Australian Government

Australian Centre for International Agricultural Research

Final report C6

project

Improved domestic profitability and export competitiveness of selected fruit value chains in the southern Philippines and Australia

Component 6 – Program Management and Combined Report

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prepared by	Irene Kernot and David Hall
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Contents

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[1] *A list of abbreviations is in section 3.2*

2 Executive summary

The project 'Improved domestic profitability and export competitiveness of selected fruit value chains in the southern Philippines and Australia incorporated five components; papaya supply chains, jackfruit and durian diseases, papaya nutrition and diseases, mango production and integrated crop management and economics and policy. This report covers the sixth coordinating and management component and includes brief summaries of the technical work. The five technical components have provided separate final reports. Executive summaries of these components are included in this report to provide context to the size and scope of the program.

An analysis of a supply chain for papaya in the Philippines enabled the identification of improvement opportunities to reduce losses, maintain produce quality and deliver greater consumer-defined value. There was a 37-73% reduction in rejection of papaya fruits delivered from grower-suppliers. A "walking-the-chain" approach of bringing at least one key company representative as part of the training team gave a better understanding and appreciation of why improvements are needed and how they could be implemented.

A disease survey of jackfruit showed as many as 100% of jackfruit trees in some orchards were affected by a decline syndrome progressing from leaf yellowing, leaf drop, girdling stem lesions and root rot, to tree death. *Phytophthora palmivora* was identified as the cause. A high level of disease in jackfruit and durian nurseries, as a result of poor nursery practices also contributed to the spread of the pathogen and the incidence of disease.

Red spider mites, choco spot, the disease BCR and *Phytophthora*-related diseases were the major production constraints identified by growers and contractors during a baseline survey conducted in Mindanao. By the end of the project, BCR had become the greatest concern for growers. The causal organism of choco spot was identified as *Corynespora cassicola* and BCR was identified as *Erwinia papayae*. Research by USeP and DMPI showed that 300 and 450 kg N/ha gave maximum yield of fresh and processing papaya, respectively.

Two species of thrips were identified, both species being polyphagous with a wide host range of cultivated and wild plant species. Within the mango production areas where the studies were undertaken, natural enemies such as predacious insects were absent, which was attributed to the overuse of broad-spectrum insecticides. For export and pesticide residue safety, extended withholding periods are required to ensure compliance with MRLs in export destinations such as Japan.

The economic and policy component identified key factors affecting profitability and productivity of mango and papaya farmers. Gross Margins (GMs) were expected to increase by 93% for Jackfruit and156% for mango farming if recommended interventions from these projects were adopted and for durian GMs would increase by 26%, 47% and 107% with low, medium and high management interventions respectively.

Having a number of components linked together as an overall program and the annual meetings in Australia and the Philippines delivered advantages including sharing of ideas skills and some resources, use of resource material provided by other components and contributions to economic analyses. The program approach also provided a higher profile for the collaboration in both the Philippines and Australia, which served to ensure Government support and contributed to the development of a significant portfolio of ongoing work. From 2014 ACIAR has supported four new fruit projects in tropical fruits, papaya mango and banana, plus postharvest and value chain projects that will have a mango focus in the Philippines.

There were many recommendations in each component final report and it would be valuable if some of these recommendations could be further assessed and possibly be

progressed. Also the recommendations from the 2011 external review are included in this report.

3 Background

3.1 Overall project

3.1.1 Partner country and Australian research and development issues and priorities

In the United Nations Human Development Report of 2007–2008, the Philippines GDP (US$PPP[2]) figure was $5,137, with 14.8% of the then current population living below the poverty line on an income of $1 a day. Australian government policy then and also currently recognises the assistance required by the Philippines to counter these issues of poverty and access to basic infrastructure. Agriculture, which in 2008 accounted for 18.7% of the Philippines' GDP and employed over a third of the available workforce, represented a key industry as it has the greatest potential to influence those currently affected by poverty.

Horticultural crops account for a large number of the major crops produced by the Philippines, with the Philippines Department of Agriculture identifying cashew, durian, highland vegetables, papaya, lazones and ginger as priority crops due to their industrial and commercial potential. At December 2007 prices, the gross value of Philippines agriculture was PhP 972 billion ($AUD 26 billion). In 2007, the crops subsector accounted for 47.6% of total agricultural output. While rice and coconuts were the two largest agricultural sectors, production of horticultural crops was important both domestically and for export.

In accordance with the Australia aid and development strategy for the Philippines, ACIAR works with partner agencies predominantly in the southern Philippines (Leyte - Region VIII, Northern Mindanao - Region X and Southern Mindanao - Region XI). In these regions mango (Region XI), jackfruit (Region VIII), durian (Region (XI), papaya (Region X) and vegetables (Region VIII, X and XI) had been identified by the federal, regional and local government authorities as priority horticultural crops for development for domestic and export markets. Fruit crops form an important source of income for smallholders in Mindanao and Leyte.

The overall fruit project was based on a Philippines-Australia agricultural R&D priority setting workshop in the Philippines in March 2006. This identified a range of R&D priorities in the horticulture, land and water management and systems agricultural sectors. These priorities formed the basis of the R&D priorities for the 2007-08 ACIAR Annual Operating Plan for the Philippines and were incorporated into the then Philippines Council for Agriculture, Forestry and Natural Resources, Research and Development (PCARRD) Integrated Science and technology agenda for 2006-2010.

The horticultural priorities were refined at a Horticultural R&D priority setting workshop held at Cebu in September, 2007. These priorities were:

Domestic and export market improvements for high value fruit crops

- To conduct high value crop market chain analysis
- To address food safety issues in domestic and export fruit (to be confirmed after completion of a scoping study)
- Implementation of postharvest handling systems for high value fruits (packing and product presentation)

[2] *Purchasing Power Parity*

- Education and communication policy.

More profitable production of durian and jackfruit

- To design and implement integrated crop management strategies for *Phytophthora* disease control
- To design integrated crop management strategies for major insect pests
- To package and disseminate crop management packages for durian and jackfruit
- Overcoming disease and quality constraints for papaya.

Design and implement strategies for management of diseases of papaya

- Overcoming disease and quality constraints in papaya
- To design and implement ICM strategies for major insect pests
- To package and disseminate package of technology ICM strategies for papaya.

Implementation of better mango value chains (Visayas and Mindanao)

- To identify and develop strategies to manipulate flowering
- To design and implement ICM strategies for major pests and diseases
- To develop and implement postharvest technologies that provide better access to competitiveness in export markets
- To package and disseminate improved production and handling technologies in conjunction with industry.

These priorities were further refined and focused following discussions between commissioned organisations and Australian and Philippines collaborators.

The design of HORT/2007/067 *Improved domestic profitability and export competitiveness of selected fruit value chains in the southern Philippines* was based on these priorities and comprised six Components

Component 1 - Analysis of the constraints to selected tropical fruit (Papaya) supply chains and implementation of improved quality systems for the Philippines and Australia.

Component 2 - Integrated management of Phytophthora diseases of durian and jackfruit in the Philippines

Component 3 - Integrated crop managements strategies for productive, profitable and sustainable production of high quality Papaya fruit in the Philippines and Australia

Component 4 - Improved and sustainable value chains for mango production in the Philippines and Australia

Component 5 - Economic Impacts of New Technologies and Policy Constraints in the Production of Fruit in the Philippines and Australia

Component 6 - Program Management

In recognition of the size and complexity of this program, ACIAR commissioned a major Australian R&D service organisation to provide overall management for each of the fruit and vegetable projects. DAFF was appointed to provide overall management for the fruit program. The decision to move to a program-based approach was based on potential efficiencies in program management and resource use, the potential to capture synergies and develop linkages between components and the opportunity for improved capacity building and cross learning between the component scientists.

3.1.2 Research and/or development strategy and relationship to other ACIAR investments and other donor activities

To goal of this Program was to contribute to economic growth through increased income and improved livelihoods of tropical fruit growers in the southern Philippines (specifically regions 8 (Leyte), 10 (Northern Mindanao/Cagayan de Oro), and 11 (Southern Mindanao/Davao).

The fruit project was closely aligned to the vegetable project and shared annual project meetings.

The component projects also had links to other ACIAR projects. For example, the mango component (C4) was closely linked to ACIAR project in Indonesia HORT 2008 /041 'Area-wide management of pest fruit flies in an Indonesian mango production system'. More details of the links are provided in the individual component proposals and final reports.

3.2 Abbreviations

BCR	Bacterial crown rot
C1	Component 1, Papaya supply chain
C2	Component 2. Jackfruit and Durian diseases
C3	Component 3, Papaya diseases
C4	Component 4, Mango production
C5	Component 5, Economics and Policy
C6	Component 6, Management
DMPI	Del Monte Philippines Inc
FPM	Fruit project manager (initially Dr Bob Williams, then Irene Kernot)
GAP	Good Agricultural Practices
GM	Gross margins
IPM	Integrated Pest Management
JAF	John Allwright Fellowship
MRL	Maximum Residue Limit
NSW DPI	NSW Department of Primary Industries
PCAARRD	Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development

RPM	Research Program Manager, ACIAR
RPM HORT	RPM Horticulture (Dr Les Baxter)
RPM ASEM	Agricultural systems management (Dr Caroline Lemerle)
PHM	Philippines Horticulture Manager (John Oakeshott)
DAFF DAFF	Queensland Department of Agriculture, Fisheries, and Forestry (formerly QDEEDI)
DAFFSEARCA	Southeast Asian Regional Center for Graduate Study and Research in Agriculture
SER	Stem end rot
UPM	University of Philippines, Mindanao
USeP	University of Southeastern Philippines
VPM	Vegetable Project Manager (Dr David Hall)
Web2	The publicly available and also part project restricted web site hosted by ACIAR on the internet

4 Objectives

The purpose of this Program was to improve the smallholder and industry profitability and export competitiveness of southern Philippines selected tropical fruits industries (mango, durian, jackfruit and papaya).

Component 6 - Program Management

The aim of this Component was to provide management, communication and strategies for ensuring integration of Program Components and identification of opportunities for efficiency and effectiveness gains through sharing of resources, trial sites and extension activities.

Objective 1: To assist in planning, development and implementing the overall Program.

Objective 2: To assist in the monitoring, review and evaluation of the overall Program.

Objective 3: To maximise synergies and integration of the Component within the Program.

