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Plant pathology research and capacity building in developing countries: issues and opportunities

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Abstract To date Australia R&D institutions have provided significant and resilient plant pathology research and capacity development skills which have had a positive impact in developing countries and there is little doubt that there will be a range of future opportunities. This paper uses an assessment of four separate case studies in the horticultural crops sector to: 1) demonstrate the range of plant pathology-related research and capacity building activities and interventions currently being used by ACIAR in developing countries; 2) identify some of the major issues associated with the implementation of these activities; 3) highlight progress to date, major successes and identify major lessons learnt. While opportunities exist for future involvement of Australia's plant pathology capacity and expertise in official development assistance programs (ODA), capturing these opportunities will require a change in the current mindset of Australian R&D agencies. It is important that scientist, technicians and R&D organisations wishing to participate in the ODA program fully appreciate the changing nature of the R&D and international development environments and develop a deep understanding of how these impact on these future opportunities. To capitalise on these opportunities it is suggested that: 1. Australian R&D agencies become more proactive in aid/development policy and strategy; 2. Australian scientists and technicians learn the new and rapidly evolving aid/development language and determine the intersections of plant pathology research and capacity development with development themes; and 3. Australian plant protection practitioners stay abreast of developments not only in their own fields of technical expertise, but also the international aid/development landscape.

Keywords Australian development program · ODA · ACIAR · Plant pathology research · Plant pathology capacity building

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Introduction

The Australia Centre for International Agricultural Research (ACIAR) was established in 1982 with the objective of commissioning research that leads to more productive and sustainable agriculture through cooperative projects involving Australia and developing country partners. The rationale for the establishment of ACIAR was that Australia had developed a diverse, efficient and effective agricultural research expertise and infrastructure which could potentially be used by the ODA program to address agricultural development constraints and opportunities in Australia's developing country partners.

This rationale still largely holds today, though it is true to say that there are now major gaps in Australia's expertise in several agricultural-related disciplines and specialist areas. These gaps are expected to widen as Australia's agricultural R&D infrastructure rationalises further, key retiring experts are not replaced, and public sector R&D agencies continue to amalgamate and downsize.

Pests and diseases are major production constraints in all plant-based commodities and in all the developing countries targeted by ACIAR activities. They impact on both farm-scale and country-scale economic development, food security and particularly affect poor smallholders. As a result, pest and disease-related R&D has been a major focus

for ACIAR since the organisation's inception and this is anticipated to be the case for the foreseeable future.

What have been some of the major features and successes of plant pathology R&D in the ACIAR program to date, what are some of the changes that are occurring in ACIAR plant pathology-related research and capacity building and what does the future hold given the rapidly changing ODA landscape, the environment associated with plant pathology-related research (e.g. changes in technology, the move towards 'organics' etc), changes in Australia's plant pathology R&D and capacity building capability and the challenges faced by developing countries? This paper attempts to address many of these issues.

An assessment of four separate case studies in the horticultural crops sector is used to:

(i) demonstrate the range of plant pathology-related research and capacity building activities and interventions currently being used by ACIAR in developing countries;
(ii) identify some of the major issues associated with the implementation of these activities and interventions including the constraints often encountered; and
(iii) highlight progress to date, major successes and identify major lessons learnt from each of these case studies.

The future of plant pathology-related research and capacity building with respect to ACIAR research and development projects, anticipated changes and future developments and opportunities for further work in these areas is then discussed.

Case studies

Case 1: Plant biosecurity: technological research and training for improved pest diagnostics in Thailand and Australia

Project background

Thailand's farming population accounted for 38% of the country's 65 million population in 2005. Around two thirds of total farm outputs were exported as primary and processed farm and food products to final consumers in overseas markets, accounting for around 21% of total export earnings (4,436 billion baht) in 2005. For economic and social reasons there was a need to enhance the security of agricultural production in Thailand and the risks from invasive exotic pests and pathogens, particularly given the reliance on agriculture and the expected growth in that sector. A request for assistance in building biosecurity capacity in Thailand was raised in discussions with the Director of the Plant Protection Research and Development Office in 2006. In preliminary discussions with Thai Department of Agriculture (DOA) staff three main areas where biosecurity diagnostic capacity required enhancement were identified: the diagnosis of pests and diseases for export citrus; the diagnosis of pests and diseases for imported seed potatoes; and general fruit fly diagnosis for fruit exports since Thailand has several exotic species excluded by many countries (Anon 2004).

