Sustaining Horticulture Through Quarantine

Farrer Memorial Oration, 1998

This is a copy of the 1998 Farrer Memorial Oration, presented by Mr Michael Kinsella.

The Farrer Memorial Trust was established in 1911 to perpetuate the memory of William James Farrer and to encourage and inspire agricultural scientists. Initially it awarded scholarships for 'study or research in agricultural problems'. Later it included the delivery of an annual oration and the presentation of the Farrer Memorial Medal to a distinguished agricultural scientist for service rendered in the fields of research, education or administration.

For more information see the Trust website at

www.dpi.nsw.gov.au/farrer-memorial-trust

The 1998 Farrer Memorial Oration

SUSTAINING HORTICULTURE THROUGH QUARANTINE

Michael N Kinsella

Firstly I wish to thank the members of the Farrer Memorial Trust most sincerely for honouring me with the 1998 Farrer Medal. I am very proud indeed when I read the long list of recipients since the Medal was first awarded in 1935.

This is the first time that the award has been made to a horticulturist and for that matter to a quarantine administrator. I believe that I am only the third Victorian to be honoured by the Trust. It is also very pleasing to be presented with this Medal at the Fourth Australian Horticulture Conference.

I will firstly tell you something about Farrer, then about the history of quarantine leading to some present day developments.

William James Farrer, of course, is remembered not only as the face on the two dollar note, but as one of the great pioneers of agricultural science in this country, not only for his contributions as a plant breeder, but also as an agronomist.

He was born in 1845 in England, the son of a farmer. After schooling in London he read mathematics at Cambridge and graduated with honours in 1868.

He was forced to abandon a career in medicine after being diagnosed with tuberculosis. At the age of 25 he migrated to Australia to seek a healthier climate.

He married in 1882 and acquired a small one hectare property on the Murrumbidgee at Tharwa, south of Canberra. The property was too small to support Farrer and his new wife so he fell back on his mathematical training and became a surveyor with the New South Wales Lands Department.

While surveying stock routes through the central-west of New South Wales Farrer observed the impact of rust on wheat crops and pondered solutions to this problem.

Farrer was an admirer of Darwin, and in fact a distant relative, and he developed a deep interest in natural selection leading to his plant breeding experiments.

Developments in horticulture and in particular the development of disease-resistant fruits and grapevines suggested to Farrer that varietal resistance might be the solution to the rust problem in wheat. In a letter written to Professor B T Galloway, Chief of the Division of Vegetable Pathology in the United States Department of Agriculture in 1894, Farrer wrote:

'It is by selection, either natural or intentional or both, that we have become possessed of our blight-proof or blight resistant apples, of varieties of the grape which are not affected by ordium, which resist mildew, which possess roots that phylloxera cannot injure. What is to stand in the way of our taking advantage of the variability as regards the amount of resistance they offer to rust, that our wheats exhibit?'

In 1885 he resigned from the Lands Department to concentrate on the development of new varieties on his small property at Tharwa. The early 1890s were bad rust years and Farrer was able to make good progress in identifying resistant lines. The next year he began an extensive crossing program. He was induced to join the NSW Department of Agriculture as a wheat breeder in 1898.

His variety *Federation* was a leading cultivar for almost 20 years and continued to be grown in some countries for upwards of 40 years. This high yielding cultivar was the foundation for other breeding programs in Australia.

Farrer corresponded with wheat breeders around the world and acquired new seed lines for his breeding programs. However, in those days the plant breeder did not have the frustrating wait for his material to be cleared by quarantine!

Origins of Quarantine

The word 'quarantine' originates from the Latin word for 40 'quarantum'. A 40-day quarantine was applied to ships arriving from countries subject to endemic diseases such as bubonic plague, cholera and yellow fever. Ships crew and passengers were isolated on board for 40 days to permit latent cases to develop.

The first quarantine is thought to have been imposed in Venice in 1374 when travellers suspected of having been infected with bubonic plague were prevented from entering the city.

Two plant health disasters in Europe in the mid-nineteenth century had a momentous impact on the populations of Ireland and France in particular; potato blight in Ireland around 1845 and phylloxera in France in the 1860s.

The phylloxera story in Europe was a chapter of accidents. In 1847 powdery mildew was introduced into Europe on American vines. In order to control this disease a further introduction of powdery mildew resistant vines from America took place in 1861. Unbeknown to these innovative vignerons these powdery mildew resistant vines were infested with the vine root aphid, *phylloxera*. Phylloxera resistant vines were then imported into France in 1875 to overcome this problem, but these introductions in turn brought two more grape diseases, downy mildew and black rot.