Objective 4: To design and implement a communication plan for the Program

5 Methodology

5.1 Project management

Some of the management and administrative budget was used to provide clerical support that directly assisted the ACIAR Program as well as assisting the DAFF Program Manager to manage the significant administration required by a large program and thus allowing them more time for the scientific management of the ACIAR Program.

The direct role of the clerical support with the ACIAR Program was in providing an ongoing available point of contact, assisting with the communication plan strategy, assisting in preparing Program reports and assisting in organising the Australian planning meetings.

A summary of the methodology for each objective was as follows. More detail of activities is provided in section 6.

1. Assist in planning, developing and implementing the overall Program.

- The FPM reviewed initial component proposals and provided comments and advice through the relevant ACIAR Research Program Manager.
- Assisted in developing contracts between ACIAR and DAFF and between DAFF and subcontractors and with the Memorandum of Subsidiary Arrangement.
- Organised four annual planning and review meetings in Australia.
- Participated in planning/review trips per year to Philippines to attend annual Philippines planning meetings and to visit Philippines sites.
- Provided advice on additional participants within Components and in conjunction with ACIAR to foster new partnerships with industry groups and other funding sources.
- Advised the Program staff and ACIAR on possible interaction benefits of other projects conducted in the Philippines and Australia.
- Assisted ACIAR to ensure technical coherence within and between Program Components.

2. Assist in the monitoring, review and evaluation of the overall Program

- Reviewed submitted milestones from each Component and recommended their submission to ACIAR.
- Recommended to ACIAR changes in contracted Component objectives, milestones and budgets
- At the second and third planning meetings, documented objectives for the final Program evaluation and ensured that the appropriate data collection mechanisms were in place.
- Identified Project opportunities, gaps and limitations and recommended Project changes to ACIAR.
- In conjunction with Philippines Horticulture Manager and RPMs arranged for internal mid-term review and independent end of Project evaluation.
- Based on all Component budgets, prepared and monitored the overall Project budgets.
- Participated as a member of the Program Steering Group.

3. Maximise synergies and integration of the Component within the Program.

- On the basis of the activities carried out in objectives 1,2 and 4, the FPM identified potential Program synergies and integration of Components and Component activities and advised on strategies to capture these commonalities and linkages between Components to maximise effective synergies.
- Monitored Component research activities, workshops, field days and other activities and advised Component staff where improved synergies were possible.
- With the Component staff, developed an overall Program theme and common objectives.

4. Design and implement a communication plan for the Program

- Reported to ACIAR, participating organisations and Program staff on results of annual planning meetings.
- Ensured effective communication between Components within the Program as part of objective 3.
- Developed and enhanced the profile of the Program to ACIAR, participating organisations and other agreed stakeholders, in particular the benefits of the Program to Australian Agriculture and Australian Foreign Aid responsibilities.
- Liaised regularly (at least monthly) with the Philippines Horticulture Manager and Component team leaders on progress, challenges, opportunities and any factors likely to limit the planned Program outcomes. Provided updates on this liaison to ACIAR Research Program Managers.
- Communicated at least quarterly with the Philippines Vegetable Project to maintain consistency and where possible some integration.

General

The overall Program was managed by DAFF with support from an ACIAR Davao-based Philippines Horticulture Manager (John Oakeshott).

The overall strategy for the Management of this Program was:

1. Assist ACIAR in the planning development and implementation of the overall Program

DAFF assisted ACIAR with the review and final development of the Components, the development of subcontracts with collaborators and was responsible for the overall implementation and ongoing management of the Program.

2. Assisting ACIAR in the monitoring, review and evaluation of the overall Program.

DAFF assisted ACIAR with the review and evaluation of the overall Program and had ongoing responsibility for Program annual reporting.

3. Develop and implement strategies to capture synergies and foster integration of Components within the Program.

DAFF worked with the Philippines Horticulture Manager to identify opportunities for and implemented strategies to capture potential synergies, foster Program integration and seek operation efficiencies.

4. Implement a plan to ensure effective communication within the Program and to Program stakeholders

The **Philippines Horticulture Manager** had four major roles:

1. Support the management of stakeholder and collaborator relationships associated with the Program

2. Identify and develop potential collaborations between the Program, agribusiness and commercial organisations
3. Support Program implementation and M&E activities
4. Identify and develop potential opportunities for integration, leveraging and collaboration between Program Components particularly with regard to extension, dissemination and technology transfer activities.

The **Fruit Program Manager (DAFF)** was responsible for the overall financial management, reporting, M&E and developing integration/synergies between and within the Program Components.

Each of the Components was managed by a Component Leader who was responsible for the management of the planning and implementation of the Component strategy. Relevant ACIAR Research Program Managers were responsible for ensuring the overall consistency of the Program in relation to ACIAR, Philippines and other relevant strategies and M&E in relation to the Program plans.

Table 1. RPMs and component leaders of the Philippines vegetable project

Component	Short name	RPM	Component lead Investigator	Australian organisation	Philippine leader
1	**Papaya Supply Chain**	Dr Les Baxter, RPM Horticulture	Terry Campbell	DAFF	Dr Elda Esguerra, UPLB
2	**Jackfruit and durian diseases**	Dr Les Baxter, RPM Horticulture	Prof David Guest	Sydney University	Dr Lucia, Borines, VSU
3	**Papaya diseases**	Dr Les Baxter, RPM Horticulture	Lynton Vawdrey	DAFF	Valeriana Justo, UPLB
4	**Mango production**	Dr Les Baxter, RPM Horticulture	Dr Chrys Akem then Dr Ian Newton	DAFF	
5	**Economics & policy**	Dr Caroline Lemerle with Dr Les Baxter	Dr John Mullen, then Dr Randall Jones, then Dr Kirrily Pollock then administered by Dr Hall	DAFF who contracted NSW DPI	Dr Larry Digal, UPMin
6	**Management**	Dr Les Baxter, RPM Horticulture	Dr Bob Williams, then Irene Kernot	DAFF	Dr Joy Eusebio, PCAARRD with John Oakeshott

5.2 C6 Staffing

ACIAR contracted the whole project to DAFF and three of the five technical components were led by DAFF. DAFF asked Bob Williams and subsequently Irene Kernot to manage the overall project as ‘Fruit Program Manager’ (FPM).

5.3 Project management

1) On project matters, the FPM worked directly with the component leaders
2) On in-country Philippines issues the FPM worked with the Philippines Horticulture Manager (PHM).
3) On strategic, technical, monitoring and evaluation issues he or she worked with the ACIAR RPMs for Horticulture and ASEM.
4) On across fruit and vegetable issues he or she liaised with the vegetable program manager, Dr David Hall.
5) For financial management project leaders liaised with Qld DAFF administrative staff.
6) Michelle Sinn was responsible for the corporate responsibilities including legal and contracts management, financial reporting and funding disbursement.
7) Reporting and financial issues were managed with Betty Robertson, Program Support Officer and RPMs.
8) For the economic and policy component (C5), which was contracted to NSW DPI, the FPM assisted with payments and some transfer of funds near the project end.

   With this C5 component, the VPM also acted as coordinator / administrator during more than half the component's life when there was no component leader (September 2009 to May 2011 and March 2012 to final report submission in July 2013).

   The VPM also coordinated the writing of the C5 fruit final report and arranged an external review of this report.

5.4 Travel

Funds from C6 were used to support travel to the Philippines and within Australia.

The FPM visited the main fruit research sites in the Philippines one to three times a year from 2008 to 2012. .

5.5 Component funding and financial variations

The components managed their own financial activities, which are described in the component original proposals. During the whole project there were some component variations:

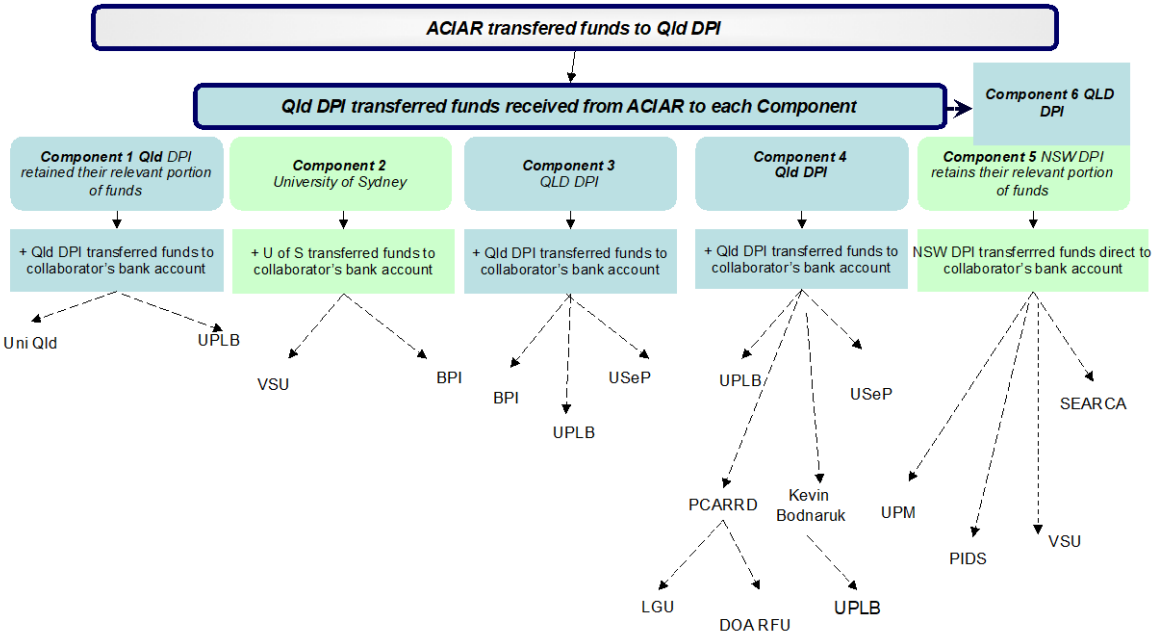
C3 Papaya required additional money to compensate for the loss of a trial and the need to replant as a result of cyclone Yasi.

Funding processes

Funds flowed from ACIAR to DAFF and then were distributed to the externally lead components, University of Sydney and NSW DPI. Acquittal reports flowed back to DAFF with consolidated acquittals being provided to ACIAR. Funds went to PCAARD for further distribution.