Research/development/capacity building issues

The overall objective of this project was to build biosecurity capacity in Thailand by enhancing the diagnostic and surveillance skills of Thai scientists. The specific project objectives were (Anon 2007a):

1. To enhance the general and specific skills and knowledge of research workers and scientists in Thailand and Australia in plant pest and disease diagnostics using a range of molecular and traditional diagnostic techniques;
2. To test and introduce new pathogen detection tools, and to provide selection and training methods for inspection and surveillance staff;
3. To develop diagnostic protocols and simple manuals for molecular diagnostics of selected plant pests focussing on citrus canker, potato viruses and fruit flies; and
4. To introduce and train staff in the use of advanced knowledge systems that can be used for ongoing training and establishment of informal networks. For example, databases such as PaDIL, the EPPDD and remote microscope network.

Project implementation

Specific training in molecular diagnostics for potato viruses, citrus canker and exotic fruit flies was provided by Australian molecular diagnostics and research laboratories located at Knoxfield, Victoria and EMAI, New South Wales. Thai DOA scientists were located inside these laboratories for a three-month period for each year of the project. Workshops were conducted in Thailand each year dealing with general groups of pests and diseases and were designed to cater for both DOA diagnostic and field staff. Training was also provided through the use of the Remote Microscope system being developed by CRC for National Plant Biosecurity and in the use of PaDIL, a web-based database that provides a library of diagnostic quality images of pests and diseases. Training in basic surveillance methods was provided to Thai DOA staff in both Australia and Thailand (Anon 2004).

Initially progress was hampered by poor laboratory facilities in Thailand and this took some time to solve.

The range of base level diagnostic and basic plant pathology and diagnostic skills also varied widely between staff from the participating Thailand agencies. Use of Remote Microscopy was initially a problem due to poor internet access. This was resolved following the allocation of local funding for laboratory and internet refurbishment.

Project highlights (Kong, 2011, personal comm.)

As a result of this project, Thai DOA staff have now been trained in a range of molecular and traditional identification and diagnostic techniques. They are using these skills routinely in their own work (including the development of PCR primers) and are extending the skills to other workers in a range of local agencies. Thai DOA staff are now competent in the use of Remote Microscopy and the use of PaDIL.

Lessons learnt (Kong, 2011, personal comm.)

- The development of resilient and ongoing personal relationships is critical to project success;
- Short-term in-country training for technical skills development is of limited benefit. Embedding the scientists in Australian laboratories for periods of three months was very successful;
- It is important that models are established using local language and under local conditions; and
- Good infrastructure is critical. In this project a start was made on refurbishing laboratories and the project (and Government) has leveraged off this.

Future

The Thai DOA plans to establish nine more diagnostic units around Thailand based on this initial model. A new ACIAR project is currently being designed to leverage off the capacity built in Thailand for the development of biosecurity diagnostic and identification expertise in other Mekong Countries such and Laos and Cambodia.

Case 2: Integrated management of Phytophthora diseases of durian and jackfruit in the southern Philippines

Project background

Durian is an important crop in the southern Philippines region of Mindanao. Much of the crop is consumed locally, however there is a large unsatisfied demand from urban communities in Mindanao and elsewhere in the Philippines. Jackfruit is being developed in the southern Philippines region of Leyte as a 'flagship fruit' with considerable unmet demand both in the Philippines and on the export market. A scoping study conducted in December 2007 identified that Phytophthora diseases were a major limitation to durian production and are potentially a major problem in jackfruit. Understanding of Phytophthora diseases, the capacity for their accurate diagnosis, and the development of effective management strategies in the Philippines is limited (Anon 2007b).

