Plant Health AUSTRALIA

Assessment of the current status of the human resources involved in diagnostics for plant insect and disease pests

ASSESSMENT OF THE CURRENT STATUS OF THE HUMAN RESOURCES INVOLVED IN DIAGNOSTICS FOR PLANT INSECT AND DISEASE PESTS

A survey conducted for

Plant Health Australia

by

Jane R. Moran
Team Leader, Biosecurity and Policy Support
Victorian Department of Natural Resources and Environment

and

Ian F. Muirhead
Sub-program Leader, CRC for Tropical Plant Protection

April 2002

This project was funded by the Commonwealth Government through Agriculture, Fisheries and Forestry—Australia

Department of AGRICULTURE FISHERIES & FORESTRY - AUSTRALIA

Images supplied courtesy CSIRO, extracted from The Insects of Australia, Published by Melbourne University Press 1991

Table of Contents

List of Figures

List of Tables

Acronyms

AFFA	Department of Agriculture, Fisheries and Forestry - Australia
APPD	Australian Plant Pest Database
AQIS	Australian Quarantine and Inspection Service
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DNRE	Victorian Department of Natural Resources and Environment
DPIWE	Tasmanian Department of Primary Industries, Water and Environment
ELISA	Enzyme Linked Immunosorbent Assay Technique
FTE	Full Time Equivalent
IPM	Integrated Pest Management
ISO	International Standards Organisation
NAQS	Northern Australia Quarantine Strategy
NATA	National Association of Testing Authorities, Australia
PCR	Polymerase chain reaction
PHA	Plant Health Australia
PHC	Plant Health Committee
QA	Quality Assurance
QDPI	Queensland Department of Primary Industries
RIRDC	Rural Industries Research and Development Corporation
SARDI	South Australian Research and Development Institute

Without a national diagnostic science capability, crop losses from pests and diseases would increase, along with the costs of chemical control and associated environmental impacts.

Acknowledgements

The input of all respondents to the questionnaire is gratefully acknowledged. Gathering the information required would have taken considerable time, particularly for the larger diagnostic laboratories. The authors appreciate that this was a significant imposition and the survey would not have been possible without the cooperation of all respondents.

We are grateful for the input of the steering committee comprising:

Rob Allen - Queensland Department of Primary Industries

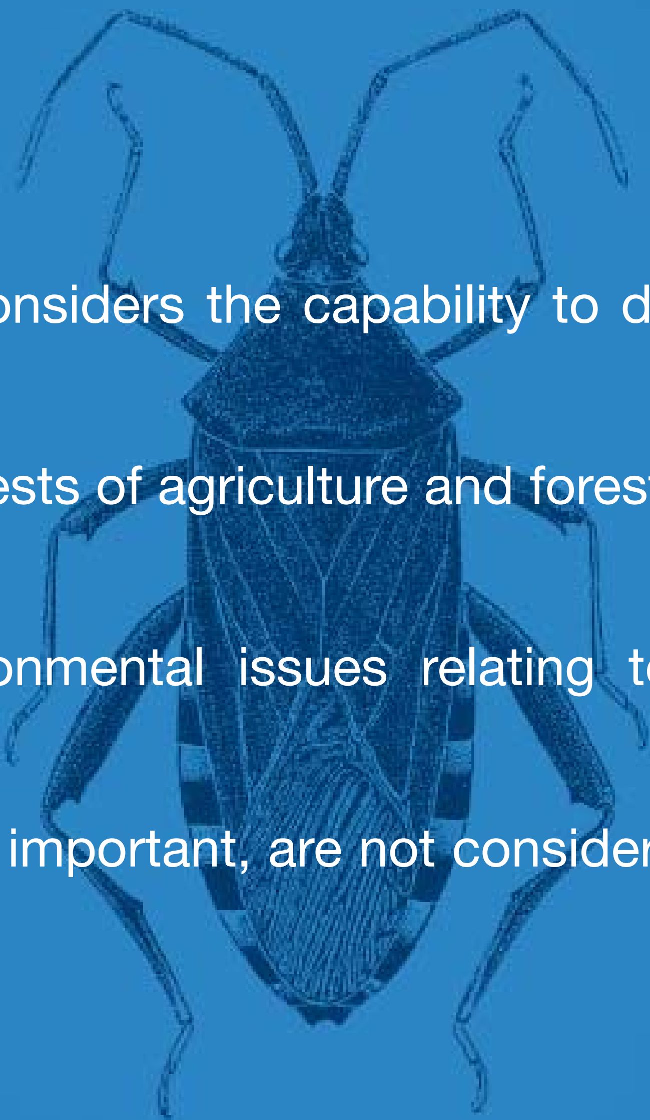
Michael Cole - Agriculture, Fisheries and Forestry - Australia

Rob Floyd - CSIRO

Simon McKirdy - Department of Agriculture (Western Australia)

Peter Merriman - Victorian Department of Natural Resources and Environment

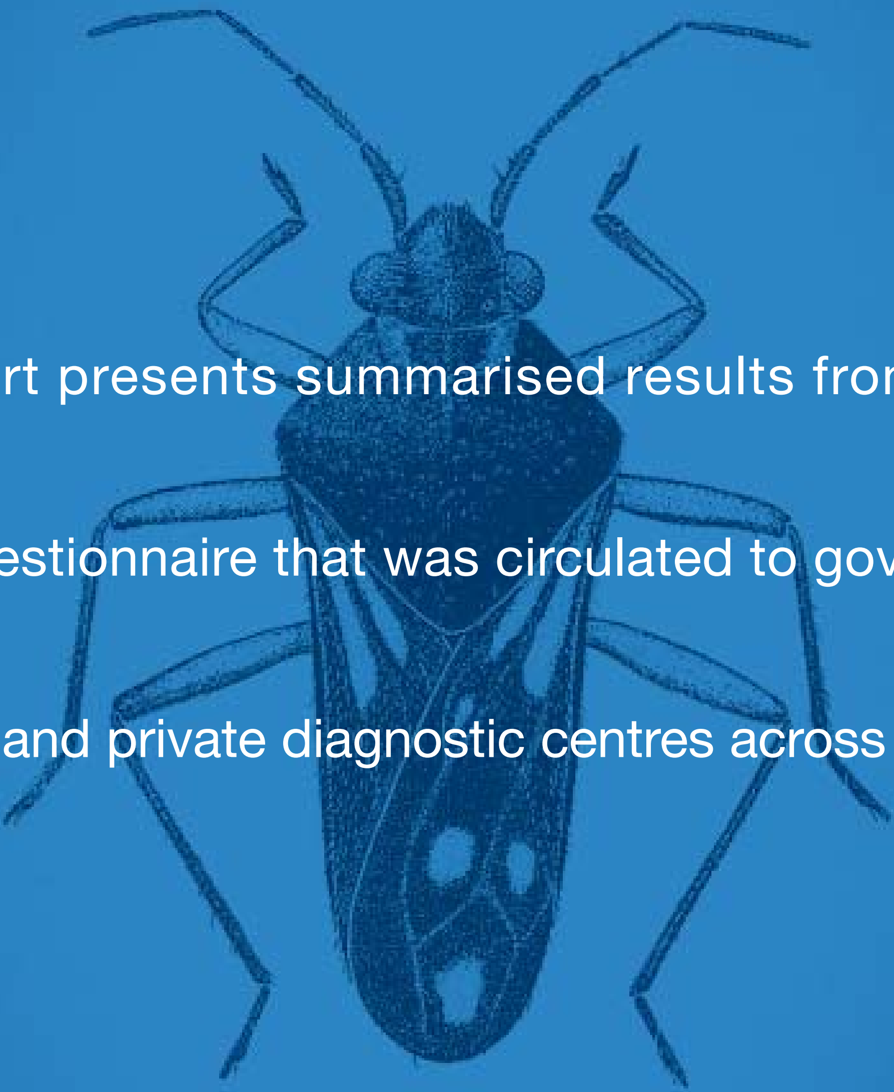
Jack Simpson - State Forests NSW



This project considers the capability to diagnose insect and disease pests of agriculture and forestry in Australia. Broader environmental issues relating to native flora, which are also important, are not considered in depth.