Phylloxera destroyed one and a quarter million hectares of grapevines in France between 1860 and 1885 ruining the livelihood of thousands of growers and the viability of entire regions of the country.

Phylloxera was first found in Australia at Geelong in 1877 but, thanks to our quarantine service, black rot has not been introduced into Australia.

The crop industries in Australia are based almost exclusively on imported plants and animals and even our only native commercial food plant, the macadamia, was domesticated overseas.

The import of cropping plants and farm animals into Australia dates from the first fleet and they thrived without many of the pests and diseases which afflicted them in their homeland. Inevitably some pests and diseases did survive the journey with their hosts.

One of the earliest horticultural pests to arrive in Australia was the woolly aphid of apple which was first found in Victoria in 1846. The Mediterranean fruit fly was found in Western Australia in 1896, others such as brown rot of stone fruits, black spot of apples and bunchy top of bananas arrived early this century.

Early horticulturists also found some native pests to be particularly damaging. One native insect species which has been of major concern to Australian horticulture over the years, and which has dominated the plant quarantine scene for the last 50 years, is the Queensland fruit fly.

The light brown apple moth is a native pest, which is widespread across southern Australia. This pest affects a number of deciduous fruits and grapes and is of particular concern to the United States and Canadian quarantine authorities.

The native bud worm affects a wide range of field and horticultural crops including tomatoes, sweet corn, apples and stone fruit.

Australia has escaped many of the plant pests and diseases that afflict agriculture in other countries by both good luck and good management. For the first hundred years or so crop and ornamental plants were brought into Australia from around the world without any precautions.

Some more recent arrivals in the last decade or so have been giant African snail, green snail, chrysanthemum white rust, citrus canker, potato cyst nematode, papaya fruit fly, western flower thrips and spiralling white fly. Fortunately giant African snail and citrus canker and now papaya fruit fly have been eradicated.

The controversial detection of the fire blight bacterium, *Erwinia amylovora* on cotoneaster plants in the Royal Botanic Gardens in Melbourne last year cost industry $7 million and the government $2 million. Extensive national surveying throughout pome fruit orchards and

public and private gardens have found no evidence of this disease. As a precaution all fire blight host plants were removed from the Royal Botanic Gardens and surrounding public and private gardens.

Early Quarantine Legislation and Administration

The Dutch government proclaimed the world's first plant quarantine legislation in 1877 prohibiting the import of coffee plants into the Dutch East Indies from Ceylon where coffee rust had devastated the coffee industry around 1869.

The Victorian Public Health Statute of 1865 was the basis of the State Plant Health legislation and the Commonwealth Quarantine Act. The Victorian Vegetation Disease Act was passed in 1887 following the discovery of phylloxera. Legislation in other states also dates from around this time.

In 1908 the Commonwealth Parliament passed the Quarantine Act which came into force in July 1909. The Commonwealth assumed responsibility for protecting the whole of Australia against the introduction of pests and diseases affecting plants, animals and man.

While the Federal Government took over legislative responsibility for international quarantine the states continued to carry out quarantine operations until 1995, when these functions were passed to the Commonwealth by all states except Tasmania, Western Australia and the Northern Territory.

During World War II the administration of quarantine was not given a high priority and two important pests, the sirex wasp and the European house borer, are thought to have slipped into the country during this period.

After the war plant quarantine was revitalised under Dr T H Harrison who was in charge of plant quarantine from 1947 to 1965.

The modern era of plant quarantine probably dates from 1965 when Mr Jack Morshell took over responsibility for the administration of plant quarantine in the Department of Health. During this period important advances included the development of quarantine procedures for container cargoes, disinfection of aircraft cabins and holds and further development of post entry plant quarantine nurseries.

In 1984 responsibility for quarantine was transferred to the Department of Primary Industry and two years later it was combined with the Export Inspection Service to form the Australian Quarantine and Inspection Service (AQIS).

Quarantine and Trade

Australia was an initial signatory to the FAO International Plant Protection Convention (IPPC) in 1951. The IPPC develops international operating rules and documentation for plant quarantine.