Research/development/capacity building issues

The overall aim of this project is to improve the productivity of jackfruit growing in the eastern Visayas, and durian production in Mindanao. The specific objectives are (Anon 2007b):

1. To identify key constraints to jackfruit and durian productivity;
2. To diagnose jackfruit decline symptoms in the southern Philippines;
3. To implement farmer trials to test farm management strategies on yield, disease losses and productivity; and
4. To evaluate and implement a limited series of disease management options designed for farmers of various backgrounds and capacity.

Project implementation

At the commencement of the project a series of stakeholder workshops were held in Mindanao and the eastern Visayas. The aim was to identify key constraints to production, current management practices and strategies, evaluate information currently available and identify potential constraints to adoption. Potential disease management strategies were identified by growers and tested on their farms using a participatory action research approach (Anon 2007b). A limited range of integrated strategies were identified based on appropriateness, cost-benefit and effectiveness and disseminated widely to growers, scientists and extension workers. The causal organism for jackfruit decline was identified and confirmed (using Koch's postulate) and the aetiology of the pathogen was also determined.

From the outset it became apparent that a lack of a functional extension system was a major constraint to industry development. This was combined with a lack of staff with field-based plant pathology identification, diagnosis and basic plant protection management skills. A number of excellent plant pathology staff were identified as collaborators in the project but these individuals lacked the confidence to develop good research strategies, access to specialist plant pathology expertise and were often working in inadequately equipped and maintained laboratory and glasshouse facilities

Project highlights (Guest, 2011, personal comm.)

As a result of this project effective plant pathology capacity has been built in a number of R&D organisations in the southern Philippines. The causal organisms of jackfruit decline has been isolated, identified and confirmed. Growers have identified a number of effective Phytophthora management strategies which have been demonstrated under commercial conditions and are now being integrated into crop production packages.

Lessons learnt (Guest, 2011, personal comm.)

- Talented local scientists are available but often lack the resources, confidence, access to specialists skills and motivation to develop effective R&D strategies and interventions;
- Instead of external experts coming in and offering advice it is often better to act as a resource and sounding board and help them to develop their own solutions to local problems;
- Talented people in developing countries often just need help in developing critical thinking skills; and
- These staff are being bombarded with a lot of new information and potential new solutions. What they need is capacity building in the development of scientific scrutiny to evaluate these new things.

Future

A future phase of this project will focus on the development of integrated crop management packages and the extension of these to farmers, researchers and technicians.

Case 3: Improved plant protection in Solomon Islands (IPPSI)

Project background

This project originated from a visit to Solomon Islands by the ACIAR Deputy Director and the ACIAR Pacific regional priority-setting consultation for the South Pacific held in Fiji in December, 2003. Priorities identified at that consultation were the need for ACIAR to work closely with regional organisations to design projects that built collaborative linkages between them and national agencies to develop institutional capacity and assist in support of extension. Specific crop protection priorities were (Anon 2004):

- Identification of the quarantine and pest risk issues for specific crop germplasm requiring exchange between countries for conservation and introduction;
- Development of integrated crop management packages for breadfruit, yam and sweet potato; and
- Integration of existing knowledge into information packages for banana and taro; and Facilitation of national adoption of earlier research on pest, weed and disease management.

Research/development/capacity building issues

IPPSI began in 2005 to re-establish crop protection capability in Solomon Islands in order to secure sustainable production of food crops for domestic consumption and food generation. The specific project objectives were (Anon 2004):

1. To develop integrated pest management (IPM) strategies for major food crops (slippery cabbage, long bean, taro, brassicas and cucurbits; and
2. To increase government staff and community awareness and understanding of plant pests and diseases, leading to improved and sustainable crop management.

Project implementation

Project implementation revolved around (Anon 2004):

- Development of IPM packages for slippery cabbage, long bean, taro, brassicas, and cucurbits;
- Strengthening of plant protection capability within the Department of Agriculture and livestock (DAL);
- Introduction of higher yielding germplasm of staple crops;
- Developing a plant protection curriculum for training of agricultural extension workers;
- Training of trainers in DAL and NGOs; and
- Development and dissemination of information packages.