See the following figure

Fruit Project
Component Collaborators in the Philippines & Australia



Responsibilities: Green = Non QLD DPI, Component Leaders, Blue = Qld DPI

6 Achievements against activities and outputs/milestones

Objective 1: To assist in planning, developing and implementing the overall Program.

No.	Activity	Outputs/ Milestones	Completion dates	Comments
1.1	Review initial project proposals and provide comments and advice to ACIAR	Advice to ACIAR regarding suggested changes to proposals to allow better implementation	April 2008	Completed 2008
1.2	Assist in developing contracts relevant to the Program	Appropriate contracts developed and implemented	April 2008	Completed 2008
1.3	Manage annual planning and review meeting in Australia and co-manage annual planning and review meeting in the Philippines	Meeting held as agreed between stakeholders	June 2008-2011 (Australia) July-August 2008-12 (Philippines)	Annual planning meetings were held in Canberra in 2008, 2009, 2010 and 2011. They were jointly managed by Les Baxter, the FPM and the VPM with help from the PHM Annual Philippine Planning Meetings were in held in Davao 2008 and 2009, in Leyte in 2010 and Bohol in 2011. These were jointly managed with the PHM and VPM. In 2010 and 2011 fruit meetings were combined with the vegetable project. At the 2010 and 2011 meetings, separate 'discipline' discussions occurred with the participants who were soil scientists, entomologists, pathologists and economist / supply chain staff. Reports were prepared on discussions including future opportunities, linkages and improving science within the discipline areas.
1.4	Participate in three planning trips per year to the Philippines	Planning meetings organised and held	2008-2011	The FPM had from 1 to 4 Philippine visits in each of 2008 through to 2012 These coincided with Annual planning meetings (See 6.1.3) and / or were separate trips to participate in component meetings and monitoring trips to all sites plus meetings with PCAARRD in Los Baños. See also Section 6.1.5.

1.5	Provide advice on additional participants and partners for Program components	Appropriate additional partners participating and investing in Program activities	2008 - 2011	Negotiations in the Philippines effectively supported by the PHM liaising with component leaders. Additional funding partnership through the Terrain NRM group in Australia found to complement nutrition and environmental impact aspects of papaya in component 3 and partnership with USDA developed to increase the efficiency of semiochemistry work in C4 Additional work on potatoes Linkage with Landcare program and Noel Vock to develop extension activities relevant to the program and involvement in annual meetings

PC = partner country, A = Australia

Objective 2: To assist in the monitoring, review and evaluation of the overall Program.

No.	Activity	Outputs/ Milestones	Completion dates	Comments
2.1	Review submitted milestones from each Component and submit to ACIAR	Milestone reports submitted to ACIAR	Annually	Annual reports lodged with ACIAR
2.2	Recommend to ACIAR changes in contracted Component objectives, milestones and budgets	Advice to ACIAR on proposed changes to budgets, objectives etc	Annually	Changes were recommended and supported for components as needed including changes in C1 to refocus as a results of partnership changes and changes to C4 following adjustments to activities and budgets. Australian component work was affected by cyclone Yasi
2.3	Document objectives for final evaluation of Program and ensure information collection mechanisms are in place	Objectives for final Program evaluation documented	October 2011	Assistance was provided to RPM Horticulture and PHM for external reviews on objectives and processes. The FPM collated and advised on reports for evaluation of C1-C4 and prepared the C6 report for the reviewers.
2.4	Identify Program opportunities, gaps and limitations and recommend appropriate changes	Advice to ACIAR on proposed changes to Components	Annually	Numerous opportunities, gaps and limitations were recommended throughout the project and final decisions were made by or in conjunction with RPMs, PHM and component leaders.

2.5	Develop and implement formal M&E plan as necessary and appropriate	Formal M&E plan developed and in use	2009	M & E was predominantly through reviewing reports, face-to face discussions, meeting attendance and site visits Evaluation followed monitoring activities, annual reviews and the final review.
2.6	Arrange for internal mid-term review and independent end of Program evaluation	Mid-term and End of Program evaluation completed	Dec 2009 and June 2011	The mid-term review was completed in August 2010. The main activity was the 2010 annual meeting plus RPMs, PHM and PCAARRD site visits and the subsequent report and its dissemination. The external review was completed in October and November 2011. See also 6.2.3 above.
2.7	Prepare and monitor overall Program budgets	Overall Program budgets submitted to ACIAR	Ongoing to Feb 2013	With a large number of collaborators and the complicated flow of funds (Section 5.5) monitoring of the budgets was difficult. Most budget changes happened with C5 where the initial allocations were 'to be determined', and unfortunately the principal investigator retired before the 'determining' happened. The FPM also assisted with the budgets for the C5 fruit component that had no principal investigator for much of the time. Acquittals from DAFF to ACIAR were all completed as were those for 2 external providers (US and NSW DPI). The component acquittals to Philippine collaborators were completed as far as possible.

PC = partner country, A = Australia

Objective 3: To maximise synergies and integration of the Components within the Program.

No.	Activity	Outputs/ Milestones	Completion date	Comments
3.1	Identify potential Program synergies and integration of Components and advise on strategies to capture these	Advice to ACIAR management team	Ongoing	Synergies developed between Components C1 papaya supply chain and C3 papaya diseases and between this latter component and C3 vegetables. C5 developed some economic analyses with C2 jackfruit and durian and with C3 papaya and C4 mango. The discipline meetings on entomology, pathology, supply / value chain and soils / physiology and extension across all the fruit and vegetable projects increased links.

3.2	Monitor Program activities and advise on improvements for greater synergies	Program monitoring reports and advice to ACIAR on potential improvements	Ongoing	Program monitoring occurred through site visits, component and annual meetings and reading and reviewing annual and final reports. Regular meetings involving RPMs, FPM, PHM and component leaders occurred. The FPM conducted some monitoring of programs through Philippine visits from 2008 to 2012 and site visits to Mareeba, Innisfail and Brisbane.
3.3	Prepare flow charts and tables indicating links between projects	Flow charts and tables developed and in use	Ongoing	These were developed by the VPM in the vegetable project

PC = partner country, A = Australia

Objective 4: To design and implement a communications plan for the Program.

No.	Activity	Outputs/ Milestones	Planned Completion date	Comments
4.1	Report to stakeholders on annual planning meetings	Report circulated to stakeholders	Annually	The FPM submitted reports on the Australian and Philippines annual meeting to DAFF, ACIAR and other associated people including component leaders and project staff. Other reports included internal travel reports which were prepared by most project members for trips and submitted to their own organisations, ACIAR and the FPM. Philippine component leaders submitted reports to PCAARRD.
4.2	Ensure effective communication between projects	Communication plan developed and implemented	Ongoing	Communication occurred between projects through emails and face-to-face meetings included 4 annual meetings in the Philippines and Australia. See also 3.2 above. Effective communication also occurred through the PHM's newsletter 'What's Cropping Up', quarterly teleconferences, annual meetings, emails and Web2 Communication in the Philippines was further facilitated by the PHM.

4.3	Develop and enhance the profile of the Program to ACIAR and other stakeholders	Other stakeholders engaged with and investing in the Program	Ongoing	The FPM promoted the Philippines program to senior DAFF managers and industry whenever possible and as relevant. The significant contribution of ACIAR to Australia's R&D effort for both mango and papaya is well understood and appreciated by industry. Promotion of the benefits of the Philippines ACIAR program has resulted in the Australian Banana industry being engaged in the new program. Some promotion was through meetings and some through circulating reports on outcomes. Attendance at local industry association meetings by program staff was a major strategy to gain industry support. Presentation to Horticulture Australia and peak industry associations highlighted the value of the program to the mango research program Web2 provided a profile for the program The durian jackfruit (C2) and mango (C4) videos prepared by Sharron Olivier and Gordon Rogers with separate funding resulted in good publicity. The FPM hosted Philippine project visitors throughout the project as well as John Dillon Fellows in February each year.
4.4	Review, recommend and implement a cost-effective communication plan	Communication plan developed and implemented	September 2008	Basic communication plans were prepared in 2008. Reporting is inherent in earlier sections of this report. Effective communication also occurred through site visit meetings, web 2 and reviews of reports proposals and plans
4.5	Liaise regularly with the Philippines Horticulture Manager and the Component team leaders	Monthly meetings held at least monthly with Philippines Horticulture Manager and Component team leaders	Ongoing	Discussions occurred regularly with the PHM. FPM had regular teleconferences and meetings with Australian component leaders. See also 4.2.
4.6	Participate quarterly in the Program Reference Committee Meetings	Quarterly meetings held with the Program Reference Committee	Ongoing	Reference Meetings were held in June 2011, July 2011 and May 2012. A number of other meetings involving some of PCAARRD, PHM, RPMs and the vegetable program manager and the FPM occurred. All dates not recorded.

4.7	Communicate at least quarterly with the Philippines Vegetable Program to maintain consistency and integration	Quarterly meetings held with management of Philippines Fruit Program	Ongoing	The FPM attended vegetable planning meetings in both of June and July 2008 and 2009, June and August 2010 and June and July 2011. FPM also attended fruit review meetings in July 2011(Bohol), November 2011 (Brisbane) and April 2012 (Brisbane). He / she had meetings with the Vegetable Project Manager in August, November and May 2011, April, July and August 2012 and April 2013.

PC = partner country, A = Australia

7 Key results and discussion

Technical results from the separate components and are recorded in component final reports. Only a selection of outputs (summary of component final reports and recommendations plus recommendations from the external review) and impacts are included in this report (section 7.4).

7.1 Management

7.1.1 General

The original completion date of 30 April 2012 was extended to 31 December 2012. Final reports for all components were not submitted until 2014.

Most of the management activities are documented in Section 5, Methodologies of this report.

The main issue with this component (C6) was the difficulties with C5 (Economics and Policy) which was contracted to NSW DPI. Thankfully the NSW DPI VPM was able take over completion of this project with a satisfactory outcome.

7.1.2 Budget management

Acquittals were required from DAFF by ACIAR for each six-month period to June and December. There was also an expectation that collaborators would provide acquittals to their component leader each six months. These were usually provided but were often hard to obtain.

7.1.3 Monitoring and evaluation

Monitoring of individual components and their progress was the responsibility of each component leader. Issues where milestones were not achieved were discussed and when necessary interventions facilitated. An important feature of this program approach were regular meetings both in Australia and in the Philippines where project leaders and staff reported component progress to a whole of program forum. The regular communication to scientific peers, and the review of project work inherent in those presentations, formed a significant and very useful part of a largely informal monitoring plan. The peer review of presentations and of the posters presented at those meetings was valuable to both management and scientists. Formal documentation of these discussions would have added more rigour to this process.