Through the 1980s Australia played a leading role in the development of quarantine policy within the Uruguay Round of the General Agreement on Tariffs and Trade. These discussions led to the *Sanitary and Phytosanitary Agreement*, the so-called *SPS Agreement*, which came into force on 1 January 1995 with the establishment of the *World Trade Organisation* (WTO).

The agreement sets out the basic rules for maintaining food safety and animal and plant health in international trade. While the agreement allows countries to set their own standards, these standards must have a scientific basis and be applied only to the extent necessary to protect human, animal or plant life or health.

SPS measures must be established on the basis of an appropriate assessment of the actual risks involved.

However, the basic philosophy of the Australian Plant Quarantine Service, enunciated in 1983, has not really changed:

'The identification and assessment of the risk which exotic diseases or pests pose to Australian agriculture and forestry and in the light of that assessment, to impose restrictions and conditions necessary to prevent the introduction of disease or pest.

'The restrictions and conditions are based solely on biological evidence and not in response to economic or political pressures.'

Quarantine Risks

The basis of the SPS Agreement is the assessment of the risk involved in importing a plant or plant product. While the notion of acceptable risk is often difficult to accept, it is realistic and reflects the fact that all imports, legal and illegal, inevitably involve a level of risk.

There is a risk of accidental or deliberate entry because of imperfect quarantine methods or imperfect means of detection.

Continually increasing quarantine security does not necessarily mean a reduction in risk. The total banning of entry inevitably leads to the temptation to smuggle and uncontrolled entry.

A no risk policy implies total exclusion, which is either undesirable or unworkable.

The movement of people, plants, plant products, machinery, vehicles, ships, containers, etc., always involves some risk.

Threat or hazard management more accurately describes what quarantine can realistically aim to achieve. In determining quarantine conditions the various channels of importing a pest or disease are examined and the risks assessed.

Risks can vary according to the commodity and the pest or disease of concern. The level of risk can change over time.

In developing quarantine policies, both international and domestic, it is most important that everyone understands the concept of risk assessment and why a 'no-risk policy' is not possible in practice.

In assessing risk, issues which must be canvassed include:

- What is the status of the pest or disease in Australia and overseas?
- What plants are known to be affected by the pest or disease?
- Is the pest or disease being monitored or controlled?
- What is the impact of the pest or disease?
- Most likely origin.
- How does the pest or disease spread?
- Probability of the pest or disease entering, establishing and spreading in Australia.
- Economic and environmental implications of the presence of the pest or disease.
- National economic considerations, e.g., impact on the community.
- Biological characteristics of the pest which would aid its survival.
- Most likely means of entry into Australia.
- Ease of detection in hosts and other goods and the scope of new technologies.
- Potential alternative control strategies such as resistant varieties.
- Possible means of eradication.

If one or more of these areas are adverse then Australia may benefit from imposing restrictions on entry to the country.

However, unless clearly justified on biological grounds a quarantine restriction may be regarded as an unjustified, non-tariff trade barrier and lead to reciprocal imposition of barriers and/or challenge by the WTO.

Government must also consider the impact of quarantine restrictions on domestic prices and consumer choice and the direct and indirect costs of imposing quarantine restrictions. Industry may also have to face reduced access to new genetic material.

The priority that Australia gives to particular imports can also affect the degree of risk of entry of pests or diseases that may be tolerated. Imports for feed grains during the drought in 1990 were of particular concern to the local cereal industry. AQIS had to develop protocols which minimised the risk of introducing pests, diseases and weed seeds and yet provide sufficient volume of grain to meet the requirements of the pig, poultry and feedlot industries.

Quarantine risk varies with time and circumstances, particularly the changing pest or disease status of countries or regions. For

example, the outbreak of Karnal bunt, a fungus disease of cereals in Asia, assumed far greater importance when it was found in the United States, a major wheat exporter.

The outbreak of papaya fruit fly in far north Queensland had a very direct impact on growers in far north Queensland but a minimal impact on southern states which already had quarantine restrictions for the control of Queensland fruit fly. Establishment of roadblocks south of Cairns overcame quarantine problems for NSW and southern Queensland.

This objective approach to assessing quarantine risks must also be applied to interstate and intrastate quarantine in maintaining the integrity of quarantine decisions.

Integrity of Quarantine

At a special session of the Australian and New Zealand Association for the Advancement of Science (ANZAAS) in Melbourne in January 1935, the Professor of Public Law at the University of Melbourne Prof. K H Bailey warned:

'But we must face the fact that the politician, and behind him the plant expert, is widely suspected of yielding to the pressure of local trade interests, and devising systems of regulation which, on the face of them, are based on scientific grounds, but are really mere camouflage for the old State-protection idea, which federation was intended to supersede. There is room for the frankest kind of scrutiny of policy in the light of that feeling.'