Initially progress was hampered by a dysfunctional extension system in Solomon Islands. This project necessitated the development of strong partnerships between the Secretariat for the Pacific Community (SPC), the Solomon Islands Government and NGOs. These partnerships took two years to develop but ended up being a major strength of the project. A lack of infrastructure (entomology and plant pathology laboratories), lack of expertise (e.g. entomology), inadequate resources (e.g. vehicles for travel to trial sites) and over-reliance on a small number of under-resourced NGOs for extension and capacity building were also major constraints for this project.

Project highlights (Jackson, 2011, personal comm.)

Key achievements resulting from this project were:

- Enduring relationships developed between Government, NGOs and the Secretariat for the Pacific Community (SPC);
- New plant pathology laboratory developed and entomology laboratory re-equipped;

- A crop protection curriculum was formulated and crop protection manual prepared; and
- Leaflets and 65 fact sheets on pests and diseases produced.

Lessons learnt (Jackson, 2011, personal comm.)

- Collaboration between NGOs and the Government was essential but they need to be eased into this;
- Infrastructure and staff with core competencies are needed as soon as possible; and
- The lack of functional extension services is a key constraint but is a difficult problem to deal with.

Future

IPPSI is now in a position to be able to be used as a platform for other activities including further development of extension materials. Plant health clinics are being considered for inclusion in future plant pathology work in the Pacific as are the use of international diagnostic networks (Pestnet) and databases (CABI Invasive Species Compendium).

Case 4: Strengthening the Cambodian and Australian vegetable industries through adoption of improved production and postharvest practices

Project background

Plant Pathology capacity in Cambodia has been improved as a direct result of two previous ACIAR projects; one in rice pathogens and one in vegetable R&D. However, the capacity within the country remains very limited, with the Cambodian Agricultural Research Development Institute (CARDI) being the only institute to have adequate capabilities to perform diagnostics and broad based research in plant pathology. Compounding this lack of infrastructure is a knowledge gap in graduate and undergraduate students involved in agricultural sciences at the Royal University of Agriculture (Anon 2009).

Research/development/capacity building issues

This project is a component of a wider vegetable production program and aims to build capacity of research and extension staff in vegetable production, postharvest research and plant pathology.

Project implementation

Project implementation is based on (Anon 2009):

- Conducting field surveys in target provinces to determine disease constraints;
- Conducting plant disease monitoring, diagnostic and plant pathology R&D research skills workshops;
- Development of remote access packages for disease identification;
- Conducting yield loss trials for major vegetable diseases;
- Conducting research trials for basic management strategies of the major plant diseases of vegetables; and
- Designing disease assessment keys for disease constraints.

Major constraints to project implementation have included:

- Cultural differences between Cambodia and Australia project staff;
- Postgraduate staff ending up in administration and not research;
- lack of suitable infrastructure;
- Problems getting staff out into the field; and
- Problems getting staff to attend training.

Project highlights (Stodart, 2011, personal comm.)

Despite a number of problems constraining project implementation, good progress has been made. Two plant pathology laboratories are operating successfully with the staff from these performing well. Bacterial ID tests are up and running (and staff are able to perform the seven biochemical tests). A plant pathology curriculum is being developed in partnership with the Royal University of Agriculture and this is already being used.

Lessons learnt (Stodart, 2011, personal comm.)

- Focus needs to be on classic taxonomy, basic identification and diagnostics and field work and not molecular-based testing;
- Need to get staff out in the field rather than in laboratories; and
- More training of field staff in field-based diagnostics and disease management

Future

This project is due to run until November 2012 but will be reviewed in late 2011.

Discussion

Any reflection on the future of plant pathology research and capacity building with respect to the Australian aid program and the integration of lessons learnt needs to be considered in the context of a changing Australian (and international)

agricultural research landscape and a rapidly changing international development environment.

The changing agricultural research landscape

The landscape for agricultural research both in Australia and overseas has been constantly changing and these changes have also impacted on agricultural plant pathology research and training capability. This has been of particular significance in three areas. First, there has been a downsizing of public R&D capability due to privatisation and rationalisation of resources, running down of R&D infrastructure, non-replacement of key resources and staff and amalgamation of R&D organisations (e.g. the formation of the Tasmanian Institute for Agricultural Research). As a result, fewer Australian resources and specialists are available to the Australian aid program and there is often tension regarding the use of these resources for Australian domestic or developing country R&D programs; particularly those with little or no direct benefit to Australian industries.