Meetings in Australia were attended by Australian component leaders with representation form PCAARRD in the Philippines. At these meeting updates on the strategic intent of the Philippines government research program were presented. Again the peer review provided at these meeting informed both the monitoring and evaluation of individual components.

Both in the Philippines and Australia the time available to allow full discussion was restricted. While additional time would have allowed for more critical discussion, the size of the program was responsible. While the size of the program and the large attendance of staff provided benefits from the broad nature of the review it also restricted the time available and in some cases participants willingness to speak up at a large public forum.

The FPM contributed through attendance at many meetings, including annual meetings, the mid-term review and the end of project review (Chapman *et. al.* 2012). The FPM contributed to M & E through comments and suggestions at meetings throughout the project.

As meetings performed a critical monitoring and evaluation function issues were acknowledged and dealt with at those meetings as well. Project components were able to hold meetings with program management to resolve issues.

7.2 Linkages and themes across components

Common staff, sites, institutions, meetings

The opportunity to value add to components was mainly through some common staff and common institutions for some components eg UPLB for C1 and C3, VSU for C2 and C5, and in Australia with Qld DAFF for C1, C3 and C4.

Some experimental activities were shared on papaya (C1 and C3).

Staff from the economic and policy component, C5, had a number of joint meetings and workshops with the other components.

The opportunities to utilise skills in one component to assist other components is an opportunity that needs to be progressed in new projects. As the 5 technical projects were initially scoped and essentially developed independently, across component collaboration was initially limited. The program meetings addressed this to some extent, but in the future this needs to be more pro-active.

The overall link was that all components were working on fruits, and of the five components three were led by DAFF whose leaders had regular interaction both within and outside the scope of the projects.

During the annual review and planning meetings in Ormoc 2010 and Cebu 2011, the FPM and VPM assisted in organising some meetings of i) entomologists ii) pathologists iii) agronomists and soil scientists, iv) economists and v) value chain staff.

These meetings helped scientists and extension officers who had similar interests to meet and develop better working relationships. Some of the suggestions from these meetings were implemented in following years and contributed to the new 2013-17 Philippines Horticulture Program. With hindsight, some of the suggestions should have been followed through further within the vegetable project.

It would be valuable in the future to promote these across project link meetings so staff benefit from more interaction, scientific debate and sharing of resources.

Some common messages and themes across components

1. C2 to C4 had pests and diseases as major issues and experiments were affected by their impacts. It is acknowledged that this is not unusual for tropical fruit but it seemed to reflect limited pest and disease management skills from some technicians rather than random uncontrollable events. Similarly, in Australia, pest and diseases had major effects on yields of C1, C3 and C4 experiments.

At some stage there may also be an opportunity to involve the Philippines plant protection research stations. A visit to the NOMIARC plant protection facility by John Oakeshott, Les Baxter and David Hall highlighted high industry involvement, but a lack of resources, commercialisation skills and networking.

2. This fruit project, particularly C1 and C5 (both the transport and market analysis studies), highlighted variable quality and losses of fruit after harvest and figures on losses were documented.

3. Gross margins (GM) from various fruit cropping enterprises were documented from component 5 (Some of these are summarised in Table 9, Component 5 final report, page 61).

4. Within C5, the SEARCA and UPMin studies highlighted the effects of high transport costs on profitability of fruit production. The results of the SEARCA study were widely disseminated throughout the Philippines.

5. It is believed that across the components there was under reporting of outputs.

6. There were some common issues with capacity building that are noted in the next section.

7.3 Capacity building

A key objective of ACIAR is to have a *capacity-building impact* through 'a change in the knowledge and skills of individuals (particularly those in the partner country) that has occurred through their participation in the project and its training elements'.

The VPM highlighted some capacity building issues which the FPM agreed with (Hall 2013). These were as follows

'It was apparent from the M & E process, including the reading of reports and papers, that the Philippines collaborator's staff and also with Australian staff, that there were varying levels of competence in many of the key skill areas. These included:

i) Statistical analyses. In 2010 and 2011 there were a number of discussions with researchers on the need for improved statistical analysis skills and for some training in basic statistics. This need remains. The VPM had discussions with two Australian statisticians about a possible role. However, we considered it also beneficial to include Filipino statisticians as trainers. The PHM investigated the IRRI program 'CropStat'. A number of the projects in the new Philippines Horticulture Program are considering some early training on experimental design and data analysis.

ii) Extension skills. There was recognition that extension skills and processes could be improved. Thus at the 4th year fruit and vegetable planning and review meeting in Bohol, 2011 an extension workshop was conducted. This followed the Australian ABC's Q and A concept, including a panel of experts. It was led by Irene Kernot and Noel Vock, Qld DEEDI and the expert panel included the RPM HORT.

iii). Economic analyses. It is critical that when new farmer recommendations are made that they are checked to ensure they are likely to improve farmer livelihoods. In some cases some recommendations were not subjected to basic checking of likely benefits within cropping systems.

Participants in a training course 'Economic Analysis Techniques for the Evaluation of Farm Fruit and Vegetable Systems' at VSU made some valuable 'generic' suggestions and comments in November 2012. (See Attachment 12.6, C5 final report for more notes on this evaluation). The suggestions and comments may have wider implications than just farm economic analyses training and thus are repeated here.

The VPM helped plan, implement and evaluate this course. The workshop was originally intended for junior economists from the C5 economic program. However, there was significant interest from others and thus economists also attended from the C4 vegetable supply chain component, plus some VSU staff, other senior economists as well as some non-economists from other components of the fruit and vegetable program.

The 'generic' comments and suggestions documented as part of the evaluation included:

- *Attendees appreciated having a Filipino as the trainer (even though she is now an 'Australian').*
- *Appreciation of the value of the exercises which were relevant to Philippine agriculture*
- *Participants would have liked to have had more exercises*
- *They would have liked more training time (up to 5 days, rather than 2).*

- *Handouts to be in bigger print*
- *It was appreciated that topics were basic and there was a lot of discussion on applications of the techniques*
- *They would like to have a 'reflective' or further training course in another year*
- *They would have liked to have had smaller groups*
- *They appreciated the interactive session which identified the strengths and weaknesses of each analytical tool and when appropriate to use*
- *For other training courses they suggested having groupings set up at the start of the training across institutions but with one advanced person in each group*
- *Other training courses they would like to attend were: Technical writing, data analysis for researchers and photographic techniques to capture events or good agricultural practices or symptoms of pests / diseases to support the results of projects.'*

7.4 Technical results for components 1 to 5 and external review recommendations

7.4.1 Component 1 Papaya supply chain

Executive summary from C1 final report

'Solo' papaya production over the past decade has developed into a major industry in the southern Philippines, and this area is now the major source of papaya for export and domestic markets.

A multidisciplinary team conducted a value chain analysis (VCA) of papayas produced in Tupi, South Cotabato, and marketed in supermarkets in Metro Manila and outlying provinces. Since the primary aim of VCA is to deliver consumer-defined value, two consumer focus groups were conducted followed by surveys of 232 consumer and conjoint analysis. Results indicated that papaya consumers valued and would pay for freedom from blemish and decay, sweetness and good colour (yellow-orange).

Interviews with major chain stakeholders showed that information flows were partial at best, relationships were basic or transactional and there was a general lack of consumer insight by chain members. Mapping product flows from the farm to the distribution centre in Metro Manila revealed losses from disease, non-uniform ripening, fruit immaturity and mechanical damage. Thus product performance was highly variable. Results from consumer research combined with chain mapping enabled each activity from farm to market to be characterized as value adding, necessary but non-value adding or wasteful. These performance measures enabled the identification and implementation of improvement opportunities to reduce losses, improve product quality, build better relationships and deliver consumer-defined value. Quality improvement opportunities included improving sweetness through correct harvest maturity, freedom from decay through hot water treatment which reduced the effects of the diseases anthracnose and stem end rot by 33 to 100%, and treatment with ethephon, a ripening regulator. Modified atmosphere packaging (MAP) and 1-methylcyclopropene (1-MCP) prevented premature ripening during the 3-day sea shipment. However, the high incidence of decay using MAP and the failure of fruit to soften with 1-MCP treatment were limiting technique constraints

Two trial shipments to Metro Manila supermarkets and surveys to determine market response to improved fruit quality confirmed that consumers were willing to pay more and buy more. The consumer value thus created could be used to motivate growers and other chain members to commit to activities that improved fruit quality.

Four training sessions on papaya production and postharvest handling, enhanced information flows in the chain, and chain-wide participation in quality improvement

activities resulted in a 37-73% reduction in in the number of papayas that were rejected or "bad orders" supplied by growers-shippers to the key collaborator.

Initial research of the Singapore market, conducted by a group student from the University of Queensland sponsored by ACIAR in Sept, 2012, found that Philippine Solo Papaya had great potential. Harvesting and postharvest handling guidelines were then developed to help meet the export requirements. Three trial shipments were sent to Singapore in 2013, one of which was fully monitored by the project with Dr Tim Sun and two researchers from UPLB following the shipment. It was found that Philippine "solo" papaya was under supplied in the market. Organising enough supply from the Philippines to Singapore with the required quality was the primary limitation. Apart from Singapore market, this project also sent two shipments to the Middle East in 2012.

In Australia, chain mapping and interviews with chain participants identified fruit diseases, which caused wastage of up to 25% during summer production, as the major limitation to industry profitability. Trials of ripening temperatures, effect of pre- and postharvest chemicals, hot water treatment and tree age were undertaken to develop solutions to this wastage. Subsequently, changes to summer ripening temperatures have been adopted by collaborators to reduce disease without affecting other quality attributes. There remains a need to further reduce disease problems and develop a more consumer-value oriented approach to papaya chain improvement.

Summary recommendations from the external review (Chapman *et al.* 2012):

1. Specific activities recommended for the next phase include further training in Value Chain based approaches for researchers and stakeholders, embedding within commercial practices activities such as 'walking the chain', undertaking baseline performance analysis to establish the cost benefit of chain interventions, and continue participatory action research along the whole chain with stakeholders.
2. Value chain analysis and management of a papaya export chain to the Middle East or Hong Kong with involvement of willing commercial participants. Developing export markets is important for the industry and the impact of VCA has been demonstrated in phase 1 as a systems-based approach to market development. Extending it to an export value chain is the logical, though more complex, next step.