Terms of Reference

1. Document the existing government and non-government diagnostic laboratories, the staff and their skills, and resources dedicated to diagnostics.
2. Compare the 2001 situation with a previous analysis of Australia's diagnostic capability commissioned in 1995.
3. Undertake a gap analysis of the Australia's diagnostic capability, including the identification of issues which impede efficient use of resources.
4. Identify the constraints to the formation of a diagnostic network with a capability for both exotic and endemic pest and diseases diagnosis.
5. Develop recommendations for a strategic plan to address the issues identified in Terms of Reference 1 to 4.



This report presents summarised results from a web-based questionnaire that was circulated to government, university and private diagnostic centres across Australia.

Executive Summary

Plant Health Australia (PHA) has identified national resources in plant pest and disease diagnostics as an important strategic issue for industry and government in Australia. The Department of Natural Resources and Environment (DNRE) and the Cooperative Research Centre (CRC) for Tropical Plant Protection were commissioned by PHA to undertake a survey of human and physical resources currently available throughout Australia.

This report presents summarised results from a web-based questionnaire that was circulated to government, university and private diagnostic centres across Australia. The questionnaire was forwarded to over 150 contacts in diagnostic centres identified mainly by personnel in state and territory agriculture departments.

A 41 per cent response rate (66 responses) was achieved. While all of the major government laboratories responded, some commercial laboratories declined to participate - mainly for commercial reasons.

The results were collated and discussed with a number of professionals working in the area, including those attending a diagnostics workshop run by the Australasian Society of Plant Pathology in Cairns in September 2001. These results were then compared with those from an earlier survey commissioned in 1995.

Major findings are that:

- although the resources devoted to plant diagnostics are substantial, these services are not well coordinated across Australia to deliver nationally relevant outputs;
- government and certain universities are the only groups identified that provide comprehensive services for identifying bacteria, fungi, insects, nematodes and viruses;
- laboratories have (or are) introducing fees for service, but there are significant differences between the level of cost recovery from private and government sources between states and territories;
- commercially oriented government diagnostic services compete within and between states for business;
- funding is a key issue for all diagnostic providers who responded to the survey;
- there is little quality control to ensure the delivery of standardised techniques and methods such as those used in veterinary laboratories in Australia.
- documented procedures for identifying exotic pests and diseases are generally not available, and many laboratories have limited capabilities to identify exotic insect pests and plant pathogens;
- resources in certain disciplines (especially bacteriology and nematology in some states) have apparently declined in recent years, potentially compromising national capability in these areas; and
- there is little evidence of a structured approach to succession planning to address the issue of replacement of the ageing population of diagnostic scientists

Recommendations

1) PHA should develop a strategic plan to establish a national network of diagnostic laboratories within a quality assurance (QA) framework.
2) The strategic plan should define the minimum resources required to maintain a national diagnostic capability.
3) A model for identifying and funding essential non-commercial activities of the diagnostic network (without the need for cost recovery) be developed.
4) The strategic plan includes procedures for succession planning and staff development, particularly for discipline areas that are considered to be at critically low levels.
5) The above recommendations be adopted as a two stage process:
   - secure enhanced networking and management of existing laboratories
   - identify centres with specific capabilities for biosecurity and secure their national roles and responsibilities.
6) A review of Australia's current and future requirements in taxonomic plant pathology and entomology be undertaken as a separate initiative.

Introduction

Diagnostic science and services underpin integrated pest management (IPM), quarantine and plant health programs essential for Australia's primary industries. Correct diagnosis is a prerequisite for effective control strategies - as the identity of the target must be determined so appropriate treatments can be selected. Accurate diagnosis avoids the costly problems of misuse and overuse of pesticides and associated environmental problems.

Diagnostic science is also vital for the identification of exotic plant pests and diseases and is required to support credible quarantine and inspection services operating to the standards required by the international agreements to which Australia is a signatory. Accurate, sensitive and timely tests are required to detect and manage exotic incursions, and to demonstrate area freedom where this is a prerequisite for export trade. Without a national diagnostic science capability, crop losses from pests and diseases would increase, along with the costs of chemical control and associated environmental impacts.

Plant pest and disease diagnostics in Australia has traditionally been a responsibility of state agriculture departments. The CSIRO, universities and private consultants are also involved to varying degrees.

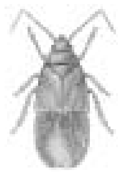
Increasing fiscal pressure on the agriculture budgets of states, together with the 'user pays' philosophy, has meant that many diagnostic services are under threat. Vacant positions for specialists in particular disciplines are not always filled. This is partly linked to diminishing levels of core funds, and to the difficulties of covering budget commitments using fees for service. At the same time, diagnostic services are under strain, particularly in some specialist areas, and coverage of some key disciplines is patchy.

There are three important technical considerations. The first is the increasing need to provide support for major incursions of exotic pests and diseases. The second is the requirement to provide predictive services to primary producers seeking to manage important endemic threats with minimal chemical inputs. The third is the requirement to embrace new technologies, which increase the sensitivity and timeliness of tests.

This report describes the current diagnostic position, identifies gaps, and suggests measures that will lead to a strong and viable national diagnostic service. There are many aspects to this issue, and this report is a first step in developing a national perspective on plant health service capability - one of PHA's four key priorities.

This project considers the capability to diagnose insect and disease pests of agriculture and forestry in Australia. Broader environmental issues relating to native flora, which are also important, are not considered in depth.

A survey comprising 32 questions was designed in consultation with a steering committee of plant health representatives from state agencies, AFFA and PHA. The basis for the construction of the questionnaire was a previous national survey of diagnostic capability commissioned by RIRDC in 1995.