These remarks are just as true today as they were 63 years ago when they were spoken during a fierce debate about restrictions on the interstate movement of potatoes because of the disease powdery scab.

While quarantine provides no guarantees that pest and disease incursions will never occur, the postponement of the establishment of a disease or pest can be very valuable because additional costs of controls may be avoided, improved control measures may become available (including the development of resistant varieties) and new detection methods could improve security and thus postpone pest introductions.

Impact of a Changing Environment on Quarantine

The advent of the jumbo jet and the cargo container ship have dramatically changed the quarantine picture over the last 30 years or so with an increase in the volume of imports and increased airline passenger traffic.

Quarantine has not only had to cope with increased passenger numbers and a greater volume of cargo, but people and cargo also come from more diverse parts of the globe.

The lowering of tariffs and the liberalisation of trade have focused attention on non-tariff trade barriers such as quarantine.

Similarly pressures from tourism interests to speed international passengers through airports have also focused on quarantine impediments to passenger movement.

In 1996 the so called 'Nairn Review' of Australian quarantine recommended that the capacity of AQIS to gather information and to undertake risk assessments should be enhanced. A new name has been coined for this process—*Import Risk Analysis.*

In order to carry out an effective analysis of applications to import commodities into Australia, seek access for our produce to new overseas markets or undertake domestic environmental impact studies, comprehensive information on the national or regional status of plant pests and diseases is required. At the present time there is no complete national inventory of our agricultural pests and diseases, although AQIS, CSIRO, the state departments, museums and universities hold considerable information. There is also a lack of specialist entomologists and plant pathologists in the states to carry out identifications and maintain databases. It is indeed unfortunate that when the Federal Government provided the additional resources for AQIS to undertake import risk analysis work in Canberra no additional resources were provided to the states to gather and collate the necessary data from the field.

Quarantine and Horticulture

Over the years quarantine, international, interstate and regional, has sustained horticulture through preventing the introduction and spread of many serious plant pests and diseases and enabled the safe introduction of new varieties into the country. Some of the more significant quarantine pest problems which have occurred in horticultural crops in recent years and which are of continuing concern to trade, both local and international, are considered.

Phylloxera

Probably the most notorious invader has been the phylloxera aphid which, as indicated earlier, was first found at Geelong in 1877. It quickly spread to north, central and north-eastern Victoria adjacent to the border areas in NSW, the counties of Camden and Cumberland around Sydney and at Eagle Farm near Brisbane.

Following the removal of vines the pest can no longer be found in old infested areas such as Geelong and Bendigo.

The spread of phylloxera last century occurred at a time when the viticultural industry was rapidly expanding, perhaps in a similar way to the expansion of the industry today. Industry and government are now working together on the development of a national strategy to manage phylloxera and prevent any further spread of this pest. To the credit of industry and state quarantine authorities the spread of this pest over the last 100 years has been minimal. The King Valley outbreak in 1991 is the only infestation to have been found outside the areas that were originally phylloxerated at the turn of the century.

Controlling the movement of vine planting material is the key issue along with the movement of machinery and people. Unfortunately some parties have focused attention on the more remote pathways for phylloxera movement, particularly transmission in grape must.

Fruit Flies

The Mediterranean fruit fly was discovered in Western Australia in 1896. Although occasionally detected in South Australia, interstate quarantine has prevented the pest becoming established in the eastern states.

Early this century fruit flies were found fairly regularly in shipments of bananas arriving on the docks in Melbourne. It was not until after the Second World War that a significant effort was made to prevent Queensland fruit fly becoming established in Victoria and South Australia. The first recorded outbreak of Queensland fruit fly in South Australia was in 1947 when larvae were found in nectarines in a garden in Glen Osmond, an Adelaide suburb.

Fruit fly area freedom has achieved major significance in south-east Australia in recent years when the United States agreed to accept oranges from the Riverland, Sunraysia and the MIA on the basis of fruit fly freedom established by an ongoing and intensive fruit fly monitoring program. As a fall back, cold temperature sterilisation is accepted if there is a fruit fly outbreak.