Second, technology has developed at a rapid rate with both positive and negative consequences. The development of new technologies such as molecular-based technologies has enabled scientists in developed countries to make huge gains in plant breeding, disease diagnosis and understanding of plant diseases organisms and their interactions. Unfortunately these technologies have also proven to be generally expensive in terms of both infrastructure and operating costs. Most of these technologies are also highly technical and appear to have come at the expense of the development of scientific generalists and staff with a well-developed understanding of field based skills such as plant pest and disease diagnosis and management. With regard to developing countries we must face the reality that many of them will never be able to afford the infrastructure associated with these technologies, let alone the technical capacity required to operate this equipment and the ongoing operational costs.

Thirdly, the ease and speed with which biological materials now move around the world intentionally or by accident has proven to be a challenge for even the most developed countries. Advances in biotechnology, agricultural research and biosecurity have been demonstrated to be no match for the ability of pests and diseases spreading between countries naturally, accidentally assisted or consciously transported by humans. With the potential changes in climate at both global and local levels, the incidence of problems associated with these incursion is likely to increase.

A fourth significant factor impacting on the R&D landscape is communications technologies. Unlike the first three factors considered above, communication technologies have the potential for huge benefit in respect to agricultural research in developing countries. The use of Remote Microscopy, plant pest and disease networks and virtual clinics for example have the potential to fill the void caused by the absence of specific plant diagnostic expertise in developing countries and can make available to these countries a wide range of international expertise at relatively little cost.

The rapidly changing international development environment

The Australian ODA program will increase from $AUD 4.3 billion (2010–11) to an estimated $AUD 8–9 billion by 2015–16. This is indeed potentially good news, however for those interested in agricultural R&D in developing countries it is important to understand how this increase in the aid budget will affect the development program and how those changes will impact the future of agricultural R&D interventions (including plant pathology research and capacity building).

Firstly, as international aid budgets have grown there has been a movement towards what are called ‘thematic approaches’ (for example ‘Making Markets Work for the Poor’ (or M4D)). A main consequence of this is that strategy development and planning at the aid Donor level is carried out a much higher level of abstraction than previously. Much of the lower-level design work is being left to agencies such as ACIAR (in the case of agricultural research), managing contractors, program technical consultants or are developed in the later stages of program implementation. Thus traditional Australian R&D providers may not be involved in the initial stages of the design of these programs; in reality, they may not be involved until almost at the implementation of project design stages.

Secondly, there is a trend towards the use of multi-donor facilities which involve smaller aid donors such as Australia investing in large multi-nation programs, again at a high level of design abstraction. In this arena programs are tendered on a truly international basis and in this environment it may be difficult for Australian R&D providers to compete on the basis of size, geographic spread or the transactions costs involved in contesting these projects.

Third, Australia, like most of the other aid donors, will be investing more in the Consultative Group on International Agricultural Research system (CGIAR) (e.g. IRRI and CYMMIT) and thus there may be little additional funding available for Australian R&D providers (over and above the current funding).

Integrating lessons learnt into future projects and programs

As illustrated by the four case studies considered above, ACIAR plant pathology research and capacity building

activities implemented by Australian R&D providers in partnership with international and recipient country agencies have been able to make a significant difference in developing countries. That said, there are a range of lessons that can be learnt from these and other projects for general integration into future activities. The major lessons are:

- Talented and potentially motivated technical and scientific staff are often available in developing partner countries. What theses staff need more than direction is mentoring, nurturing, further development of technical and research skills and an ongoing network of scientific and technical expertise. To this end, the development of resilient and ongoing personal relationships is critical, as is the development of in-country networks and alliances with other providers and the private sector;
- Embedding of developing country staff into Australian institutions for periods of three to twelve months is often superior to short-term training carried out only in the developing country. This embedded training should be supplemented by in-country training customised to local needs and the local culture and language;
- Infrastructure development is important but is often problematic due to initial investment cost, local capacity, accessibility to ongoing maintenance expertise and the ongoing costs of consumables;
- Extension systems and field-based capacity are often a constraints to industry development in developing countries and should not be neglected at the cost of high-technology skills and capability development; and
- Plant pathology skills development is often lacking in developing countries at undergraduate university degree level. This needs to be addressed through curriculum development and a number of Australia institutions are well placed to do this for plant pathology capability development.