Existing government and non-government diagnostic laboratories, staff and resources dedicated to diagnostics

Survey methodology

A survey comprising 32 questions was designed in consultation with a steering committee of plant health representatives from state agencies, AFFA and PHA. The basis for the construction of the questionnaire was a previous national survey of diagnostic capability commissioned by RIRDC in 1995 (Miller and Moran, 1996). Questions were developed and refined through a consultative process with the steering committee and the final version was converted into a web-based format. Committee members provided information on the location of organisations providing diagnostic services for each state. This was supplemented by searching the yellow pages for likely service providers, and by word of mouth. The intent was to capture information from government laboratories, including state departments, universities, CSIRO, AQIS and the private sector. Dr Ian Muirhead, Sub-Program Leader, CRC for Tropical Plant Protection, managed the analysis of responses from the Northern Diagnostic Network and other agencies operating in tropical Australia. Jane Moran handled responses from agencies operating in temperate Australia.

This questionnaire was sent out to laboratories via e-mail and the respondents entered their responses directly onto an electronic database. E-mails were sent to over 150 people. Every survey response was checked carefully and unusual answers were double-checked by personally contacting the service provider. All responses were kept confidential.

The questions were designed to address three critical attributes of a diagnostic service.

1. Business/management systems

- the number of samples processed, number of tests conducted, breakdown of specimens by geography and crop type;
- the existence of specimen tracking systems and databases for invoices, clients, and specimens;
- the existence of dedicated reception, administrative and management staff;
- sources of revenue/funding; and
- accreditation or QA systems.

2. Biosecurity

- links with reference collections and specialist discipline expertise in plant pathology and entomology;
- validated tests for exotics;
- AQIS certification and reporting responsibilities;
- protocols for the safe movement of specimens between laboratories; and
- access to containment facilities.

3. Infrastructure and human resources

- access to technology (traditional and molecular); and
- staff expertise and age.

Response to the survey

While 66 groups responded to the questionnaire, five felt the questions did not apply to their business and did not complete the questionnaire, leaving data from 61 groups. This equates to a response rate of 41 per cent. It should be noted that the reluctance of private providers to disclose details of their business, and questionnaires sometimes sent to multiple staff members within the one laboratory contributed to the response rate. In spite of the relatively low response rate, it is considered that this survey includes information from all the major diagnostic providers around the country.

Limitations on interpretation of data

Conclusions about the state of diagnostic services in Australia have been drawn with the following limitations in mind:

- the survey was not based on statistically valid samples of all types of laboratories;
- the survey sought information about taxonomic support for diagnostic services, but it is likely that some of the replies may not have included diagnostic services provided by taxonomists which fell "outside" the area of responsibility of diagnostic laboratories;
- some questions may have been interpreted differently by respondents;
- commercial diagnostic laboratories, several of which provide general or specialist services, are poorly represented in the results; and
- high volume work for routine screening (e.g. ratoon stunt disease of sugar cane and fruit flies) is a component of a small number of laboratories - and this can distort the overall interpretation of data.

The authors have reported the data collected, identified major trends or features, and interpreted these against a background of their own knowledge and experience.

It should be noted that the survey did not include crop consultants (e.g. those who provide bug-checking services for the cotton industry). These services were seen as distinct from those provided by specialist diagnostic laboratories.

Survey results

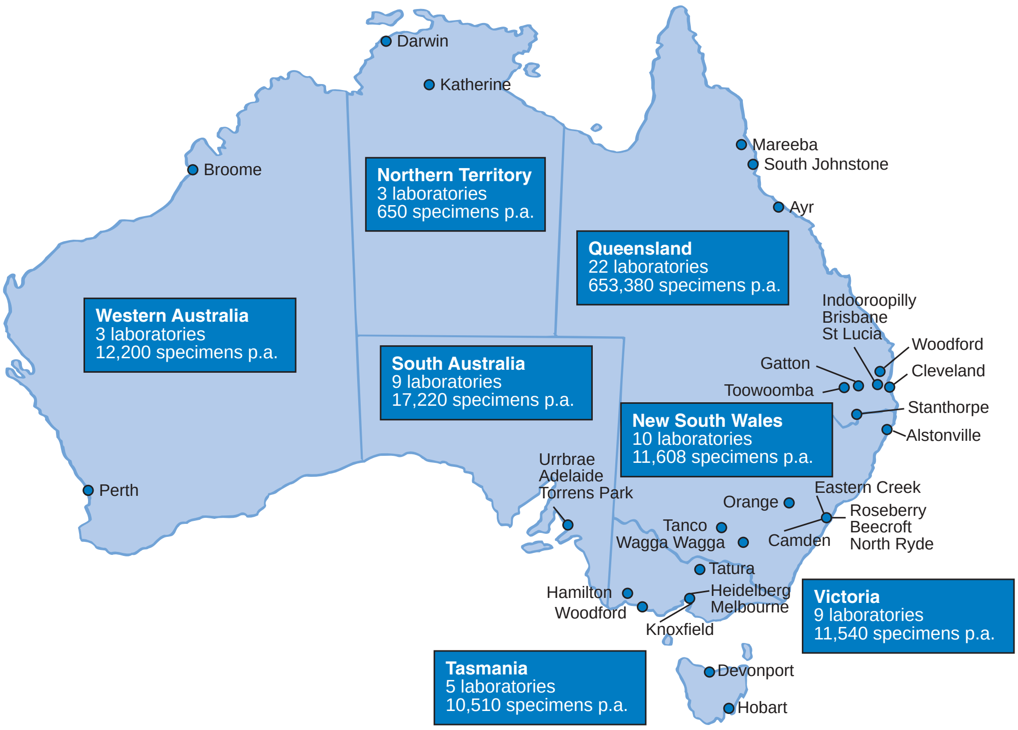
Most data is presented in diagrammatic format and the analysis has focused on issues of strategic importance such as:

- distribution of centres;
- types of providers;
- demographics - including age profiles and succession plans;
- the state of specific disciplines - including which ones are under threat;
- financial support - including revenue sources and problems;
- science infrastructure;
- business systems; and
- quarantine - including how incursions are identified and reported.

Distribution of centres

Responses were received from laboratories in all states and territories. The results are summarised in Figure 1.

Figure 1 - Distribution of laboratories responding to the survey



Most of the major service providers in each state and territory were covered by this survey, including regional laboratories. Figure 1 indicates that services are distributed widely throughout Australia, including every state and territory.

Services are generally provided from cities and regional centres in Australia's major agricultural and horticultural production areas.

Of the 61 responses received, 42 responses were from state government laboratories, 10 from universities, seven came from AFFA, including the Northern Australian Quarantine Survey (NAQS), and two were from private providers.

These laboratories process a very large number of specimens, but most of these are for routine quarantine and surveillance for pests such a fruit flies. In Australia, over 700,000 specimens are submitted for diagnosis annually.

Nature and extent of the client base and associated stakeholders

Client groups

Table 1 - Percentage breakdown of clients by state

Source of specimens	VIC	NSW	SA	QLD	WA	TAS	NT
Chemical/seed sellers/agribusiness	19.5%	13.5%	50.0%	0.1%	5.7%	9.1%	0%
Growers	51.2%	17.6%	15.3%	14.5%	11.0%	35.7%	37.7%
Local government	2.1%	3.0%	0.2%	1.6%	1.0%	1.0%	0%
Private consultants	6.2%	2.7%	5.6%	1.0%	4.3%	9.9%	0%
Commonwealth or state agencies	17.3%	61.1%	4.5%	82.0%	73.1%	34.1%	43.1%
Other	3.8%	2.1%	24.4%*	0.8%	4.9%	10.2%	19.3%
Total number of samples	**11,540**	**11,608**	**17,220**	**653,380**	**12,200**	**10,510**	**650**

** Samples processed for research programs.*

Table 1 indicates that with the exception of Victoria, South Australia, and Tasmania, most tests are conducted for the public sector - local, state or Commonwealth agencies. This is interpreted to mean that samples are submitted and paid for through government channels.