Other comments on C1

A major issue was the sourcing of a potential commercial collaborator. Whilst collaboration was eventually obtained, confidentiality had to be maintained. This limited some opportunities for promotion of the work although many of the learnings from the chain study enhanced the capacity of the team and general learnings could be widely applied.

7.4.2 Component 2

Executive summary from C2 final report

'*Integrated management of Phytophthora diseases of durian and jackfruit in the southern Philippines'* is one of 10 components that comprise the ACIAR Program HORT/2007/067. The Component aimed to address the major disease problems affecting jackfruit and durian production in the southern Philippines by testing disease management strategies in order to develop a package of options that could be presented to farmers and industry stakeholders.

Jackfruit and durian are marketed as 'flagship fruit' for their respective regions, the Eastern Visayas and Mindanao. Both fruits are high-value, commanding high prices with the potential to provide sustainable incomes for local farmers through domestic markets, and the prospect of being developed for export as quality and production increase and infrastructure improves.

At the beginning of the project, a workshop involving growers, researchers, extension staff and industry stakeholders was held to identify key constraints to the production of durian and jackfruit, currently available management strategies, sources of information and support for growers, and potential constraints to the adoption of new technologies. Participants were given theoretical and hands-on practical training on the biology, epidemiology and management of Phytophthora diseases, and in the design and conduct of on-farm trials. Participants then developed proposals to test farm management strategies on yield, disease losses and productivity in on-farm PAR trials.

Phytophthora disease was identified as a major limitation to the production of durian, but little information about management was available or disseminated to growers. Jackfruit has been promoted throughout the Eastern Visayas through a 'plant now, pay later' scheme. A disease survey conducted at the start of this project showed that in some cases as many as 100% of jackfruit trees in some orchards were affected by a decline syndrome progressing from leaf yellowing, leaf drop, girdling stem lesions and root rot, to tree death. *Phytophthora palmivora* was identified as the cause of this decline. Diagnosing the cause of jackfruit decline was fundamental to the development and dissemination of disease management strategies.

A high level of disease in jackfruit and durian nurseries, as a result of poor nursery practices, is also likely to have contributed to the spread of the pathogen and the incidence of disease. Seedlings were propagated in unsterilised soil and maintained on the ground, increasing the risk of infection by Phytophthora. Most of the planting material distributed through the 'plant now pay later' schemes came from these nurseries. Through this project, best practice nursery practices (such as raised benches and clean potting medium) have been introduced and efforts are now being made by the DA-RIARC (Department of Agriculture) to establish a nursery accreditation scheme.

Diagnostic capacity was limited and disease management strategies were underdeveloped and poorly disseminated. Durian and jackfruit growers and industry representatives were often unaware of the cause of the disease and effective disease management strategies. Improved orchard management was seen as a way of reducing disease losses, leading to sustained increased yields and higher fruit quality.

A participatory action research (PAR) approach was implemented to test and disseminate technologies for disease management in durian and jackfruit. PAR trials were established in collaboration with jackfruit and durian farmers, extension staff, agriculture officers, academics and researchers. Yield and disease data were collected and presented at a final workshop. The results were used to develop management recommendations for each industry. In jackfruit, improving drainage, application of organic materials and application of plant defence activators were particularly effective at reducing disease incidence and severity. In the durian trials, application of Garden Balsam extract, application of chicken manure and EM4 (Effective Microorganisms) and phosphonate were very effective against Phytophthora. In some cases methods tested to manage Phytophthora were not effective, highlighting the importance of knowing to critically evaluate potential control methods before recommending it to growers.

The low-, medium- and high-level input options identified during the workshops were tailored for adoption by growers from a range of backgrounds, resources and capacity. The recommendations were first presented at the Tagum City Durian Festival in September 2011, and were subsequently disseminated through farmer field days and training sessions with extension staff in collaboration with local government units.

Summary recommendations from the external review (Chapman *et al.* 2012):

Fruit Component 2: Phytophthora

3. Specific ongoing research activities are the simplification of nursery bench designs and costs, soil solarisation and alternative potting mixes, C: N ratio fibrous mulches

and organic manure supplements, testing organic options, resistant rootstocks, diagnosis capacity building, and promotion of nursery accreditation and planting of healthy trees.

4. Potassium Phosphonate is a commercial product approved as a fertiliser in the Philippines which requires Fertiliser & Pesticides Authority (FPA) approval before it can be used as a crop protection chemical. This should be followed up with the manufacturer and the FPA to get the correct registration approval.

Other comments on C2

Some of the work from this component will be followed through in a new Qld DAFF led project HORT 2012/095. 'Tropical tree fruit research and development in the Philippines and northern Australia to increase productivity, resilience and profitability'.

7.4.3 Component 3

Executive summary from C3 final report

Integrated crop management strategies for the productive and profitable production of high quality papaya fruit in the southern Philippines and Australia' was a component of ACIAR Project HORT/2007/067, 'Improved domestic profitability and export competitiveness of selected fruit value chains in the southern Philippines and Australia'. The component aimed to identify and address the disease, insect pest and nutrition-related problems associated with the growing of papaya in the southern Philippines and Australia.

Baseline surveys of papaya growers and contractors in Cagayan de Oro City, Misamis Oriental, Bukidnon, Davao del Sur, Davao del Norte and South Cotabato identified constraints to production as being red spider mites, choco spot, bacterial crown rot (BCR) and *Phytophthora* root and fruit rot. A lack of knowledge of the nutrient requirements of papaya was also identified, with little information being available to growers. The diagnostic capacity of pests and diseases by researchers was recognised as being very limited and thus pest and disease management strategies were either non-existent or ineffective.

As component activities progressed, entomologists within the team were able to identify six phytophagous species of mite *Brevipalpus californicus* (Banks)*, Eutetranychus africanus* (Tucker)*, Tetranychus kanzawai* Kishida*, T, piercie* Mc Gregor*, T. urticae* Koch and an unidentified Tetranychid species associated with papaya. *Tetranychus kanzawai* was found to be the most damaging and abundant phytophagous mite on papaya. A predatory mite *Neoseiulus longispinosus* (Evans) and a predatory beetle *Stethorus pauperculus* were identified on papaya. Mass rearing techniques for these predators were developed.

The diseases choco spot (*Corynespora cassiicola)* and BCR (*Erwinia papayae*) were researched by members of the team. Isolates of *C. cassiicola* were tested for pathogenicity, and trials were conducted to evaluate fungicide efficacy and cultivar resistance. The fungicide propineb applied at 312 g a.i./100 L of water was found to be most effective at controlling choco spot achieving a 114% increase in marketable yield.

Dr Anthony Young demonstrated the difficulty in recovering and identifying *E. papayae,* the causal agent of BCR. A technique was developed to assist researchers in the successful recovery of the *E. papayae*. By the end of the project, the disease BCR was identified as the greatest concern for growers in the Philippines. It is recommended that further studies be conducted into seed transmission, spread and management of BCR of papaya.

Collaborative research with University of South-eastern Philippines and Del Monte Philippines Inc (DMPI) showed 300 and 450 kg N/ha gave maximum yield of fresh and

processing papaya, respectively. Over the range of rates tested (15 to 600 kg/ha), the incidence of fruit stem-end rot increased. DMPI have adopted their findings for production of processing papaya in northern Mindanao. The Merck Reflectoquant® RQflex 10 rapid nutrient (plant sap) test was shown to be a potential plant N monitoring tool. An efficient method of sap extraction was developed that makes the analysis test system adaptable for in-field use where electrical power is not available. A best management practice approach to papaya fertilization was clarified from the literature and applied in N rates research in Australia. Plant response in Stage 1 (transplanting to flowering) suggests that rates above 15.5 kg/ha (during this stage) exceeded plant requirement.

Field trials conducted in Australia showed that copper hydroxide at 375 g a.i./100 L was the most effective in controlling *Phytophthora* fruit rot. In glasshouse experiments, the chemicals dimethomorph and furalaxyl effectively controlled *Phytophthora* root rot. The growing of canola (KBNSR1.3) reduced the severity of root rot in *Phytophthora*-infested soil compared to BQ mulch and a bare fallow.

Eight papers were presented to national conferences and one manuscript written for publication to a science journal. Flyers and handouts were produced and distributed to 54 growers during a grower workshop at Tupi, South Cotabato. A papaya production video titled 'Growing papaya: your guide to getting it right' was produced to assist new and experienced Australian and Philippine growers.

Summary recommendations from the external review (Chapman *et al.* 2012):

5. *Pests:* Collection of seasonality data on mites and try to correlate to weather and farmer practices; bio-control of mites using predators including developing mass rearing facilities; monitor predator and pest mite populations following release of predators on grower properties'; cost-benefit analysis on pest control and management strategies; development of a miticide resistance strategy including bio-controls;

6. *BCR Disease*: determine the role of insects in disease infection; effects of fungicides on mite predators; vectors and transmission of Bacterial Crown Rot (BCR); determine if BCR is seed-borne; BCR soil survival; BCR diagnostic primers; BCR resistance;

7. *Nutrition*: Effect of other nutrient elements to growth and yield of papaya; demonstrate the use of leaf colour chlorophyll technologies as a guide to leaf N; Nitrogen effects on pest and disease susceptibility; cost-benefits of N applications

8. Extension material is required

Other comments on C3

Research into BCR in papaya (see recommendation 6 above) will be progressed in a new Qld DAFF led project HORT 2012 / 113. 'Integrated disease management strategies for the productive, profitable and sustainable production of high quality papaya fruit in the southern Philippines and Australia'.

7.4.4 Component 4

Executive summary from C4 final report

In both the Philippines and Australia, sustainable development of the mango industry is hampered by pest and disease losses, variable productivity, supply-chain deficiencies and market access challenges. The Component aims were to develop, evaluate and

implement sustainable practices for the production and marketing of quality mangoes with less reliance on pesticide use, leading to improved incomes.

