

In order to achieve my aims I visited Southern California, Southern Texas, Florida, Southern Spain and Northern South Africa.

In each of these countries I was fortunate to be able to meet with scientists, advisors, consultants, farm managers, farmers, packinghouse managers and marketers, all of whom had had many years experience in the industry.

I was most grateful that all the people with whom I met were ready, willing and able to provide me with the information which they considered would be of value to my study.

In order to produce a report which is both logical and hopefully easy to understand, I intend to follow the life cycle of a grapefruit tree from rootstock through to harvest, comparing and contrasting different practices and finally, suggesting practices which might be worthwhile adopting in the dry tropics of Australia.

5. REPORT

The Citrus tree

Because most citrus seedlings are slow to flower and produce fruit, common practice is to grow a rootstock and then graft or bud the desired variety onto the rootstock in order to reduce the time from planting to fruiting.

Rootstock

It is important to use certified seed in order to produce clean true to type rootstock.

There is no such thing as a perfect rootstock, however there seems to be a general consensus that on normal type soils on which citrus is grown, Swingle citrumelo is the preferred rootstock for grapefruit at present.

Spain, with calcareous soils, high pH and high salt content in irrigation water tend to favour Carrizo citrange and Citrus macrophylla.

Spain is also trying to produce a rootstock which will tolerate salt levels of 5,000 ppm.

Florida – new plantings - Swingle citrumelo 44%; Carrizo citrange 37%

It should be noted that because the perfect rootstock doesn't exist, there are many programs in place, each producing up to 2000 new varieties each year, seeking better rootstocks and cultivars.

Scion cultivar

Establishment of a reliable source of planting material is essential to the success of a citrus industry.

Dissemination of diseased or genetically inferior trees can have a catastrophic effect on the productivity of the citrus industry for years to come. Consequently, many of the major citrus producing countries have stringent nursery regulations, and the establishment of a budwood registration program is essential for the long-term success of developing as well as established citrus industries. (Davies and Albrigo 1994)

The grapefruit cultivars investigated included; (See appendix)

White :

Duncan
Jackson
Marsh

Red :

Flame
Henderson
Nel Ruby
Ray
Rio
Ruby
Star (Star in Nth.America and Australia

is significantly different to the Star grown in South Africa)

Pummelo:

Hirada buntan seedling
Orablanco

All of the above varieties would grow in our conditions but any new introduction would need to be trialled under our conditions before a commercial planting was contemplated.

Propagation

Propagation methods vary from container grown plants to field grown, bare rooted plants.

Micropropagation techniques are being used in order to speed up propagating and to reduce the time in the nursery.

In Texas, ridged pots are being used in order to force the roots down, rather than have the roots circle around the inside of the pot.

The rule for planting seems to be; use the method you are most comfortable with.

Ridging (Bed forming)

Ridging or bed forming seems to be a universally accepted practice, irrespective of soil type. In Spain where citrus have been grown for over 500 years, ridging has become common practice over the last four to five years.

Soils throughout the world citrus growing areas which I visited varied from excellent to poor (stony, calcareous with high pH and high salt levels).

Soils

Spanish soils seem to be the poorest, yet Spain is the world's largest exporter of citrus. (Source FAO)

Florida – Sandy, generally high water table (0.5 m)

South Africa - good soils

Water

California – scarce and high in salts – low rainfall

Texas – scarce – in June 2002 Texas State had 60 days water supply remaining – low rainfall

Florida – plenty of poor quality water – rainfall 1400 mm – high water table and sandy soils cause problems

Spain – Low rainfall 200 to 250 mm – poor quality water (up to 3000 ppm salts) in short supply.

South Africa – reasonable rainfall, adequate irrigation water of good quality.

Planting density

Planting density varies, depending on growing conditions and rootstock. I saw densities varying from 145 trees per Ha. to 4000 trees per Ha.

Texas – 145 up 4000 trees per Ha.- average 500 trees per Ha.

Florida – trials suggest optimum production at 375 trees per ha.