In Victoria, South Australia, and Tasmania, most tests are conducted for growers or for the sectors directly supporting growers. The large numbers of specimens handled by Queensland laboratories include 500,000 specimens from fruit fly monitoring, 45,000 for ratoon stunt disease screening and 100,000 for *helicoverpa* resistance monitoring.

The figures in Table 1 do not include the vast number of routine diagnostic services provided for the agricultural sector by consultants and crop monitoring services (where specimens are not processed by laboratories), or where tests are provided by the relatively small number of specialist private diagnostic laboratories that support specific industries.

Interstate and international movement of specimens

Table 2 - Percentage breakdown of specimens by location

Source of specimens	VIC	NSW	SA	QLD	WA	TAS	NT
Within state	85.4%	91%	77.5%	85.5%	95.3%	67.8%	77.7%
Other state	14.5%	9.0%	19.9%	2.2%	0.7%	31.6%	22%
Overseas	0.1%	0.03%	2.6%	12.3%	4.1%	0.6%	0.3%

Table 2 shows a substantial interstate movement of specimens (over 24,000 p.a.), particularly into South Australia, Victoria, New South Wales and Tasmania, reflecting the recent trend towards development of laboratories specialising is particular areas and offering services sector-wide. Examples are the South Australian Research and Development Institute (SARDI) Root Disease Testing Service for field crops, bacterial identification services offered by NSW Agriculture, and the ELISA indexing service provided by the Tasmanian Department of Primary Industries, Water and Environment (DPIWE).

The interstate movement of samples for diagnosis may have implications for interstate quarantine management, but this point is not addressed in this report.

Queensland laboratories conduct a significant proportion of tests (over 75,000 p.a.) on specimens from overseas. This results from activities conducted under the NAQS, where specimens are collected from Papua New Guinea, Indonesia and other neighbouring countries. It is understood that there are appropriate quarantine containment protocols in place to minimise the risks of escapes.

Breakdown by commodity/host

Table 3 - Percentage breakdown of specimens by host type for each state

Source/type of specimens	VIC	NSW	SA	QLD	WA	TAS	NT
Field crops	7.2%	5.8%	70%	30.9%	41%	5.1%	31.5%
Forestry	11.2%	8.9%	0%	0.8%	0.2%	16.5%	1.5%
Fruit and nuts	28.3%	25.2%	12.6%	46.2%	27.1%	8.3%	21.9%
Native flora	4.8%	1.1%	0.5%	1.2%	7.9%	6.6%	10.8%
Ornamentals	18.7%	17.4%	1.0%	3.6%	4.3%	26.5%	6.9%
Pastures	0.8%	0.2%	8.5%	0.03%	4.4%	6.5%	5.0%
Turf	8.8%	1.0%	0.2%	0.02%	6.9%	0.2%	1.5%
Vegetables	15.4%	17.1%	5.7%	17.2%	8.2%	24.9%	16.9%
Other	4.8%	23.4%	1.6%	0.03%	0.2%	4.8%	3.9%
Total number of samples	**11,540**	**11,608**	**17,220**	**653,380**	**12,200**	**10,510**	**650**

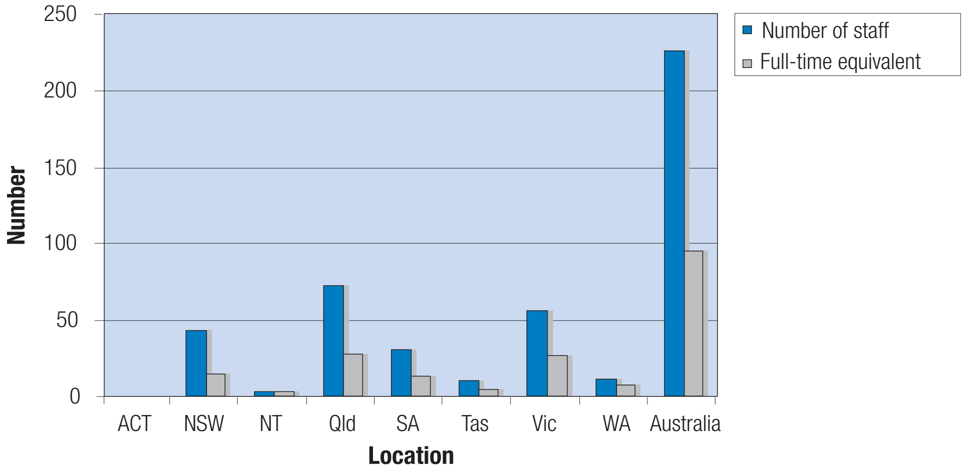
Table 3 indicates the surveyed laboratories receive samples from all major field crop, horticultural, forestry and pasture industries, and from growers of native plants, and that diagnostic services are available for most commodities within each state.

Field crops account for about 30 per cent of all samples, horticultural crops 60 per cent, while forestry, pastures and native flora contribute the remaining 10 per cent.

Scientific expertise, resources, technologies and other relevant infrastructure

Total staffing

Figure 2 - Number of staff involved in diagnostics, and full-time equivalents by state



The survey identified 214 scientific staff with a role in the delivery of diagnostic services. The involvement of most scientists in diagnostics is on a part time basis and, in general, the remainder of their time is committed to research. Aggregation of these part time positions translates to 90.1 full time equivalents (FTE's) involved in diagnostics.

Figure 2 shows that the staffing resource for diagnostics in Australia is substantial, with Queensland and Victoria reporting the highest staff numbers.

Roles

Of the 214 scientific staff identified as being involved in diagnostics, there were:

- 73 diagnosticians;
- 45 consultants or discipline specialists;
- 30 taxonomists; and
- 66 technicians.

11 administrative staff were also identified, bringing the total number of staff to 225. Administrative staff play an important role in larger laboratories, through tasks such as databasing and cataloguing samples.

Generally, specialist scientific inputs to diagnostic services are on a part time basis. Most scientists appear to have predominant roles in research and development with a minor commitment to diagnostic support. Agencies with dedicated diagnostic staff include the Queensland Department of Primary Industries (QDPI), SARDI, NSW Agriculture, DPIWE and DNRE.

The impact of part time commitment on provision of diagnostic services is not fully understood - but there are three important considerations.

Firstly, the time that individual scientists may have available for diagnostics will probably change as they move between different research and development projects (this can be expected to happen approximately every three years). Secondly, these changes can be expected to impact on resourcing, discipline strengths, and communication (i.e. who to go to for advice). Finally, it is difficult to develop succession plans with a dependency on part time diagnosticians. All three considerations impact on Australia's overall diagnostic capability.