In the Philippines, the results have led to improved crop management methods, which were demonstrated to control the key targeted pests (thrips, cecid flies, mango pulp and seed weevils, anthracnose and stem end rot). As a result, losses and input costs were reduced, which translated into improved farmer profits. For the control of the mango postharvest diseases, anthracnose and stem end rot, a package of in-field fungicide spray treatments and postharvest treatments was developed and disseminated to growers. Nutrition studies were assessed in relation to disease incidence. The fruits developed anthracnose at ripening, regardless of chemical flower inducer or N-fertilizer levels. Extended pesticide withholding periods are required to ensure compliance with residue limits in export destinations such as Japan. For other export countries and for the local market, it is recommended to strictly follow preharvest good agricultural practice (GAP) guidelines. A key area of success in this component was the extension programs. A system of using “farmer clusters” and selecting and training key growers within each cluster was developed and provided a superior system of extension, reaching more farmers. In Australia, new integrated pest management (IPM) solutions for key production and market access pests were developed, including an effective pheromone trap for fruit spotting bugs and a chemical control method for mango seed weevil.

This component has improved the scientific and management capacity of scientists, extension workers, farmers and other stakeholders that will have benefits now and into the future. The most significant impact is the economic benefit that the farmers will gain in increased income due to higher yields and higher quality (pest and disease-free) fruits; correspondingly, the reduced yield losses, improved fruit quality and reduced production costs have increased farmer profits. In an economic analysis from Palawan, the IPM package produced an income of PhP 1,730 (AUD 42.00) per tree, in contrast the conventional farmers practice produced PhP 21 (AUD 0.50) per tree. In Southern Mindanao, it was estimated that IPM practices developed from this project could reduce losses and rejects by 20%, improve yields by 33% and reduce the cost of production by 16% (through reduced chemical control costs), which would produce an estimated 156% increase in farmer income. With improved systems of pesticide residue control, Philippine mangoes will be more competitive to export destinations. There will also be environmental, social and health impacts from a reduction in pesticide use and less chemical residues in the consumed fruit.

Future project work should concentrate on developing: IPM compatible inputs, pesticide resistant management plans, and area wide management strategies that engage not only the farmers, but also the contractors. Further research into organic inputs could provide some cost-effective solutions to nutrition, pest and disease problems, but more research with conventional synthetic chemicals and residue management is required. Farmers need to reduce their crop pest pressure (in particular thrips, cecid fly and fruit fly), disease incidence (to increase shelf life) and reduce the risk of pesticide residues. Research in nutrition and canopy management could provide improved methods of reducing pests and diseases, as well as producing export quality mangoes. The farmer cluster model should be extended, so as to reach more farmers and perhaps more importantly to include contractors. However, further resources are required to support research and extension staff.

Summary recommendations from the external review

(Chapman *et al.* 2012)

Fruit Component 4: Mango

9. *Pests:* Sustainable management strategies for Thrips; Cecid fly management.

10. *Diseases:* SER and Scab management strategies;

11. *Nutrition*: Investigate Ca as a foliar application and the incidence of fungal diseases; establish critical nutrient levels and a balanced fertiliser program;

12. *Chemical residues*: Recommendations focus on strengthening institutional networks with laboratories and major stakeholders to improve testing and traceability as well as government and international regulators.

13. *Extension*: Expand the implementation of ICM program in other mango supply areas in the Davao region.

Other comments on C4

Further disease, pest, nutrition and management research with mangoes will be progressed in a new Qld DAFF lead project HORT 2012 / 19. 'Research and development of integrated crop management for mango production in the southern Philippines and Australia'

7.4.5 Component 5

Executive summary from C5 final report [3]

The economic and policy components of the Philippine fruit and vegetable projects have provided an understanding of the economics underlying the technical research, new gross margins GM and recommendations on policy. Many technical recommendations for farmers and / or their advisors can now be valued economically

The research aimed to understand the markets, profits, prices and cost structures of horticulture crops in Mindanao. Economic analyses of the value chains for mango, papaya, cabbage, eggplant, tomato, potato, eggplant and durian were completed, as were analyses of the profitability, productivity and technical efficiency of the growers of the initial five of these crops. Smallholder farmers in Southern Mindanao do not have sufficient capital for production, thus they rely heavily on financiers (external loans) for the production and marketing of their produce. In addition, they usually did not have adequate technical knowledge that may help them improve productivity. There were many associations for example, trained cabbages farmers had a 55% increase in profit ($P<0.05$) compared to non-trained cabbage farmers whilst the comparable value for tomato farmers was 48% ($P<0.05$).

The impacts on farm level profitability of increased technology for three fruit crops and using protected cropping for vegetables were assessed. To support these analyses GMs were prepared for many crops. Using assumptions for supply changes, costs and adoption rates, the benefit cost ratio (BCR) for phytophthora research with jackfruit was 48:1 and for integrated pest management (IPM) of mango was 51:1. For durian, high

[3] The original executive summary included the research with vegetables, but specific vegetable comments are omitted here

management options to control phytophthora will provide farmers with estimated increases in GM of 107%.

Studies were conducted on the Philippines' investment in research and development (R&D) for the fruit and vegetable sector. A model, called 'WISER', was developed and was used to calculate measures of project worth (i.e. net present value, BCR and internal rate of return). The prospective impact of an ACIAR-PCARRD horticulture project at the industry level had very positive outcomes; hence it is recommended that resources be reallocated in favour of public investment in horticultural R&D.

A macro-level analysis of transport revealed that economies of size, level of market development, presence of good quality transport infrastructure, particularly road networks and ports, and geographical proximity are important determinants of inter-regional agricultural trade in the Philippines. A micro-level analysis of tomato, lettuce and papaya crops found for all key actors in the supply chains, inefficient transport and logistics resulted in increased transport costs, reduced product quality and quantity and diminished viability and profitability. The recommendations were widely disseminated.

In Australia, analyses of the economic benefits of research on fruit spotting bug, crop resilience to cyclones and phytophthora management in papaya were conducted.

Capacity development included 25 project staff completing training courses on economic analysis and a further 7 staff attended 3 specialized impact assessment courses. Three component research assistants received postgraduate scholarships (a PhD to Japan, and a Masters and a PhD John Allwright Fellowship to Australia).

Summary fruit recommendations from the external review (Chapman *et. al.* 2012):

That for future research, economists be embedded in each project, they be networked and they define at the outset the measures required to assess the returns to research. In addition, ex-ante analysis of proposed research should occur and there be careful site selection and project design to ensure that results generated are applicable over a wide, economically significant area.

Other comments on C5

The absence of a principal investigator from October 2009 to May 2011 and from March 2012 plus the resignation two project officers affected this component. More details are provided in the component final report. Also the C5 component was over ambitious in its objectives.

Nevertheless, the component did undertake a large number of economic analyses of work conducted in the technical fruit and vegetable components. Some of the analyses have also been used as support for projects in the new Philippines Horticulture Program.

Further analyses of data may be useful to Philippines fruit and vegetable research. In particular, the UPMin team have large data sets obtained from surveys of potato, cabbage and tomato farmers (plus mango and papaya). This data covers both financial and production areas and includes fertiliser, pest and disease control costs and marketing costs. The types and amount of inputs as well as the importance of educational level, training, membership etc are being analysed to see if they are associated with vegetable profitability, yield and farmer technical efficiency. Whilst some of the work is being published there is a further opportunity to conduct secondary analyses of the data and to document typical farmer practises of the over 300 fruit and vegetable farmers surveyed. Any further analyses need to consider how this can be used to improve smallholder livelihoods. The data set will be provided to ACIAR.

Some of the UPMin studies on marketing issues with farmers and others in the value chain would have benefited if they had involved production people in the studies, whether

from ACIAR funded projects or other sources. This would have benefited the economists as they would be working with people who understand the technical farming issues and production staff would have gained a better understanding of costs and where research and extension could be focussed.

The project also contributed to policy development. SEARCA as part of C5, widely promoted their policy recommendations on transport infrastructure and the annual Agribusiness Economic Conferences at UPMin (C4 and C5) provided researchers and students opportunities to interact with senior policy makers particularly on issues that affect smallholder farmers. Forums need to be used to debate issues and assist in formulating policies and recommendations that will benefit smallholder farmers. There is a need to develop skills in policy analysis so that policy recommendations are based on sound evidence derived from rigorous investigations.

As a result of some of the issues in the C5 component, some suggestions have been made on the role economists within new Philippine projects (See Section 7, page 55, C5 final report). These included: it may be preferable if economists are embedded within projects and not be part of a separate project, very basic economic analysis training be provided to some staff within new projects, the booklet being prepared as part of this component 'Farm economic analyses, with Philippine examples' be disseminated and process be implemented for cross-project economics meetings to increase co-operation and sharing of experiences and skills.

7.5 Management opportunities

The C6 executive summary is in Section 2.

Obviously as the project progressed there were many new ideas generated on ways to improve management for a large project such as this one.

The key opportunity is to build on the gaps and opportunities highlighted in this now complete fruit project to develop new fruit projects that will enhance farmer profitability, food security and stakeholder capacity.

See also section 8.2 Capacity

Management guidelines for new projects

The VPM and PHM prepared some guidelines for new projects in the Philippines. These were incorporated directly into the external review (Chapman *et. al.* 2012) and were supported by the FPM. The suggestions were:

- Involve existing Philippines extension and training organizations from the outset
- Involve southern Philippine's Universities more in future programs.
- Include individuals who have been successful and highly committed to R&D & E for the Philippines
- Ensure that standard remuneration rates are paid across projects for research assistants.
- Involve commercial organizations more
- Project Leaders must be good managers and team players as well as good researchers
- Develop a truly bilateral program with clear benefits to Australia and Philippines and capture bio-security implications for both countries.
- Suggested new project areas for reporting and ACIAR financing might include:
    - Extended value chain research on fruits and vegetables with more crop targeting.
    - Postharvest
    - Soils and plant nutrition

    - Integrated crop management for mangoes and other less utilized fruits such as jackfruit, durian and pomelo.
    - Research on diseases of tropical crops
    - Assist strengthening diagnostic labs across disciplines (eg. Residue testing, insect and disease identification, etc.)
- No separate economics and policy project. Include economists within each project as an objective. One project economist from Australia could coordinate the economics across each project.
- One management project would be enough to handle both a future fruits and vegetable program (i.e. no separate fruit and vegetable manager) with the support of the ACIAR in-country program manager
- Projects must utilize opportunities to be flexible and for example support conference attendance of key persons involved in relevant projects
- Capacity development should begin early in projects
- Communication, reporting M&E systems need to be revised by ACIAR.
- Revise the annual reporting and final reporting systems

Summary recommendations from the external review *(Chapman et al. 2012) were*

11. That for a new program, ACIAR considers involving more Philippines agencies, a more detailed monitoring & evaluation framework, documenting of gross margins or net profit benefits from introducing new interventions and incremental annual reporting to better link past outputs to present reports. ACIAR could also consider the other suggestions in section 4 of the C6 review report.