Spain – average 500 trees per Ha.

South Africa – new plantings at 550 trees per Ha.

Fertilizers

Books have been written on this subject. In summary, fertilizer programs are based on soil and leaf analysis, the age of the tree and the amount of crop harvested. With improved fertilizer programs I believe we can achieve higher yields and earlier yields than at present.

Nitrogen to Potassium ratio has a significant effect on fruit size and crop yield.

Irrigation

Irrigation seems to be a hit and miss affair. The more advanced growers are using technology such as 'Enviroscan' or tensiometers. Others rely on evaporation figures, experience (litres / tree) or advisories from Universities or consultants. We can improve our irrigation management and hence we can improve our yields. Historically the larger the volume of roots that are irrigated the greater the yield, with the proviso that over-watering can lead to root rots and lower total soluble solids.

Pests

Books have been written on this subject as well. People in Florida identify on average four new pests each year. We have our fair share of pests in Australia, most of which can be managed. However we need to be vigilant in order to try and keep the Asian citrus psyllid (*Diaphorina citri*) and the Sugar cane root stalk borer (*Diaprepes* spp.) out of the country.

The Asian citrus psyllid is the vector for Huanglongbing – Citrus greening or Yellow dragon disease a devastating bacterial disease of citrus, which is present in Irian Jaya.

The Sugar cane root stalk borer, also known as the beetle from hell, is difficult to control and slowly kills citrus trees through larvae attacking roots, girdling the roots and at the same time allowing fungi to attack the root system.

Diseases

As with pests, we have our share of diseases in Australia, most of which we are able to control. However as mentioned previously Citrus greening (Yellow dragon disease) is already in Irian Jaya and is a severe threat to our citrus industry.

Citrus canker, another bacterial disease, which is found in SE Asia, Japan, India, Africa, Middle East, New Zealand, North America and the Pacific Islands can be rapidly spread by humans, rain, animals, birds and machinery. It is another threat which we need to guard against.

In Florida, the USDA has removed 1,500,000 citrus trees in the past twelve months in an attempt to eradicate citrus canker.

Brazil replaces approx. 30,000 acres of citrus each year because of disease problems.

Integrated Pest Management

Australia is among the world leaders in Integrated Pest Management, we need to be more conscious of the role of IPM in our management practices in the dry tropics.

Integrated Pest Management is a strategy which encourages the reduction of pesticide use by using a variety of controls in harmonious combination to contain or manage pests below their economic injury levels. (Citrus pests and their natural enemies - Edited by Dan Smith, GAC Beattie & Roger Broadley - 1997)

Weeds

Most citrus growing countries are subject to chilling damage at some time or other. In order to reduce chilling damage the groves are kept weed free.

In the dry tropics this is not an issue and there are arguments that suggest 'total elimination of weeds within the rows by either cultivation or herbicides can have a detrimental effect on pest management' (Citrus pests and their natural enemies – Edited by Dan Smith, GAC Beattie & Roger Broadley - 1997)

Flower induction.

Flower induction in citrus requires approx. 900 hours of accumulated chilling hours. Most citrus growing areas of the world achieve this figure relatively easily. Hence flower induction is not a problem. Not so in the dry tropics of Northern Australia, where accumulated chilling hours rarely reach this figure. There is also some evidence to suggest that high temperatures during the day may further increase the accumulated chilling hours required. Hence a strategy has to be devised to induce flowering.

In our dry winter period, water stress for at least 30 days, followed by a return to a normal watering and fertilizer program, plus a foliar application of low biuret foliar urea (1.5 g. per tree) should increase the number of flowers per tree and should increase fruit set. (Carol J Lovatt 1990)

This program has now been modified –

Water stress for 8 weeks, then foliar urea - 1.5% to 3.3% then return to full watering and fertilizer program, followed by another foliar urea at full bloom.

Fruit production

To achieve optimum fruit production it is necessary to supply adequate water and fertilizers.