Professional skills

Table 4 -Total numbers of discipline specialists available to diagnostic services in each state

Discipline	VIC	NSW	SA	QLD	WA	TAS	NT	Total
Bacteriology	1	2	0	1	0	0	0	4
Entomology	9	12	5	14	1	2	1	44
Forest pathology	1	1	0	0	1	3	0	6
General plant pathology	8	9	8	21	2	2	2	52
Mycology	7	2	3	2	1	2	0	17
Molecular biologists	1	1	2	3	0	0	0	7
Nematology	2	3	2	1	0	0	0	8
Virology	5	2	3	4	0	1	0	15
Total	**34**	**32**	**23**	**46**	**5**	**10**	**3**	**153**

Table 4 shows the number and type of discipline specialists listed as being directly involved in the delivery of diagnostic services, excluding administrative staff and technicians. It includes a mix of scientists with special skills in a discipline area and those involved in taxonomic science, which represents a higher level of specialisation. Taxonomic specialists provide unique and critical inputs to the diagnostic process, especially with respect to the identification of exotic and quarantinable organisms. However, care should be taken when interpreting Table 4. The authors are aware of discipline specialists, including taxonomists, who are not listed. These specialists were perhaps missed because they are not directly associated with routine delivery of diagnostic services on a day-to-day basis, but would be available to assist in particular situations, including quarantine emergencies.

In terms of the balance of professional skills, most states and territories appear to be reasonably well served by the various discipline specialists. Diagnostic services in plant pathology in the Northern Territory have access to specialists in Queensland through the Northern Australian Diagnostics Network.

From a national perspective, the level of support for diagnostic services in plant bacteriology is low. There are few taxonomic specialists operating in this discipline, and some at least have other duties.

Entomology inputs into diagnostics are not considered to be at risk from a national viewpoint, although the numbers of experts vary greatly from state to state. This is not to say that taxonomic support for entomology is adequate. The authors are aware that the taxonomic position for many key insect groups is such that insect identification is often compromised. It should be noted that the figure for Queensland is high because the survey was sent to many regional government laboratories in which entomologists have routine duties in diagnostics/identification in addition to research and development commitments.

On the available date, inputs into forestry diagnostics appear to be at low levels, but further analysis may be needed to confirm that the survey data is correct.

Substantial numbers of staff are involved in the provision of general plant pathology inputs. This is an ill-defined area and probably reflects the part time commitments of 'mainstream' research and development scientists to diagnostic services.

Nationally speaking, mycology inputs into diagnostics are not considered to be at critically low levels.

Nematology is a discipline that has experienced reductions in staff numbers in recent years, and the overall picture is that numbers are low and access may be matter of concern for diagnostic services in most states.

At the national level, virologists provide adequate levels of support for diagnostics, although levels may be a concern within states (e.g. Western Australia and the Northern Territory). There are virologists who do contribute to diagnostic services that are not reported in these figures.

It should be noted that this survey was not designed to assess taxonomic needs within disciplines. However, this is one of the recommendations of this report, and is an area that PHA may wish to address in the future.

Experience

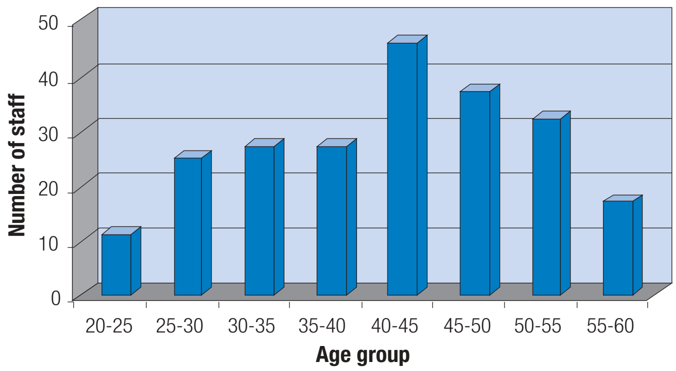
Table 5 - Experience of professional staff

Discipline	Average experience of individual scientists (in years)
Bacteriology	16
Entomology	19
Forest pathology	23
General plant pathology	18
Mycology	17
Nematology	10
Virology	18

For all professional groups except nematology, the average length of experience exceeds 15 years, which indicates that specialists supporting diagnostic services are very experienced. However, it is also an indicator that this specialist support base is ageing, highlighting the need for succession planning.

Age distribution

Figure 3 - Age of staff providing inputs to plant pest and disease diagnostic services



Approximately 60 per cent of all staff involved in plant diagnostics are aged over 40, and further analysis indicates 75.6 per cent of discipline specialists who provide 'consultancy' services to diagnostic laboratories are also, as a group, older than 40.

In comparison with the population at large, the distribution of staff involved in diagnostics is over-represented in the older age groups, and under represented in the 20 to 25 year age range. However, diagnostics typically requires some level of postgraduate experience, which may account for this.

Range of tests provided

The survey revealed that most laboratories in Australia offer a very wide range of services, differing in complexity from simple microscopic examination through to complex serological and molecular biological procedures.

Government laboratories are generally the only facilities that offer the full range of biochemical, molecular and serological tests.

The reason for this difference between government and commercial laboratories is probably due to the high infrastructure costs of maintaining laboratories and the relatively small size of the market. Commercial interests provide diagnostic services in areas such as human pathology presumably because the investment is justified by market size.

An additional issue for plant industries is that equipment and resources are usually shared between diagnostic laboratories and research and development projects.

Funding

Table 6 - Source of revenue by state

Source of revenue	VIC	NSW	SA	QLD	WA	TAS	NT
Contract services	16.5%	5.3%	32.8%	6.5%	0.3%	29.4%	0%
Diagnostic fees	40.1%	6.3%	52%	3.5%	16.1%	41.1%	0%
Other	0.1%	0%	0.2%	0.1%	0%	2%	0%
Government funding	43.3%	88.4%	15%	90%	83.6%	27.6%	100%

Table 7 - Government funding compared with source of specimens

Source of revenue	VIC	NSW	SA	QLD	WA	TAS	NT
Funding from government	43.3%	88.4%	15%	90%	83.6%	27.6%	100%
Specimens from government	17.3%	61.1%	4.5%	82%	73.1%	34.1%	43.1%

All states, except the Northern Territory, have laboratories that receive revenue from non-government sources (through contract services or fees for service). Most government agencies appear to be moving towards more commercially oriented models (e.g. fee for service). It should be noted that the states that have a high level of government funding generally have government as their major client (e.g. 82 per cent of specimens are submitted by government agencies in Queensland, with 90 per cent of funding being provided by government).

While government funds are an important source of revenue for all diagnostic services, funding levels vary considerably between states and territories. This is considered, in part, to be associated with laboratories moving from wholly government funded operations to part government/part fee for service businesses.

The move to a more commercial footing raises some key questions about ongoing government support for 'public good' issues. Experience shows that diagnostic laboratories cannot survive on private funds alone, so some level of government support is required. This can be through provision of resources and infrastructure or through meeting a proportion of staff salaries or operating costs. The question of identifying and quantifying public good is important in the context of any future national funding arrangements for diagnostics.