12. That for new fruit and vegetable projects in the Philippines, ACIAR considers crop targeted value chain research with new research on postharvest, integrated crop management for selected vegetables and fruits, including soils and plant nutrition, capability development, the strengthening of diagnostic laboratories across disciplines and coordination through one management project.

8 Impacts

8.1 Scientific impacts – now and in 5 years

Scientific impact of this component is from the scientific capacity enhancement attributable to cross component linkages made as a result of the program methodology. This was not measured but discipline workshops at the 2010 and 2011 annual meetings were instrumental in identifying the need for additional training on a discipline level and influenced the development of follow on projects.

Most scientific impacts will come from the 4 technical components C1-4, while both C1 and C5 delivered scientific impact from improvements and better understanding of the application of the methodologies chosen by project staff resulting in better analysis and therefore impact through economic assessment of production and infrastructure, and chain understanding.

A brief summary from component reports is:

C1

This project adopted value chain analysis largely based on using accepted methodologies and adapting the concepts to commercial environments with small to medium grower suppliers.

This value chain analysis approach should form the basis for working with chains and subsequent science-based interventions in other fruit and vegetable supply chains even when the principles of value chain improvement are not fully realised as chain relationships do not share their power and influence equally.

C2

Many of the management strategies tested in the PAR trials were built on experiences from previous ACIAR projects (PHT/1995/134, PHT/1996/153, CP/2000/102). Three participants from previous ACIAR projects attended the final project workshop, field day and public forum in September 2011. Their participation was very valuable as they were able to share their experiences in managing the same disease in Vietnam and Thailand. Participants in the public forum were astounded to see the differences in production methods and productivity between the countries.

C3

The scientific impacts from the research were that;

- *E papayae* was confirmed as the cause of BCR and a technique has been developed which assures the successful and consistent recovery of the BCR pathogen. This means future research into the IDM of BCR can be commenced.
- The confirmed identity of the BCR pathogen is also important to Australian biosecurity as it provides knowledge of recovery methods to use in the event of a BCR incursion.
- A new finding for the Philippines is that significant yield increases can be achieved in controlling the foliar disease ‘choco spot’ with fungicides in the Philippines. .
- High N fertilization was shown to increase stem-end rot in red fleshed papaya. This knowledge is new to papaya production in the Philippines and Australia and should help prevent stem-end rot in the cultivar ‘Sunrise Solo’ grown for the fresh market.
- The biocontrol agents, *Stethorus* beetles and predatory mites were identified as having potential in controlling pest mites.

C4

Findings on the biology, ecology and management of identified mango insect pests (mango pulp weevil, thrips, and cecid fly) and epidemiology of mango diseases (anthracnose, stem-end rots, and scab) provided fundamental understandings that have been added to the ICM package. Tolerance of some varieties to anthracnose and SER has also been identified.

Soil nutrition and its effect on the natural defence of mango fruits against disease will result in efficient production systems that increase fruit yields without risking high levels of postharvest disease development. New research has identified important influences of N on fruit yield and quality and alternative use of calcium nitrate to induce flowering, as well as new ways of detecting leaf N via leaf colour in mango.

Studies on the chemical residue limits for mango will set an example for the development of standards for other fruit commodities. This has also contributed to the database of information on residues of pesticides on mango for consideration of a National and/or CODEX MRL.

In Australia the results from the fruit spotting bug pheromone work and the mango seed weevil insecticide work have been used in subsequent continuing HAL funded research projects and have contributed new methods of pest control.

C5

A completely original and user-friendly impact assessment tool, WISER, was developed. It can be utilized by economists and trained technical staff from research and development and extension agencies to inform decisions on policy change and priorities for research investment and is much more flexible than the DREAM model.

The detailed mathematical analyses of variables that help explain profitability, productivity and technical efficiency of cabbage, tomato, potato, mango and papaya farmers will contribute to farm modelling literature and have impacts in resource allocation of smallholder farmers.

8.2 Capacity impacts – now and in 5 years

Capacity impact is also largely through the component projects. Support for John Dillon Fellows visiting Australia was provided through exposure to the governance and management processes for the research program in Australia.

C1

The UQ, Q DAFF and UPLB teams all developed their capacity in value chain analysis including consumer research and postharvest techniques.

At least 126 farmers and others were trained in aspects of value chain analysis including the supply chain of papaya for export to Singapore,. One grower-shipper invested in a modest packinghouse with hot water treatment facility.

Realising the benefits of improved handling systems one grower-shipper invested in a modest packing house with hot water treatment facility. He was the co-operator during the two Middle East sea shipments, although these were not sustained due to the problem of payments. He was also the co-operator with the Singapore shipments.

C2

The Philippines jackfruit component leader, Dr Lucia Borines, and technician, Ms Victoria Palermo, learnt to correctly identify the isolates based on morphological and cultural characteristics at UQ, Brisbane. They also learnt how to conduct molecular diagnostic tests to identify the isolates by PCR and RFLP. The training has helped to improve the capacity of Filipino researchers to conduct disease surveys, isolate and identify pure

cultures and maintain culture collections that can be used in this project and future disease diagnostic activities.

Following the PAR testing of best practice management strategies in the nursery at the Department of Agriculture, a nursery accreditation scheme is being established by DA-RIARC to ensure that certified healthy planting material is available for purchase by growers.

C3

At the commencement of the Component, none of the Philippine researchers had experience in working with papaya and papaya-related issue but by the end of the project a number of technicians and researchers had all improved their competency. Anthony Young (Bacteriologist) developed a protocol for the accurate recovery of the *E. papayae* from BCR affected papaya and used this to train plant pathologists involved in the component.

The 'Threat specific contingency plan – Bacterial crown rot (*Erwinia papayae*)' developed for the Australian papaya industry was written as a result of the component leader experiencing first hand the devastating effects of BCR in the Philippines. The knowledge of this disease outlined in the contingency plan gives Australian growers and Australian biosecurity the capabilities that enable early detection of BCR thus lessening the risk of an outbreak damaging regional production.

Plant nutrition staff at USeP and DMPI received training on the use of the Reflectoquant RQflex x10 (Merck) meter to monitor petiole NO_3 levels in papaya. Other capacity impacts included training project staff in *Phytophthora* diagnosis and management.

C4

The capability of Local Government Units and collaborators to conduct supervised residue trials has been enhanced.

Cross-visits to Australia and vice versa to experience and witness the mango industry, provided good insights for researchers and farmers. There were 4 participants in a Component leaders study tour to Australia and 12 Filipino growers benefited from the industry study tour to Australia.

Two researchers from USeP and a LGU were trained in Australia on mango disease diagnosis and identification

Hands on training, within supervised pesticide residue trials, educated collaborators (as well as farmer clusters and spraying contractors) on GAP, withholding periods and other residue issues. Some hundreds of Filipino farmers have benefited from training, workshops, field demonstrations market exposure. This has included over 700 growers attending workshops on agronomy, IPM and pesticide residue management.

Summary of capacity

Capacity impacts with farmers were predominantly through workshops, field days, farmer field schools etc and are reported in component final reports. An attempt to collate the numbers of farmers and staff involved in training is made in Table 2. This data was not always collected and / or documented actively and comparisons between components should not be made. The table more reflects the need for a more thorough collation of project outputs and also defining the capacity categories better in future projects. For example C4 and C5 did not have experimental trial sites, but they used farms and retail shops for meetings with their stakeholders.

Table 2. Some capacity impacts, Philippines, minimum values [1]

Capacity Impacts, Philippines

Capacity area	C1	C2	C3	C4	C5
Number of farmers and others trained	96	623	68	287++	0
Workshops	1+	4	2	3	nd
Field days	nd	10	3	30	nd
Undergraduate students trained			4	5	9+
Postgraduate students trained				2	nd
Specialist training or 'Train the Trainer', minimum 2 days	4	2+		3	19
Postgraduate scholarships received by staff JAF [2]				nd	1 Ph.D.Japan 2 JAF:M.Econ, +Ph.D.
Study tours JD: John Dillon to Australia				2	
Participants in study tours				16	
Number of farmers and students visiting trial sites		lots		nd	nd

[1] ND. No data available. But there would be more numbers for many of the categories if pursued. As noted above, the numbers are probably all underestimates

[2] John Allwright Fellows to Australia

8.3 Community impacts – now and in 5 years

All four production projects established better relationships with communities, farmers, wholesalers and retail outlets.

8.3.1 Economic impacts

C1 The interventions resulted in a reduction in rejections at the Company packinghouse (from baseline data, about 37 to 73% reduction) which should translate to reduced losses on the part of the shipper/supplier due to increased volume of marketable fruits. These initial results indicate that, in domestic markets at least, there is a measurable response and greater consumer value created from technological innovations in product quality in this value chain that could apply more widely to the papaya industry.

In Australia, the interventions evaluated showed that postharvest losses could be reduced by 25%. This should translate through to economic benefits.

C2 and C4

Gross margins were prepared for jackfruit, durian and mango growers based on their present systems

Then gross margins were prepared for jackfruit, durian and mango growers based on the recommended interventions from these projects.

These showed that if recommended management options were adopted, then GMs would increase by:

Jackfruit 93%

Durian 26%, 47% and 107% with respectively low, medium and high management

Mango 156%

The detailed results are reported in the C5 final report Hall *et al.* (2013) and 6 papers in Oakeshott and Hall (2013).

8.3.2 Social impacts

Social impacts through improved linkages with agribusiness, particularly in component 1 provided a demonstration of the relevance that scientists had not only to smallholders but also to businesses further along the chain. A culture of quality was impressed upon the different stakeholders as a result of an appreciation and better understanding of the importance and effects of proper postharvest handling whilst value chain analysis provides an opportunity for more effective and improved relationships among actors in the value chain (C1). Other projects (C1- C4) will have social benefits as a result of improved livelihoods, more science based farming and willingness to be involved in farming improvements, community awareness of pesticide use and the grouping of growers into clusters. The participatory research approach promoted the collaboration of scientists, extension staff and farmers (C2).