Future trends for plant pathology research and capacity building in ODA

A number of trends and future directions are emerging in the implementation of agricultural R&D programs and these need to be considered in the future design of plant pathology R&D interventions:

1. Relationships and Networks ACIAR considers, as a core strength and competitive advantage, the capacity to develop resilient partnerships, alliances and networks for the implementation of R&D interventions. Most ACIAR projects are now comprised of teams with membership from Australian and developing country institutions. ACIAR is increasingly partnering with Australian R&D providers who are open to this modality and who have leadership skills and experience in this area.
2. Program/Thematic Approaches Single-commodity, single-issue R&D projects are on the decline. Integrated, multidisciplinary and farm systems approaches are on the increase and this trend will continue. ACIAR is not likely to fully adopt thematic approaches in the near future, however as we manage more AusAID and other donor program components and move towards whole-of-government approaches to aid and development, the move to thematic approaches will increase.
3. Use of Regional Expertise Developing countries vary greatly in their technical capacity and ability to absorb new technologies. For relatively advanced countries such as Thailand and Papua New Guinea, the Government agencies have expressed an interest in a greater role in regional capacity building and the development of regional centres of excellence. This philosophy is intuitively appealing and given the understanding of regional cultures and issues and the decline in expertise in countries such as Australia, has the potential to provide at least some potential opportunities for solutions to regional development problems. ACIAR is already using some regional expertise in development projects (e.g. The Pacific Island Countries, PNG and Thailand) and this trend is expected to continue.
4. Regional/Transnational Issues An issue which continues to exercise the minds of senior management in ACIAR and one which is not easily addressed is in regard to Regional/Transnational issues. In the case of plant pathology, a potential problem which comes readily to mind is citrus greening (Huanglongbing). This is an intractable disease complex affecting citrus in most of our developing partner countries and has potential consequences for the Australian citrus industry. These types of issues present unique management problems including level of investment, logistics, political issues and strategic considerations. ACIAR will be working in the near future to develop strategies to address regional and transnational issues.

Conclusion

Plant pests and diseases are major constraints to agricultural production and food security in developing countries and this will continue to be the case. To date Australia R&D institutions have provided significant and resilient plant pathology research and capacity development skills which have had a positive impact in developing countries. This has the potential to continue despite a downsizing of the Australian expertise base and significant rationalisation.

While much has been accomplished in developing countries, important lesson have been learnt and it is important that these are integrated into future project designs and R&D interventions.

There is little doubt that there will be significant future opportunities for Australia plant pathology research and capacity skills in Australia's ODA program. That said' it is also important that scientist, technicians and R&D organisations wishing to participate in the ODA program fully appreciate the changing nature of the R&D and international development environments and develop a deep understanding of how these impact on these future opportunities. In this paper, I have attempted to highlight a few of the more important ones. They include:

- a move to integrated, multi-disciplinary programs and thematic approaches;
- multi-donor facilities;
- increasing competition for scarce development funds;
- use of partnerships and alliances; and
- regional approaches to aid/development implementation.

While opportunities exist for future involvement of Australia's plant pathology capacity and expertise in ODA, capturing these opportunities will require a change in the current mindset of Australian R&D agencies. To capitalise of these opportunities it is suggested that:

1. Australian R&D agencies need to raise their profile and become more proactive in aid/development policy and strategy. The Australasian Society for Plant Pathology would appear to be an excellent vehicle for this.
2. Australian scientists and technicians will need to learn the new and rapidly evolving aid/development language (e.g. 'Research for Development' (R4D), 'Making Markets Work for the Poor') and to determine the intersection of plant pathology research and capacity development with development themes such as 'pro-poor', 'food security', and 'social protection'.
3. Australian plant protection practitioners will need to stay abreast of developments not only in their own fields of technical expertise, but also in developing industry strategies and priorities, the Australian whole-of-government agenda and the international aid/development landscape in general.

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