Accreditation status, quality control and quarantine considerations

Only nine of the laboratories identified through the survey operate under any form of accreditation. One had accreditation with ISO, two with NATA and six with other types of systems. Most laboratories reported that their operations were not subject to independent audit that accredits laboratory management systems and processes (ISO) or testing protocols (NATA).

However, 25 of the participating diagnostic centres have certified quarantine laboratories and 18 laboratories reported that they used validated diagnostic protocols to identify exotic diseases. However, data from the survey indicated the degree of validation of the quarantine tests varies widely, which indicates a need to develop more consistent approaches and national standards

More than half of the diagnostics laboratories indicated reporting responsibilities to quarantine agencies. This group included most, but not all of the laboratories that conduct tests for exotic organisms. It is not clear if all laboratories have protocols in place and an adequate understanding of their reporting obligations to quarantine agencies. One respondent identified the potential for conflicts of interest to arise (e.g. clients paying a fee for a commercial service expect confidentiality, while government agencies require disclosure and reporting of exotic pests and diseases).

Most laboratories reported access to a containment facility (either on- or off-site), but the level of containment varied from low-level nursery facilities, through C3 laboratories to C1 glasshouses. Containment facilities are an essential part of the operations of diagnostic centres and are necessary for work on possible exotic threats that have been intercepted by quarantine agencies or brought in for diagnosis by industry. Containment facilities can also be used for onshore research and development and training on high-risk exotics. Work in Australia on exotic plant pests and pathogens has not yet been ratified, and is the subject of ongoing discussion by industry and government at national levels.

Normal post, express post, hand delivery, and courier are all methods used when samples are sent between laboratories. Plant Health Committee (PHC) has identified the need for consistent approaches in communication, packaging, and transportation when consigning specimens to other laboratories.

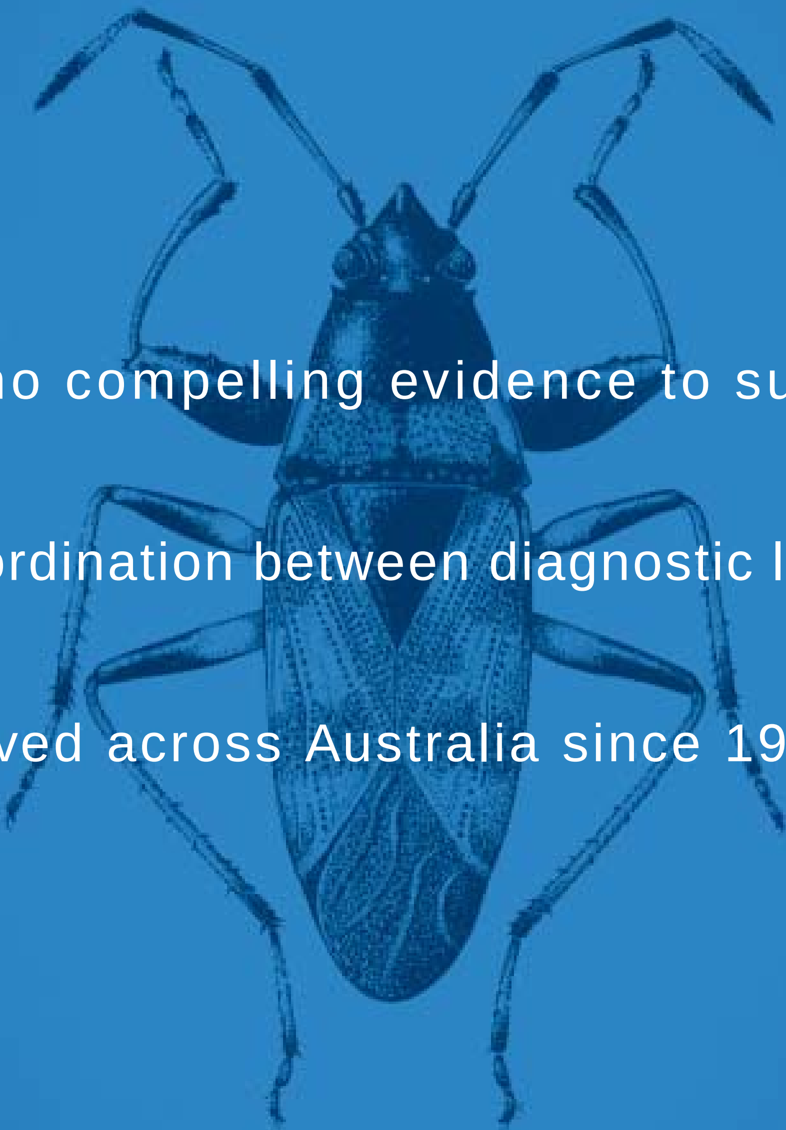
Roles and responsibilities

All laboratories recognised a need to communicate their findings on exotic incursions to state and Commonwealth authorities. All laboratories replied they would either contact AQIS (80 per cent) or their local department of agriculture (78 per cent) if they suspected an exotic incursion. However, 38 per cent of laboratories indicated they did not have reporting responsibilities to quarantine agencies in respect of exotic diseases. It appears that while most laboratories recognise the need to report, a proportion do not recognise their responsibility to do so. Only one laboratory indicated that client confidentiality compromised their ability to report a suspect exotic incursion.

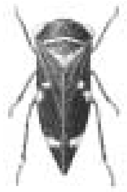
Links to taxonomic expertise and plant health research and development

Taxonomic specialists and scientists working in research and development provide unique and critical inputs to the diagnostic process especially with respect to the identification of exotic pests and pests of quarantine concern. They also provide invaluable advice on interpretation of records held in the Australian Plant Pest Database (APPD), which is needed for pest risk analyses and confirming the quarantine status of organisms.

As noted earlier, the roles of diagnostician, taxonomist, and general practitioner are intertwined. The relationship between diagnostic services and research and development scientists is strengthened by the fact that the same person is often involved in both activities. The capacity of diagnostic services to access discipline specialists, including taxonomists is generally also considered satisfactory. Whether the taxonomic research base is adequate for Australia's needs is another question, and is outside the scope of this project. However, as noted previously, the authors are aware there are important groups of insects and plant pathogens for which the taxonomic position is unclear. New molecular diversity studies are revealing new insights into relationships between individuals at sub-species, species and higher levels, and this sometimes challenges conventional views on taxonomy. Lack of taxonomic clarity confuses diagnostic issues and compromises our national capability. This is a matter requiring greater attention at the national level.



There is no compelling evidence to suggest that overall coordination between diagnostic laboratories has improved across Australia since 1995.



A comparison of the 2001 situation with a study commissioned in 1995

In 1995, an analysis of the disease diagnostic capabilities of Australian plant industries was commissioned and conducted (Miller and Moran, 1996). The report found that:

> Plant disease diagnostic laboratories are currently going through a period of change. Government services are being cut back and staff are struggling to deliver efficient, quality services. The state of plant disease diagnostics in Australia is also being eroded because the expertise base in Australia is diminishing as many experienced pathologists retire, and many reference collections are in a state of decline.

The 1995 review was confined to endemic pest and disease diagnostics for plant industries, excluding forestry and sugarcane. It did not obtain information from laboratories working on screening programs for quarantine and trade related issues (e.g. fruit fly trapping). It analysed information from 25 laboratories, which included eight private providers. In total 98 staff equating to 80 FTE positions in diagnostics were revealed.