A significant factor in the development of fruit fly control in the inland horticultural areas has been the establishment of the tri-state fruit fly committee funded by the Commonwealth, New South Wales, South Australian and Victorian Governments and the industries in the three states. The main thrust has been to make the public aware of the dangers of fruit fly through a coordinated publicity campaign.

$36 million of citrus was exported to the United States in 1997-98 under area freedom certification.

The refinement of cold sterilisation methods has opened up the Japanese market for citrus from Queensland, the MIA, Sunraysia and the Riverland. This trade is now worth some $17 million per annum.

The incursion of papaya fruit fly in far north Queensland in 1995 had a major impact on horticulture in the region and losses in trade are estimated to have cost industry some

$100 million. An eradication campaign, funded by the Commonwealth and the states and costing $34 million, was successfully completed in August this year. This effort is a credit to the Queensland Department of Primary Industries.

Japan has recognised Tasmania's fruit fly freedom status enabling the development of a new trade in squash. Negotiations for the export of apples to Japan were proceeding well until *Erwinia amylovora* was found in the Royal Botanic Gardens in Melbourne in May 1997.

New fruit fly disinfestation techniques have played a significant role in the development of both international and interstate trade in fruit fly host produce and led to the expansion of horticultural production in fruit fly endemic areas. Although these disinfestation treatments can add significantly to costs they have enabled growers to access major markets.

Controls on the spread of pests and diseases by both international and internal quarantine measures combined with pest monitoring and disinfestation protocols have provided access to new markets. Over the last decade access to new markets in Japan, the United States, New Zealand and Taiwan has provided important new outlets for Australian growers.

Disinfestation treatments need to be kept under continual review as the use of various chemical treatments comes under closer scrutiny. Ethylene di bromide was withdrawn from use just a few years ago because of health concerns and methyl bromide, which has long been an important quarantine treatment for fresh produce, now has a limited life expectancy because of the adverse environmental effects of this chemical.

Physical treatments, particularly cold and heat, are being used more widely. Cold treatments, which were developed initially for apple and pear exports to the USA, are now being used for the treatment of citrus. Hot water and hot humid air are used to treat mangoes and high temperature forced air treatments will kill fruit fly eggs and larvae in paw-paw. I believe that it will not be too long before the use of ionising radiation as a quarantine tool for fresh produce must be re-examined.

Over the last two years a systems approach to fruit fly control is being evaluated on low chill stone fruit, citrus and strawberries produced in coastal areas of Queensland and New South Wales for export to the southern states. This involves continual field monitoring of fruit flies, strategic application of control sprays and pack house product inspection under an audited quality management system. This is a major shift in thinking using a series of measures to achieve the desired level of security.

Potato Cyst Nematode

Potato cyst nematode (PCN) was first found south of Perth in 1986 in a market garden at Munster. The affected areas were taken out of production and isolated, and after some 10 years of surveying no further infection sites were found.

In Victoria PCN was found in a number of areas east of Melbourne in 1991 and 1992 including nine infected sites at Gembrook. Interstate regulations restrict the import of potatoes grown within 20 km of an outbreak. Mauritius and South Korea presently will not accept potatoes from Victoria because of the presence of PCN.

Western Flower Thrips

Western flower thrips was first found near Perth in 1993 and outbreaks were soon after reported near Sydney and Brisbane. Restrictions on interstate movement of host plant material imposed by Tasmania, South Australia and Victoria slowed the spread of the thrips. Although outbreaks were subsequently found in these three states the quarantine measures did demonstrate the importance of maintaining nursery hygiene and undertaking pest monitoring programs.

Importing New Varieties

Agricultural industries are naturally concerned about any pest incursion which may impact on

industry. However, at the same time industries require better varieties to improve productivity and product quality to enable them to better compete more effectively on local and export markets.

Quarantine requirements have delayed access to new genetic material due to post-entry disease testing requirements. These delays are now being addressed through the accreditation of overseas sources of stock which have a known high health status. Import protocols are also under review including a re-evaluation of the pest risks and the streamlining of post-entry quarantine testing procedures using new technology.

Access to Our Markets by Overseas Producers

Australia presently permits access to our markets for a number of fresh horticultural commodities from many overseas countries under specific protocols including:

- citrus from California and Israel;
- mangoes from the Philippines and Mexico;
- asparagus from the United States;
- onions from New Zealand and the United States;
- garlic from Mexico;
- stone fruit from New Zealand;
- snow peas and cut flowers from Zimbabwe;
- flower bulbs from Holland; and
- strawberries from the United States and Zimbabwe.