8.3.3 Environmental impacts

Environmental benefits derived from component projects. C1 In Australia, the recognition that Sportak® spray mixes were not delivering the planned active ingredient should mean more effective chemical applications resulting in less fungicide entering the environment. The project also identified a practical way of deactivating the chemical through the use of high pH additives.

C2 The majority of the management strategies tested were cultural or non-chemical and as a result have minimum impact on the environment, reducing contamination of soil and water. Knowledge and targeted application of chemicals also means a lesser impact on waterways and the general environment. The application of manures, vermicompost and mulch improved soil properties. The use of local materials also meant lower carbon costs.

C3 The project identified and developed the effective use of efficacious fungicides and proper application techniques to reduce health and environmental hazards. The introduction of beneficial insects and their conservation through the judicious use of less toxic pesticides will help to reduce environment impacts. This has the benefit to the consumer of reducing residues in papaya fruit and health and safety problems for the farmer. Improvements in nutrition management such as with the timing and rates of application of nitrogen fertiliser, is evidence of good agricultural practice.

C4 This project had a direct bearing on the sustainability of mango production and maintenance of the integrity of the environment through appropriate pesticide management. There will be a reduction of pesticide misuse as a result of the awareness and management of chemical residues. This scenario will result in less pesticide applications and therefore indirectly less residues in the environment and less impact on non-target organisms.

8.4 Communication and dissemination activities

Major across component communications were through:

- The initial planning meeting in Canberra, June 2008, followed by annual planning and review meetings in Canberra from 2009 to 2011.
- The project inception meeting, Davao, Philippines in July 2008 followed by annual planning and review meetings in Davao, Mindanao in July 2009 and in Ormoc, Leyte in August 2010 and in Bohol, August 2011.

- A final technical workshop held in Cebu in 2012.
- Reports were prepared for meetings and papers from the 2012 Cebu workshop were published as a book (Oakeshott and Hall 2013). This included 17 papers from the fruit program
- The PHM's newsletter 'What's Cropping Up' was published regularly and widely distributed among program staff
- The Web2 website was available as a central repository of all program and component project documents. Training was provided to all staff but the use of the site varied, possibly depending on the confidence and internet access of individuals.
- Reports on project outcomes to local grower associations in Australia at field days workshops and association meetings, were a key activity for promoting the benefits of ACIAR support for RD&E as well as being a strategy to achieve adoption of research outcomes
- Three videos were made by Sharron Olivier of Applied Horticulture Research in collaboration with component staff and are on YouTube: Two are largely intended as promotional videos while the third on papaya production was more focussed on training in production techniques.

    - ***Empowering mango growers of Samal Island, Philippines*** http://www.youtube.com/watch?v=G9Whp9KTizM
    - ***Controlling dieback in Jackfruit and Durian: Southern Philippines*** http://www.youtube.com/watch?v=jRmg_d3uxeE&fmt=22
    - ***Growing Papaya: Your guide to getting it right*** http://www.youtube.com/watch?v=0dIP-xmtehM
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For further communication and dissemination activities are detailed in the component reports.

ACIAR provided support to the VSU anniversary "Farmer and Fisherfolk Day' in August each year. In 2010 there were 2500 attendees with the CEO of ACIAR, Dr Nick Austin opening the forum.

9 Conclusions and recommendations

9.1 Conclusions

The program approach to projects was very successful in raising the profile of the collaboration between the Philippines and Australia. The size of the program supported the employment of a Philippines country manager, an initiative that resulted in positive communications and issue management within the program. While linkages and savings as a result of shared resource use were limited, the structure comprising contracts for each component necessitated through separate research providers limited opportunities for these savings. The size of the program with the resultant necessity for many scientists travelling concurrently also created challenges in getting approvals from Australian state governments that perceived this as represented additional risks to their business.

C1. In this project two differing approaches were used. In the Philippines a value chain approach was adopted. This enabled the identification of improvement opportunities to reduce losses, maintain produce quality and deliver greater consumer-defined value. This appeared to have an impact as there was a 37-73% reduction in rejection of papaya fruits delivered from grower-suppliers. A “walking-the-chain” approach of bringing at least one key company representative as part of the training team was most appropriate for a better understanding and appreciation of why improvements are needed. In Australia, a product focused supply chain approach was followed to improve the supply chain. It is believed the poor papaya performance during the wet season has affected the confidence in the product throughout the year and is a contributor to slow expansion of papaya industry growth.

C2. Phytophthora disease had previously been identified as a major limitation to the production of durian in the Philippines, but little management information was available to growers. With jackfruit, a disease survey conducted at the start of this project showed that in some cases as many as 100% of jackfruit trees in some orchards were affected by a decline syndrome progressing from leaf yellowing, leaf drop, girdling stem lesions and root rot, to tree death. *Phytophthora palmivora* was identified as the cause. A high level of disease in jackfruit and durian nurseries, as a result of poor nursery practices, is also likely to have contributed to the spread of the pathogen and the incidence of disease. Through this project, best practice nursery practices (such as raised benches and clean potting medium) have been introduced and a nursery accreditation scheme is mooted.

C3 Red spider mites, choco spot, BCR and *Phytophthora*-related diseases were the production constraints identified by growers and contractors during the baseline survey conducted in Northern and Southern Mindanao. However by the end of the project, the disease BCR had become the greatest concern for growers.

The causal organism of choco spot was identified as *Corynespora cassicola* and BCR was identified as *Erwinia papayae*. Propineb™ was shown to be the most effective fungicide against choco spot out of the seven commercial products evaluated providing growers with a 114% increase in marketable yield.

In Australia, results from recent research have shown the chemical dimethomorph to be as effective as metalaxyl-M as a pre-transplant treatment. In addition to this, the growing and incorporation of the biofumigant crop Canola KBNSR1.3 reduced the severity of *Phytophthora* root rot in papaya seedlings.

Research by USeP and DMPI showed that 300 and 450 kg N/ha gave maximum yield of fresh and processing papaya, respectively. ‘The Merck Reflectoquant® RQflex 10 rapid nutrient (plant sap) test was shown, in both the Philippines and Australia, to be a potential

plant N monitoring tool. The incidence of SER was shown to increase with increasing rates of N.

C4 Two species of thrips were identified, both species being polyphagous with a wide host range of cultivated and wild plant species. Within the mango production areas where the studies were undertaken, natural enemies such as predacious insects were absent, which was attributed to the overuse of broad-spectrum insecticides.

For the control of the mango postharvest diseases, anthracnose and SER, a package of pre-harvest in-field fungicide spray treatments and postharvest treatments was developed and disseminated to grower clusters.

For export and pesticide residue safety, extended withholding periods are required to ensure compliance with MRLs in export destinations such as Japan. For problematic persistent pesticides, it is recommended that the last application occur at 90 days after flower induction to allow degradation of residues to non-detectable levels.

C5 The economic and policy component identified key factors affecting profitability and productivity of mango and papaya farmers, the importance of transport infrastructure and regulations on costs of papaya growers and also the underinvestment in horticulture R&D. Many GMs, benefit: cost analyses and factors affecting profitability were prepared. For example, GMs were expected to increase by 93% for Jackfruit and156% for mango farming if recommended interventions from these projects were adopted and for durian GMs would increase by 26%, 47% and 107% with low, medium and high management interventions respectively. Opportunities are available to utilize the 'WISER' model, developed within C5 to evaluate the potential value of planned new research.

C6 Having a number of components linked together as an overall program and the annual meetings in Australia and the Philippines (the latter including discipline workshops on pathology, entomology, soils and production and supply / value chains in 2010 and 2011) had advantages including sharing of resources and joint experiments, use of resource material provided by other components and contributions to economic analyses. There were also many synergies developed within institutions by having two or more components located at the same location.

There were many recommendations noted in Section 9.2 of each component final report and it would be valuable if some of these recommendations could be further assessed and possibly be progressed. ACIAR has supported four new fruit projects, plus postharvest and value chain projects which will have a mango focus.

Extension processes varied across the components including the extent of involvement of farmers in demonstrations, use of key farmers and farmer field schools. Three videos were prepared on jackfruit, mangoes and papaya. Recognising the importance of extension processes, at the 4th year planning and review meeting in Bohol, 2011, all participants participated in an interactive extension skills development workshop. This workshop was led by the FPM and Landcare staff.

9.2 Recommendations

Recommendation 1: That the recommendations provided in Section 9.2 of each component final report and the external review be considered by ACIAR and PCAARRD, and if supported, they should be implemented.

Recommendation 2: That the program approach should be implemented if relevant in new programs with in-country management and joint annual planning meetings incorporating disciplinary cross linkages

Recommendation 3: That significant effort is devoted to improving capacity of all staff in experimental design, analysis and reporting and communication.

Recommendation 4: That project and program communication is a high priority with plans for communication activities both in country and in Australia. Case-studies' and small videos were a useful way of promoting messages to farmers and other stakeholders and to promote the work of ACIAR

Recommendation 5: Strong linkages between scientific research and extension are important to maximise impact, if linkages between groups such as Landcare are not available consideration of increasing the component project extension effort should be considered.

10 References

10.1 Cited in C6 report

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'Improved domestic profitability and export competitiveness of selected fruit value chains in southern Philippines and Australia'

Component 1:

Campbell, T., and Esguerra, E.B. and others (2014). 'Analysis of the constraints to selected tropical fruit (Papaya) supply chains and implementation of improved quality systems for the southern Philippines and Australia'. Final report to ACIAR, HORT/2007/067-1

Component 2:

Daniel, R., Guest, D. and Borines, L. and others (2012) 'Integrated management of Phytophthora diseases of durian and jackfruit in the southern Philippines. Final report to ACIAR, HORT 2007 /067-2

Component 3:

Vawdrey, L., and Justo, V.P. and others (2013). 'Integrated crop management strategies for the productive, profitable and sustainable production of high quality papaya fruit in the southern Philippines and Australia' Final report to ACIAR, HORT/ 2007/067-3

Component 4:

Newton, I., Eusebio, J.E., and Siano, A.B. and others (2013). 'Improved and sustainable value chains for mango production in the Philippines and Australia' Final report to ACIAR, HORT 2007/ 067-4

Component 5: see above

10.2 List of publications produced by C6 or associated component staff

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Vock, Noel, and Aspera, Ben (2011). Short report on Horticulture extension Q & A session, ACIAR Horticulture programs and Landcare project, Bohol Tropics Resort, July 21, 2011. Web 2