This review was more comprehensive and incorporated laboratories servicing forestry, the sugar industry and AQIS. It received information from 61 laboratories (including two private providers) and identified 225 staff comprising 95 FTE positions in diagnostics. Comparison between the 1995 and 2001 reviews is difficult, but an attempt has been made to achieve some parity by excluding data from diangostic providers (seven AQIS, four forest, three sugarcane and one CSIRO) that were not part of the 1995 initiative. With this data removed, there are 46 laboratories with 176 staff (75.45 FTE) involved in diagnostics.

Changes in the total resource base

Noting the problems in comparing data between the 1995 and 2001 surveys, there does appear to be one matter for concern. This relates to an apparent reduction in the number of FTE positions from 1995 to 2001. The adjusted figures from the 2001 survey (as detailed earlier) show almost twice the number of laboratories (46 compared to 25 laboratories), but the estimated number of FTE's (75.45) has fallen slightly below the 1995 levels (80 FTE's).

Comparison of disciplinary support

The following table shows reduced numbers in bacteriology, mycology, and nematology. Resources in entomology and virology are comparable. The substantial increase in numbers in general plant pathology is attributed to the fact that the second survey included responses from many regional laboratories not included in 1995. Many of these regional units provide general plant pathology advice.

Table 8 - Comparison of staff numbers involved in the provision of diagnostic services (1995 and 2001)

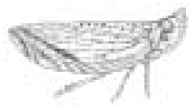
Discipline	Professional staff (1995)	Professional staff (2001)
Bacteriology	5	4
Entomology	33	44
Forest pathology	n/a	6
General plant pathology	13	52
Molecular biology	n/a	7
Mycology	21	17
Nematology	13	8
Virology	13	15
Total staff	**98**	**153**

In the report of the 1995 survey (Miller and Moran, 1996), recommendations were made in five areas:

- communications;
- reference collections;
- training;
- new technologies; and
- quality assurance.

A number of these recommendations have been undertaken by individual organisations, but there has been no nationally coordinated effort to implement the recommendations. Since the 1995 survey, more laboratories have adopted new technologies, especially molecular methods (e.g. 15 laboratories conducting PCR in 2001 compared with seven in 1995), and we are seeing molecular biologists now involved in diagnostics (see Table 8). Work has been done on enhancing reference collections and their availability through the development of a networked online database (the APPD). QA systems have been adopted by some of the bigger laboratories.

Recommendations in the area of communication have generally been poorly adopted and little progress has been made in improved communication between laboratories. One exception to this is the Northern Australian Diagnostics Network that has been formed by the participants in the CRC for Tropical Plant Protection. There is no compelling evidence to suggest that overall coordination between diagnostic laboratories has improved across Australia since 1995.



Australia's diagnostic capability and issues that impede efficient use of resources

This survey shows Australia has access to a substantial resource in plant diagnostics covering every state and all of the main disciplines, and servicing all major sectors of the industry. There have been gains in the areas of adoption of new technology and networking of reference collections and a reduced reliance on government support in some states.

However, the overall resource base may have declined over the last five years. The following gaps and issues have been identified from the information discussed in the first sections of the report, and from respondents' views on the major challenges facing the future of their diagnostic services.

Skill gaps

The survey showed a reduction in support for bacteriology in general, nematology in some states, and mycology. The data suggests that support for forest entomology and pathology may also be limited. While these are the most obvious skill gaps, it should not be assumed that these are the only issues of concern, as optimal levels of support have not been defined for some disciplines.

Specialists in entomology and arachnology report substantial gaps in the taxonomic support for many major groups of endemic and exotic insect and mite pests. Similarly, the level of support to diagnostic services from taxonomic bacteriology and nematology is considered to be at critically low levels. The adequacy of the taxonomic base was not part of the terms of reference for this survey, and a follow-up study across all disciplines is recommended.

Funding gaps

Most laboratories reported that lack of funding was a major threat to the future of their diagnostic service. There are several aspects to this issue.

There is a funding gap/constraint in respect of the assumption that fee for service can meet the funding shortfall created by cut backs to government budgets. Agencies with responsibilities for provision of diagnostic services are frequently constrained in maintaining a discipline base by tight budgets. This usually manifests itself when there is a requirement to replace staff previously paid by government funds. In instances where budget cuts are applied, vacancies are not always replaced and, if approvals are forthcoming, there is frequently a requirement to supplement the budget with external funds. Diagnostic service providers may meet a shortfall through fees for service, but experience shows fees for service cannot meet all the costs of service provision.

Diagnostics, while closely related and dependent on research and development, is increasingly being regarded as a separate activity. Purpose-built diagnostic laboratories, particularly those with a requirement for high-volume throughput, require expensive high technology equipment to handle the range of new technologies that are becoming available. Such equipment is superseded rapidly, contributing to high capital costs.

While new molecular tests are relatively inexpensive to develop, the all-important step of validation is very resource intensive and this is often underestimated both by scientists and funding agencies. This is a major impediment to the development and adoption of new technology.

Several of the major laboratories are attempting to recover costs by providing contract services or charging fees for service. This places pressure on the service to maximise delivery of profitable services, and to minimise input where symptoms are not clear-cut, routine tests are not available, and the chance of follow-up business is limited. Many of the tests in the former category are associated with routine screening, surveys, and predictive tests. Many in the latter category are post-mortems (i.e. investigation of why plants have died). Post-mortem tests can provide the first warnings of an exotic pest or disease outbreak or the resurgence of an important endemic problem. Pressure to maximise income is counterproductive in this situation.

Succession planning issues

Australia, along with most other industrialised countries, is recognised as having an ageing workforce.

Figure 4 - Comparison of the age structure of Australian workforces and diagnostic service providers (Anon 1999, Anon 2001)

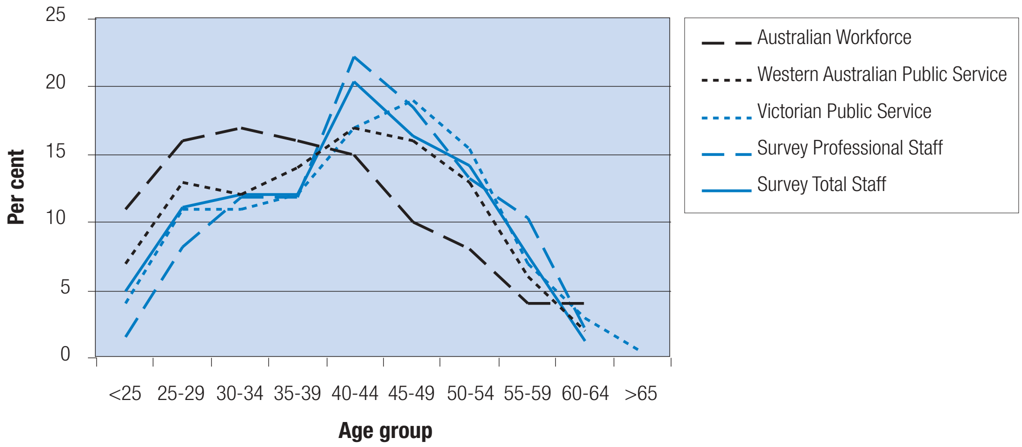


Figure 4 illustrates that the age profile of the workforce involved in plant health diagnostics in Australia is generally older than that of the overall Australian workforce and the Western Australian and Victorian public sectors.