But our quarantine regulations also exclude horticultural imports from many countries where there is a risk of disease introduction.

Australia's refusal to permit apple imports from New Zealand is being strenuously fought by the New Zealand apple industry and the New Zealand Government, including threats to seek the intervention of the WTO. Australian growers are naturally concerned that the entry of New Zealand apples would place the apple and pear industry at risk from fire blight. Victoria is particularly vulnerable as the State is a major producer of pears which are far more susceptible to this disease than apples.

The Australian apple and pear industry has developed over many years in an environment where it has not had to compete with overseas fruit in the domestic market. The impact of shifting the goal posts and permitting imports from New Zealand, the United States, South Africa or even China could be devastating for some sections of the industry.

As a member of the WTO and signatories to the SPS Agreement we are obliged to play by the new rules. If it can be demonstrated that the imports under an agreed protocol do not present any significant risk to the local industry then we are obliged to accept the umpire's verdict.

However, even under the rules of the WTO countries are permitted to implement other measures to regulate the volume of imports to minimise the impact on an industry and provide time for adjustment.

Concluding Remarks

A more systematic approach to the risk assessment has enabled plant quarantine to address increased industry and community expectations.

I believe some considerable effort needs to be devoted to explaining the concept of quarantine risk and why there really can never be a no-risk policy, either for international or internal quarantines.

Australia has built a quarantine service which is highly regarded throughout the world. Although at times, subject to criticism from at home and abroad for the decisions which it makes, or does not make, AQIS, and the organisations which preceded it, are at the world forefront of quarantine policy development and quarantine operations. AQIS officials have played a leading role in the development of the FAO International Phytosanitary Convention and the WTO SPS Agreement.

I believe it is unfortunate that the government did not accept the recommendations of the Nairn

Committee and give greater independence to AQIS. Quarantine decisions should be made, or seen to be made, for quarantine reasons only. Other sectors of government should manage the trade policy implications and the industry adjustment implications of quarantine decisions.

The nation's plant pest and disease diagnostic infrastructure has been allowed to run down to an extent that it could put our incursion management capability at risk. Certainly many institutions do not have the depth of expertise they once did. The lack of a national pest and disease database also seriously inhibits our efforts to manage quarantine and access new markets.

The Nairn Committee noted that while the separation of AQIS operations from all the states, except Western Australia, Tasmania and the Northern Territory, made good sense in some operational areas, it separated Canberra decision-makers from the state Departments. The state Departments have been the eyes and ears of quarantine around the country and the repository of considerable technical, industry and corporate knowledge. This separation has, I believe, reduced the awareness of quarantine issues by the state Departments.

Continuing dialogue, both formal and informal, between industry, state and Commonwealth Government officials, research and extension personnel is essential to development of effective quarantine services which meet the needs of industry and the community at large.

Fortunately AQIS has continued to participate in the consideration of interstate quarantine issues and both the Commonwealth and state officials along with industry are now jointly involved in the pest incursion management issues.

Hopefully the Office of the Chief Plant Health Officer and the proposed Australian Plant Health Council, will quickly address these and other issues by bringing the Commonwealth, state and industry together in a partnership which will develop the many facets of plant health and ensure that quarantine does its part in sustaining horticulture through the next millennium.

References

Commonwealth Department of Health (1983) *The Australian Plant Quarantine Service.* Australian Government Publishing Service, Canberra.

Department of Primary Industries and Energy (1988) *Australian Quarantine Requirements for the Future: Report of the Quarantine Review Committee.* Australian Government Publishing Service, Canberra.

Moyal, A. (1976) *Scientists in Nineteenth Century Australia: A Documentary History.* Cassell, Melbourne.

Nairn, M.E., Allen, P.G., Inglis, A.R. and Tanner, C. (1996) *Australian Quarantine: A Shared Responsibility.* Department of Primary Industries and Energy, Canberra.

Noble, R.J., Fish, S., Meeking, E. and Bailey, K.H. (1935) *Plant Quarantine.* Abstracts of papers presented at Australian and New Zealand Association for the Advancement of Science (ANZAAS) Congress in Melbourne in January 1935. Published in the Journal of the Australian Institute of Agricultural Science Vol. 1 No.1.

Russell, A. (1949) *William James Farrer, a Biography.* F.W. Cheshire, Melbourne.

October 1998