Soil moisture status is usually monitored using tensiometers and tree nutrient status is monitored by leaf analysis.

Yields: tonne per Ha.

California - 40- 50

Texas – approx 57

Florida – approx 58

The following yields from Marsh, Rio Red and Star ruby are being achieved in South Africa.

YIELDS/YEAR	MARSH	RED	STAR
3	6+	6	5
4	20	20	22
5	31	28	30
6	40	37	38
7	52	46	30
8	62	50	55
9	64	55	65
10	65	60	67
11	65	62	65
12	60	60	63
13	58	58	60
14	55	47	59
15	53	45	58

(Source; Transvaal Sugar Ltd.)

Post harvest management

Fungal diseases are the major source of postharvest fruit damage and losses. These problems can be controlled by using care during picking and handling, proper fungicides and good sanitary measures in the packinghouse to keep damaged, infected fruit at a minimum. (Davies and Albrigo 1994)

Canopy management

Grapefruit canopy management is not easy.

Canopy management for redflesh grapefruit is different from canopy management for whiteflesh grapefruit and grapefruit canopy management differs from other citrus canopy management practices.

With good canopy management, yields significantly higher than are presently being achieved, can be achieved.

6. CONCLUSIONS

A viable, sustainable redflesh grapefruit industry can be established in the dry tropics of Australia.

Australia, including the dry tropics, is perceived to be a producer of clean green agricultural products.

Given that suitable soils and a suitable water supply is available, and that we can develop cultural practices which are suitable for our climate, the dry tropics of Australia can produce redflesh grapefruit, and possibly other grapefruit and pummelo, which could compete in the world market, as well as replace imported product in the Australian market.

With the development of the Alice Springs to Darwin railway line and the upgrade to the Darwin port facilities, export of product from both the Ord River Irrigation Area and the Katherine area, to South East and Northern Asia should become a lot easier.

In the Ord River Irrigation Area we can meet the criteria for soils and water. We also have high heat units, which help to produce sweet fruit.

We have already produced good quality Marsh, and redflesh grapefruit.

With better management we could produce good quality Orablanca.

In my opinion the South Africans have the best variety of redflesh grapefruit – Star ruby – a selection of seedlings grown from seed imported from Texas.

We could also produce good quality tangelo if we could get the correct variety.

We have an excellent source of clean rootstock seed, and pre-immunised budwood, through Auscitrus and this avenue should be used in order to guarantee that a new industry starts off with clean planting material.

The information which I have learnt will be made available, through AgWa Seminars, citrus grower meetings in W.A., field walks and through articles in The Kimberley Echo, Good Fruit and Vegetables, Market Place News, Citrus Grower, The Countryman and through ABC – Kimberley.

7. RECOMMENDATIONS

In order to establish a viable, sustainable redflesh grapefruit industry in the dry tropics of Australia we need more suitable land to be released.

We need help from the Australian Quarantine Inspection Service and Plant Health – Western Australia in order to keep out threats such as

- Huanglongbing -Greening disease
- Citrus canker
- Asian citrus psyllid
- Sugarcane root stalk beetle

Because of climate differences between Southern Australian citrus producing areas and other citrus producing areas throughout the world, and the climate in the dry tropics of Australia, we need to do research and trial work in the dry tropics of Australia in order to get any meaningful answers.

There is a need to trial some different cultivars to those presently available,

e.g.

- South African – Star Ruby
- Pummelo varieties
- Tangelo varieties

We need to improve our management practises

- Management of young trees – fertilizer, irrigation and pruning
- Management of fruiting trees – fertilizer, irrigation, canopy management
- Management of flower induction techniques

8. BIBLIOGRAPHY

Citrus: F.S. Davies, L.G. Albrigo 1994

The Role of Nitrogen in Citrus Flowering and Fruit Set: Carol J. Lovatt 1990

Citrus pests and their natural enemies. Edited by Dan Smith, GAC Beattie &
Roger Broadley 1997

9. APPENDIX

Flesh colours of Florida Redflesh Grapefruit