Reduced funding for agricultural research in the public sector often means it is difficult to replace specialists as they retire. A national plan that identifies core staff and guarantees succession is required.

Communication issues

Responses to the survey suggest that there are several of areas in which improved communication between laboratories and agencies would enhance the national diagnostic capability. For example, closer communication is required between:

- laboratories regarding identifying strengths/weaknesses and associated referral arrangements;
- quarantine agencies and laboratories on reporting exotic pests and diseases;
- laboratories on training; and
- laboratories on consistent QA and standards.

Formation of a diagnostic network with a capability for both exotic and endemic pest and diseases

The case for the development of a national diagnostic network is based on the following points.

Governments and industries need access to the most effective and efficient diagnostic services to manage endemic and exotic pests and diseases, and to reduce the impact of those pests and diseases.

The task is so great that no single laboratory, state, or organisation can provide the range of tests and services needed to serve the nation, and the current system sometimes leads to duplicated services in some areas and no services in others.

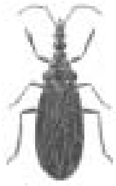
Diagnostic services relating to quarantine, export and managing serious outbreaks of exotic and endemic diseases and pests that affect the economies of whole districts or regions (or 'public good' services) are those most at risk.

The resources devoted to diagnostics, most of which come from the public sector, are limited, and it is not feasible to duplicate specialist services covering every discipline and every industry in each state

Existing laboratories could provide for most of Australia's diagnostic requirements if networked and adequately funded. Information from the survey indicates the most significant current constraints to networking are that:

- some laboratories operate in a competitive business environment, which imposes some constraints on communication and integration;
- there is no management or operational strategy for developing a common vision and shared understanding on a national approach on setting priorities, guaranteeing funding, deploying resources and succession planning; and
- specific legislation and policy frameworks within each state may impede the implementation of a national network.

Existing laboratories could provide for most of Australia’s diagnostic requirements if networked and adequately funded.



Recommendations

Key findings of this survey are that:

- government laboratories are major providers of comprehensive plant pest and disease diagnostic services across Australia;
- certain universities provide specialist diagnostic services for specific pests or pathogens;
- no private laboratory was identified which had the infrastructure to provide comprehensive services across entomology and plant pathology;
- there is no national approach - communication and coordination is considered ineffective between laboratories and agencies on a national level;
- there is a continuing decline in overall human resources in diagnostics, but in spite of this, the number of scientists with special skills in plant pathology and entomology is considered substantial;
- certain disciplines have declined, examples are bacteriology and nematology;
- specialists including taxonomists are generally available to support diagnostic services, but the adequacy of the taxonomic skills base across disciplines is in doubt;
- there is a lack of succession planning to ensure continuity of knowledge and appropriately trained staff;
- diagnostic laboratories are generally constrained by inadequate sources of revenue and ongoing budgetary restrictions; and
- there is a conflict between the need to maximise financial returns and the need to provide “public good” services.

If no action is taken to address these issues, it is likely that Australia’s overall diagnostic capacity will decline. Laboratories in all states will increasingly be expected to maximise cost recovery through commercial activities, and a possible outcome will be increased competition between laboratories and less incentive to cooperate and share knowledge - particularly in areas of public good. This is inconsistent with the development of a national policy on biosecurity for plant industries. The challenge for agencies is to identify how to better integrate resources for national and state biosecurity, while retaining the flexibility to engage in commercial fee for service activities. A second issue is to confirm weaknesses in certain disciplines and consider how to develop succession plans to address these issues.

The key recommendations of this report are that:

1) PHA should develop a strategic plan to establish a national network of diagnostic laboratories within a quality assurance (QA) framework.

2) The strategic plan should define the minimum resources required to maintain a national diagnostic capability.

3) A model for identifying and funding essential non-commercial activities of the diagnostic network (without the need for cost recovery) be developed.

4) The strategic plan includes procedures for succession planning and staff development, particularly for discipline areas that are considered to be at critically low levels.

5) The above recommendations be adopted as a two stage process:
- secure enhanced networking and management of existing laboratories
- identify centres with specific capabilities for biosecurity and secure their national roles and responsibilities.

6) A review of Australia’s current and future requirements in taxonomic plant pathology and entomology be undertaken as a separate initiative.

Two options are suggested to assist in the progression of these recommendations.

Options for networking laboratories

Networking the existing capability

This option envisages that existing laboratories are linked in a formal network, and the key laboratories in each state are upgraded to a national standard in terms of their capability and operating procedures.

This would allow each state to:

- maintain its role in diagnostics and to provide services for appropriate plant industries within or between states; and
- maintain expertise in particular disciplines, and to benefit from the expertise and technology available in other states.

However, there might not be any substantial improvement in the coordination of biosecurity activities, and this option could increase the possibility for unnecessary duplication of services and expensive capital items.

Networking (with additional specified national responsibilities for biosecurity)

This option envisages the further development of the network concept. Certain laboratories would be recognised as diagnostic centres in biosecurity for certain exotic organisms and plant industries. These units would have national responsibilities for:

- development of standardised protocols;
- training (industry and scientists); and
- providing diagnostic support to aid incursion management.

One option might be establishing centres with national responsibilities for the tropics, Mediterranean and temperate plant industries, with an additional option of specific commodity responsibilities (e.g. grains, forestry and horticulture).

Acceptance of this strategy would require long-term commitment from organisations to maintain knowledge and infrastructure for biosecurity, and the identification of sustainable and viable funding sources.

This option would:

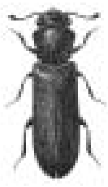
- minimise duplication of resources;
- ensure continuity of knowledge and critical mass at each centre; and
- provide a committed and coordinated national approach.

A disadvantage is that this option would require substantial reorganisation of current facilities and services.

It should be recognised that both options would require a commitment to manage the network. The first option would involve ensuring effective communication between the laboratories, a commitment to developing a standards based approach and associated national training responsibilities.

The second option would also need a higher level of national management which would include the ongoing assignment and management of specific national responsibilities in biosecurity, the management of budgets to enable centres to deliver biosecurity services, and the development of a national communication strategy.

In both of the above options, the concept of mobile diagnostic centres could be explored to cover problems of limited discipline expertise that is not immediately available. In an emergency the expertise and equipment needed could be transferred to any state for implementation by that state. This may make the second option more attractive.



References

Anon. (1999). *Passing the Torch: Managing Succession in the Western Australian Public Sector.* Department of Premier and Cabinet, Perth, Western Australia.

Anon. (2001) Planning for an ageing workforce, *Scope* Edition 2 [on-line]. Available: http://www.ope.vic.gov.au/.

Miller, J., and Moran, J. (1996) *An Evaluation of the Disease Diagnostic Capabilities of Australian Plant Industries.* RIRDC, Canberra, Australia.